

**ASSESSMENT FOR LEARNING: AN APPROACH TOWARDS
ENHANCING QUALITY IN MATHEMATICS TEACHING AND
LEARNING IN GRADE 6**

by

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DECLARATION

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I declare that: ***Assessment for learning: An approach towards enhancing quality in Mathematics teaching and learning in Grade 6***, is my own work and that all the sources that were used and/or quoted have been indicated and acknowledged by means of a complete list of references.



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SUPERVISOR STATEMENT

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DEDICATION

MAHLAMBI!

Mawuba!

Phaph'lentwala!

Ntombi yakomjuba

OMntungwa Mbulazi abadi' umuntu bemyenga ngendaba

Onyakanyaka ngyasala!

Gasolo!

Mlotshwa!

Nontena!

Ncoweni!

I dedicate this project to my lovely wife *Duduzile*, who was a pillar of strength throughout this journey of discovery. She listened, motivated and persevered through the hard times of this undertaking. I am because she was!

My son *Amile* and twin daughters *Sisanda* and *Sandiswa*, I thank them for putting up with me during the busy hours of endless working on my thesis. Thank you for walking this academic journey with me.

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ASSESSMENT FOR LEARNING: AN APPROACH TOWARDS ENHANCING QUALITY IN MATHEMATICS TEACHING AND LEARNING IN GRADE 6

ABSTRACT

Assessment is considered as integral to the teaching and learning process of Mathematics where various types of assessment are used to develop feedback for several purposes. Research has highlighted the challenge of the dominance of summative assessment in classroom assessment practices. In recent years, world countries have been acknowledging the use of assessment for learning (AfL) to enhance the learning process and thus improve learner performance. This research explored how Mathematics teachers applied AfL in their classrooms. A theoretical framework to support AfL was presented through an overview of constructivism theory, social justice theory, connectivism theory, TPACK theory and Bloom's Revised Taxonomy. A qualitative approach and a case study design were applied involving nine Mathematics teachers from nine primary schools. Data, collected through semi-structured interviews, non-participant observation and document analysis, were thematically analysed. The findings show a positive understanding of what AfL is and its importance to the teaching and learning of Mathematics. However, the application of AfL was found to be inconsistent with its purpose of creating an environment conducive to develop feedback that supports the learning process. Challenges that inhibit its application were found to outweigh successes experienced by teachers. Lack of theoretical understanding of the use of AfL, overcrowding, the language of learning and teaching and lack of resources emerged as some of the major challenges. Teachers pleaded for more in-service training opportunities to assist them with managing assessment for learning practices in Mathematics.

KEY TERMS: assessment, assessment for learning, application, benefits, challenges, constructivist approach, social justice, learner performance, Mathematics, Grade 6

ASSESSERING VIR LEER: 'N BENADERING OM DIE KWALITEIT VAN WISKUNDEONDERRIG EN -LEER IN GRAAD 6 TE VERBETER

OPSOMMING

Assessering is onlosmaaklik met die onderrig en leer van wiskunde verbind. Wiskunde word op verskeie maniere geassesseer sodat terugvoering om allerlei redes verkry word. Volgens navorsing oorheers summatiewe assessering in klaskamers. In die laaste jare word assessering vir leer (AvL) wêreldwyd aangewend om die leerproses en leerders se prestasie te verbeter. In hierdie studie is nagevors hoe wiskundeonderwysers AvL in die klaskamer toepas. 'n Teoretiese raamwerk vir AvL is opgestel uit 'n oorsig van die konstruktivistiese teorie, die sosiale geregtigheidsteorie, die konnektivismeteorie en die TPACK-teorie en Bloom se Hersiene Taksonomie. 'n Kwalitatiewe benadering en 'n gevallestudie-ontwerp is gevolg in die verkenning van nege wiskundeonderwysers by nege primêre skole se assessering. Data is deur halfgestruktureerde onderhoude, waarneming sonder deelname en dokumentontledings versamel en tematies geanaliseer. Daar is bevind dat die onderwysers geweet het wat AvL is en die belang daarvan in die onderrig en leer van wiskunde besef het. Die toepassing het egter nie met die oogmerk van AvL gestrook nie. Die oogmerk is om 'n omgewing tot stand te bring wat assessering bevorder om leer te ondersteun. Die toepassingsprobleme van AvL oorskadu die welslae wat daarmee behaal word. 'n Gebrekkige teoretiese begrip van hoe AvL gebruik word, oorvol klaskamers, die taal van onderrig en leer, en 'n gebrek aan hulpbronne is van die grootste uitdagings. Onderwysers bepleit indiensopleiding sodat hulle die assessering van leerpraktyke in wiskunde beter kan bestuur.

SLEUTELBEGRIPPE: assessering, assessering vir leer, toepassing, voordele, uitdagings, konstruktivistiese benadering, maatskaplike geregtigheid, leerderprestasie, wiskunde, Graad 6

**UKUHLOLWA KOHLELO LOKUFUNDA: INDLELA EQONDE
UKUQINISA IZINGA LOKUFUNDISA NOKUFUNDA
IMETHAMETHIKSI KWIBANGA LESI-6 (ASSESSMENT FOR
LEARNING: AN APPROACH TOWARDS ENHANCING QUALITY IN
MATHEMATICS TEACHING AND LEARNING IN GRADE 6)**

NGAMAFUPHI

Ukuhlola kuthathwa njengento esemqoka ohlelweni lokufundisa nokufunda imethamethiksi lapho izinhlobo ezahlukahlukene zokuhlola zisetshenziswa ukwakha umbiko wakamuva ngesizathu sezinhloso ezimbalwa. Ucwangingo selukhombise inselelo yokuhamba phambili kwenhlobo yokuhlola *i-summative assessment* lapho kuqhutshwa umsebenzi wokuhlola emagunjini okufunda. Eminyakeni esandakwedlula, amazwe omhlaba kade amukela ukusetshenziswa kohlelo lokuhlola ukufunda (AFL) ukuqinisa uhlelo lokufunda kanti lokhu kuthuthukisa izinga lokufunda lomfundi. Lolu cwangingo beluhlola indlela uthisha wesifundo semethamethiksi ebesebenzisa uhlelo lwe-AFL emagunjini abo okufundisa. Isakhiwo sethiyori esiqonde ukuxhasa uhlelo lwe-AFL lwethuliwe ngamafuphi ngomqondo phecelezi we- *constructivism theory, social justice theory, connectivism theory, TPACK theory* kanye ne-*Bloom's Revised Taxonomy*. Indlela yocwangingo eyencike kwingxoxo (*qualitative approach*) kanye nedizayini yocwangingo lotho (*case study design*) zisetshenziswe kuxutshwa phakathi othisha bemethamethiksi abayisishiyagalolunye abavela ezikoleni zamabanga aphantsi. Idatha iqoqwe ngokwenza inhlolovo eyakhiwe kancane, kanti kuye kwabhekiswe imibono yalabo abangadlalindima kanye nokuhlaziywa kombhalo kuye kwahlaziywa ngokuthi kubhekwe indikimba. . Ulwazi olutholwe wucwangingo lukhombisa ukuthi uhlelo lwe-AFL kanye nokubaluleka kwalo kuzwisiseka kahle kakhulu ohlelweni lokufundisa nokufundwa kwemethamethiksi. . Yize kunjalo, ukusetshenziswa kohlelo lwe-AFL kuye kwatholakala ukuthi akuhambisani nenhloso yalo yokwakha isizinda esifanele sokwakha umbiko wakamuva oxhasa uhlelo lokufunda. Izinselelo eziqukethe ukusetshenziswa kwalo lolu hlelo ziye zatholakala ukuthi zedlula impumelelo eyenziwe ngothisha. Ukwentuleka kokuzwisisa umqondo wokusetshenziswa kohlelo lwe-AFL, inani eliphuphumayo labantwana, ulimi lokufunda nokufundisa kanye nokwentuleka

kwemithombo yokufunda kuye kwavela njengezinye izinselelo. Othisha baye bacela ukunikezwa amathuba okuqeqeshwa basebenza ukuze lawo makhono abancede ukuqhuba izinhlelo zokuhlola imisebenzi yokufunda imethamethiksi.

AMAGAMA ASEMQOKA: ukuhlola, ukuhlola uhlelo lokufunda, ukusetshenziswa, izinzuzo, izinselelo, indlela ye-*constructivist approach*, ubulungiswa kubantu, izinga lomsebenzi womfundi, imethamethiksi, Ibanga lesi-6

ACRONYMS

AaL	Assessment as Learning
AATM	Australian Association of Mathematics Teachers
ACARA	Australian Curriculum, Assessment and Reporting Authority
AfL	Assessment for Learning
ANA	Annual National Assessment
AoL	Assessment of Learning
ARG	Assessment Reform Group
BRT	Bloom's Revised Taxonomy
CAPS	Curriculum and Assessment Policy
CK	Content Knowledge
DBE	Department of Basic Education
ELRC	Education Labour Relation Council
ESA	Education Services Australia
GDE	Gauteng Provincial Education Department
GET	General Education and Training Phase
GPLMS	The Gauteng Primary Literacy and Mathematics Strategy
HL	Home Language
IFRC	International Federation of Red Cross
IP	Intermediate Phase
LoLT	Language of Learning and Teaching
MCEETYA	Ministerial Council on Education, Employment, Training and Youth Affairs
MoPSE	Ministry of Primary and Secondary Education (Zimbabwe)
NBC	National Curriculum Board
NCS	National Curriculum Statement
NPA	National Protocol for Assessment
NPPPPR	National Policy Pertaining to the Programme and Promotion Requirements of the National Curriculum Statement Grades R-12
OBE	Outcomes-Based Education
OECD	The Organisation for Economic Co-operation and Development
PCK	Pedagogical Content Knowledge
RNCS	Revised National Curriculum Statement

SACMEQ	Southern African and Eastern Africa Consortium for Monitoring Education Quality
SASA	South African Schools Act
SBA	School-Based Assessment
SCK	Subject Content Knowledge
SMCF	The Singapore Mathematics Curriculum Framework
SMOE	Singapore Ministry of Education
SMT	School Management Team
TCK	Technological Content Knowledge
TK	Technological Knowledge
TIMSS	Trends in International Mathematics and Science Study
TPACK	Technological, Pedagogical and Content Knowledge
TPK	Technological Pedagogical knowledge
UNISA	The University of South Africa
WP6	Whitepaper 6
ZPD	Zone of Proximal Development

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CHAPTER 1

ORIENTATION TO THE STUDY

1.1 INTRODUCTION

Worldwide, different approaches have been suggested to advocate the significance of learner assessment that enhances the quality of classroom instruction (Yelkper, Namale, Esia-Donkoh, & Ofosu-Dwamena, 2012:319). The emergence of assessment for learning (AfL) has reinvented the way educationists view classroom practices, signalling a need for a change to assessment policy. The current trend towards the development of education policy is the acknowledgement that AfL is essential in informing how to improve teaching and learning in Mathematics (Brown, Hui, Yu & Kennedy, 2011:307). The policy reforms embrace the idea that teaching and learning in Mathematics classrooms requires an assessment practice that adequately addresses the holistic academic development from the perspective of a learner (Long & Dunne, 2014:135). According to Black and William (1998a:3), AfL has a major impact on learning and serves as a catalyst in mathematical knowledge development for both the teacher and the learner. Therefore, AfL and classroom instruction should not be seen as separate entities but an integral part of improving teaching and learning (Doğan, 2013:1621). The teacher has at his/her disposal, access to a tool that facilitates teaching and learning assisting in modifying practice and attending to contextual classroom learning realities.

However, research (Carless, 2011:3; Lumadi, 2008:40; Udoba, 2014:13) highlights that though there have been policy reforms for improved assessment of Mathematics, it has not been an easy undertaking. With particular attention to emerging nations, where this research is focused, a variety of variables that obstruct policy alignment in classroom practice have been established. Among these factors, are teachers' understanding of the impact of assessment for Learning in influencing practice (Islam, 2017:15), and willingness of learners to participate in their own learning (Aziz, Quraishi & Kazi, 2018:2012). A further identified factor is the impact of overcrowded classes, lack of technological resources, lack of the knowledge of assessment methods and

lack of assessment pedagogical knowledge each of which influences the effective application of AfL practices in Mathematics (Izci, 2016:2804).

This research undertaking was highly inspired by the need to establish concrete approaches for the use of AfL to enhance teaching and learning in Mathematics classrooms in the South African context. The next section presents the background against which this study was located.

1.2 STUDY BACKGROUND

The major goal of AfL practices in Mathematics classrooms is towards improving teaching and learning. Bloom (1968:10) postulates that AfL is a reliable tool for gathering information about the progress of learners in knowledge development and is effective in improving how teaching and learning unfold in a class. The suggestion made by Bloom is that AfL should be understood as a crucial element since it influences classroom practice, such as teaching and learning while it promotes the gathering as well as the checking of reliable learner progress towards meeting educational goals. In addition to Bloom's views, the Assessment Reform Group (ARG) (2002:5) promulgates the use of AfL to purposively increase learner participation throughout their knowledge acquisition to improve their learning.

South Africa has undergone major changes to its education system since 1995 to redress education accessibility in South Africa. The first change was the introduction of Curriculum 2005 branded as an Outcomes-Based Education (OBE) model. This learner-centred approach did not produce the intended results due to lack of proper teacher training and the availability of teaching and learning resources in schools (Jansen, 1998:326). In 2004, after the recommendations of the Curriculum Review Committee commissioned by the Minister of Education, the curriculum was re-aligned into the Revised National Curriculum Statement (RNCS) which was later renamed the National Curriculum Statement (NCS). The latter was reviewed in 2011 and amendments were made culminating into Curriculum and Assessment Policy Statement (CAPS) which is not a new education curriculum but introduced amendments to the NCS (du Plessis, 2013:55). The changes made in the curriculum and teaching approaches were envisaged at developing new standards to help

improve learner performance to reach global competitiveness (Adu & Ngibe, 2014: 987). Some of these changes, outlined in CAPS, relate to how Mathematics assessment should be approached in Grade 6 (DBE, 2011a:296).

The South African school structure system is made of two Bands, the General Education and Training (Grades R-9) and Further Education and Training (Grades 8-12). Within the Bands are phases, Foundation Phase (FP: Grades R--3), Intermediate Phase (IP: Grades 4-6), Senior Phase (SP: Grades 7-9) and Further Education and Training Phase. In 2011, Grade 6 was identified by the Department of Basic Education (DBE) amongst other two exit grades (3 & 9) to complete the standardised Annual National Assessment (ANA), consisting of end-of-year Provincial and/or National Papers in Mathematics. Although the ANA was introduced to evaluate the system, it soon became a burden to teachers because of its administrative needs. Its intended outcome of assisting teachers to improve on learner performance did not materialise (Kanjee & Sayed, 2013:463). According to Fong and Kaur (2015:20), the ANAs took place at the end of the year and aimed at improving the system and the assessment results did not give major attention to improving practice and promoting effective learning methods.

The DBE defines how Mathematics should be understood in a South African context. The South African curriculum, through the CAPS document, classifies Mathematics as a language that uses characters in aiding the learner to describe numerical, geometrical and graphical relationships (DBE, 2011a:8). To meet Mathematics curricular needs, the CAPS policy document provides specific Mathematics content, and this is viewed as helpful for most South African Mathematics teachers who lack subject confidence as it helps to reduce Mathematics complexity and administrative load in assessment (Grussendorff, 2014:43). The new standards in the Intermediate Phase Mathematics CAPS policy document highlights the progression of Mathematics content between Grades 4 to 6 (DBE, 2011a:13-31). The DBE through the teaching of Mathematics envisages a learner who has a well-developed cognitive and abstract processing that strengthen analytical and critical reasoning, precision and logical skills that has a major influence on decision-making. To achieve the above goals, CAPS stipulates that Mathematics in Grade 6 be given six hours of teaching, learning and assessment each week, and teachers are mandated to contextualise the subject

content and integrate it to real-life experiences (DBE, 2011a:8). Dreyer and Loubser (2014:148) support the preceding statement by showing that the integration of subject content to real-life makes it easier for learners to understand and it thus increases their level of performance in assessment.

The National Protocol for Assessment (NPA) Grade R-12 together with CAPS policy document, gives a structure of how assessment should unfold in Grade 6 Mathematics classrooms. The NPA proposes a frame of how schools should manage assessment and it aims at supporting improved quality in schools (DBE, 2012:1). The policy document prescribes two types of classroom assessments in the assessment of Mathematics in Grade 6. Teachers are expected to use these collaboratively in the process of gathering information regarding learner achievements. The informal assessment referred to as assessment for learning (AfL), is an assessment that should be used by Mathematics teachers to closely monitor current learning competencies to enhance mathematical concept development and performance. The AfL approach to assessment provides a worldwide view on how assessment should be used in drawing teachers' attention toward learners' needs with the intention of working towards improving their academic experiences (Mui So & Lee, 2011:421). In South Africa, according to the DBE (2012:3), teachers should use assessment for learning to develop and provide effective feedback to teachers and learners, prompting them to reconsider how teaching and learning should proceed. It should assist in increasing the interaction between the teacher and a learner to consider the outcome, allowing them the opportunity to discuss the knowledge and skills gaps that exist (DBE, 2011a:294). Teachers are not expected to record the assessment for Learning (AfL) activity outcomes formally, but rather use them to provide valuable feedback on how learners are responding to the Mathematics content taught. The AfL initiatives are meant to promote teachers' planning for effective assessment, teaching and learning as integrated processes, which are learner-centred and interactive (Dixon, Hawe & Parr, 2011:367).

A formal assessment of learning (AoL), on the other hand, consists of formally structured assessments towards assessing learners' overall progress in a subject and grade. Its main aim is, to sum up learners' overall performance, intended for promotional and reporting purposes to stakeholders by indicating the learning

progress (Dixon *et al.*, 2011:369). AoL activities are made up of School-Based Assessment (SBA) and examinations, which are formally marked and recorded for reporting purposes (DBE, 2011a:294). AoL takes various forms such as Mathematics classroom tests, internal and external examinations, projects, assignments, and investigations which are recommended as part of formal assessment. This type of assessment dominates classroom assessment as it is used to formally report to relevant stakeholders whether teachers and learners are meeting education expectations.

Working jointly with CAPS and NPA is The National Policy Pertaining to the Programme and Promotion Requirements of the National Curriculum Statement Grades R - 12 (NPPPPR) which dictates permissible progression procedures between school grades, Foundation Phase (Grades 1-3), Intermediate Phase (Grades 4-6), Senior Phase (Grades 7-9) and Further Education and Training (Grades 10-12). The NPPPPR stipulates that School-Based Assessment (SBA) will contribute 75% and examinations will contribute 25% of the Mathematics final progression mark in Grade 6. To pass Mathematics, this policy dictates that a learner must have obtained 40% and above of the total year final mark. Learners who do not meet the pass requirements within the phases are, however, condoned to the next grade taking into consideration the learner's age as well as the number of years he/she has spent in the phase. In South Africa, each phase is made up of three grades, with the Intermediate Phase comprising Grades 4 to 6. According to the NPPPPR, a learner cannot be kept in a phase for more than four years (DBE, NPPPPR 2011:16). The DBE rationale on progression is its intention to minimise high drop-out rate and maximise retention. The implications of this are that a learner who has failed Grade 4 cannot fail Grades 5 and 6 because he /she would have to spend four years in the phase for failing a grade. The school progression policy creates a problem when condoned learners reach Grade 6 without having necessarily mastered the Mathematics content of the previous grades.

The improvements made in the policy has not culminated in an improved performance of South African learners in Mathematics and has not been satisfactory when compared with other countries globally (Spaull, 2013:27). The Trends in International Mathematics and Science Study (TIMSS) report reveals that South Africa is a lower-

performing country in Mathematics, compared to international participating countries (Alex & Juan, 2017:4). According to this report, only 25% of public no-fee paying (township and rural) schools achieved a minimum competency level. Reports such as TIMSS (1995, 1999 and 2003) and Southern African and Eastern Africa Consortium for Monitoring Education Quality (SACMEQ) (2007) prompted the Gauteng Department of Basic Education (GDBE) to implement the Gauteng Primary Literacy and Mathematics Strategy (GPLMS) to deal with the knowledge deficit in Mathematics.

The introduction of the GPLMS project was aimed at assisting teachers in improving their classroom capabilities in both literacy and Mathematics in underperforming primary schools in Gauteng (GDBE, 2010:12). However, because of its standardised lesson plan approach, fast-paced delivery programme and the quality of coaches, the strategy was rejected (de Clercq, 2014:318). Another conclusion made by Msimango and Luneta (2015:195) about the failure of implementation of GPLMS was that primary school teachers still need intense mathematical training that will enable them to impart skills that will allow learners to solve problems and think critically. The implementation of the strategy, therefore, did not yield the intended results, indicating a need for reformed classroom practice that will improve teaching and learning (Spaull, 2013:7, TIMSS, 2011:314).

Despite the improvement in education policy in South Africa, teachers are giving less attention to AfL to drive practice, even though it is meant to contribute in improving how they teach and how the learning unfolds in Mathematics in Grade 6 (DBE, 2011a:294). The using of assessment results only for schools to account on learner performance impedes the use of diverse assessment approaches such as assessment for learning (AfL). The problem with this undertaking is that AoL activities are summative, that is, used for documenting the final performance of a learner and thus giving a minimal influential impact on the teaching and learning process. Various researchers agree that teachers' ways of teaching, planning of the assessment, lack of subject pedagogical and content knowledge and lack of teaching resources are some of the factors that contribute towards poor learner achievement in Mathematics (Jabbarifar, 2009:4; Suurtamm, C., Quigley, B., & Lazarus, J. 2015:12).

Research has identified obstacles and challenges that negatively influence the implementation of AfL strategies (Careless, 2007:58; Wilson & Scalise, 2006:638) and as a result, AoL is predominantly used by the DBE for school accountability purposes, which downplays AfL implementation (OECD, 2008:3). Teachers perceive AfL as an obstacle in achieving AoL goals because of time constraints associated with teaching and learning (Torrance & Pryor, 2001:620). Bennett (2011:8) extends the argument by citing teachers' lack of knowledge of AfL and its application thereof. Carless (2005:43) notes that teachers believed that to administer and implement AfL strategies in classroom instruction was good in theory, but challenging to implement, especially with all the work demands they need to fulfil. Tadesse and Meaza (2007:65) found that the planning and management of assessment plays an important role in its implementation. However, limited resources and subject advisors' support, lack of training on applying pedagogical knowledge, prompts teachers to resort to applying AoL over AfL (Mugweni, 2012:12). These perceptions and challenges have contributed to the low adoption of AfL, prompting teachers to opt for AoL as the basis through which effective teaching and learning is measured. Teachers continue to use accustomed and entrenched assessment methods even though the advantages of assessment for learning (AfL) utilisation have been acknowledged as beneficial (James & Fleming, 2005:33).

The researcher, who has worked in the teaching of Mathematics at the Intermediate Phase in poorly equipped schools, situated in Alexandra Township in the Johannesburg East District, has identified a gap in the literature regarding AfL Mathematics practices. How teachers plan and apply AfL has not been made a priority, yet the benefits of its implementation have been identified (Wu & Jessop, 2018:4). Wu and Jessop conclude that teachers should find a way of applying AfL strategies because it enables learners to develop long-term learning abilities. Instead, AoL is preferably used by educational stakeholders such as teachers, parents, and the DBE, to gauge how learners are performing. Even though assessment for learning is part of Basic Education's strategy to improve teaching and learning of Mathematics, it is not yet fully highlighted as a valuable tool to enhance classroom instruction in schools, such as township schools.

1.3 PROBLEM STATEMENT

As the value of AfL practices in increasing the standard of Mathematics teaching becomes crucial, teachers in Alexandra Township are required to integrate it into their classroom curriculum. The objective for its use is to help both teacher and learner to develop feedback that can be used in a variety of ways (Ahea & Ahea, 2016:38). According to the Organisation for Economic Co-operation and Development (OECD, 2013:139), AfL should be prioritised and used to measure how learners are progressing which would then influence teacher planning practices. To make an impact on instruction, teachers need information that is reliable about learner progress (OECD, 2013:144). Therefore, without the use of proper AfL practice, Mathematics teachers fail to collect evidence they can use to address areas of improvement in mathematical concept development and skills associated with the concept.

Observation has been made by researchers in the field (Hawe & Dixon, 2017:1190; Oyinloye & Imenda, 2019:7; Umar, 2018:24) that AfL remains an important tool that teachers can utilise. However, Hawe and Dixon (2017:1191) warn that eradicating entrenched assessment practices that have been practised over the years remains a challenge. It is for this reason that OECD (2013:149) raised the alarm that AfL practices are lagging behind their application for successful teaching and learning. The report continues to note that the assessment of learners has remained focused on the reproduction of knowledge rather than measuring complex competencies. Diversifying assessment practices to respond to classroom learning needs has remained elusive in most Mathematics classrooms (OECD, 2013:150).

A concern was raised by Kuze and Shumba (2011:69) that the DBE Policy, South Africa, has not done enough in terms of teacher reskilling on assessment practices. Govender (2019:11) points to teachers' lack of coherent understanding of AfL as an integral part of daily practice in Mathematics teaching and learning. Hence, this study aimed at exploring how AfL was being applied in Mathematics in Grade 6.

1.4 RESEARCH QUESTIONS

Against the outlined context, the primary research question was framed as follows:

How do Mathematics teachers apply assessment for learning in Grade 6?

The sub-questions listed below were posed to further explore the main research:

- How do Grade 6 Mathematics teachers understand AfL?
- How do teachers integrate TPACK in AfL in Mathematics?
- What are the benefits and challenges faced by teachers in applying AfL in Mathematics in Grade 6?
- Which assessment intervention can be adopted to improve the quality of Mathematics teaching and learning in Grade 6?

1.5 RESEARCH AIMS AND OBJECTIVES OF THE STUDY

This study aimed at exploring how Mathematics teachers apply assessment for learning in Grade 6 with the main objective to enhance quality classroom instruction in Mathematics. The researcher believes such information could assist Mathematics teachers with the appropriate course of action towards improving practice. The data gathered could also be used to inform further research needed concerning how teachers apply AfL in Mathematics and contribute to filling the gaps in the research literature.

To achieve the mentioned aim, this study formulated the following specific objectives:

- To explore what Grade 6 Mathematics teachers understand AfL is.
- To explore how teachers, integrate TPACK in AfL in Mathematics.
- To determine the benefits and challenges regarding AfL in Mathematics.
- To recommend AfL intervention to improve the quality of Mathematics teaching and learning in Grade 6.

1.6 SIGNIFICANCE OF THE STUDY

Assessment for learning (AfL) in South African primary schools was introduced as a practice and has been implemented in classrooms for several years. An assumption can be made that this practice has had an impact on learner performance and has contributed to teacher planning and teaching strategies. This research was designed to explore AfL classroom practices of Mathematics teachers in Grade 6 and to show the benefits and challenges of implementing its strategies in the teaching and learning of Grade 6 Mathematics.

The exploration of the implementation of assessment for learning (AfL) is of interest in the South African Education system for several important reasons:

- i) It is a policy requirement that teachers should apply AfL as part of teaching and learning Mathematics.
- ii) Very little research has been done to study AfL effectiveness in addressing its intention in the system.
- iii) The study may provide valuable findings and suggest recommendations to ensure that teachers embrace effective use of AfL in Mathematics to support learners' performance in primary schools.

The findings of this study are of particular significance as it hopes to offer an AfL model to guide the Mathematics teachers regarding its application in their classrooms. To answer the main research and sub-questions and achieve the research aim and its objectives, the next sub-section discusses the research methodology followed.

Theories, which will be fully elaborated upon in Chapter 2, have been identified to frame this research study and the subsequent section provides a brief introduction of these theories.

1.7 THEORETICAL FRAMEWORK

This sub-section presents the researcher's choice of educational theories used as the theoretical framework for this study. The framework gives an outline of the research

by relying on formal theories based on the observed phenomena (Eisenhart, 1991:205). These theories assisted the researcher in making a valuable prognosis of the outcomes, and also in analysing and the interpretation of the results based on the existing literature.

The research study reviewed various theories to establish a theoretical base that support the implementation of assessment for learning. The Bloom's Revised Taxonomy, Connectivism, Technological, Pedagogical, and Content Knowledge (TPACK), Social Justice and Constructivism were theories that researcher believed provided clear principles that guide assessment for learning practices. Each theory addresses an important element that need to be considered in applying assessment for learning to improve teaching and learning of Mathematics.

One cannot study the impact of assessment for learning (AfL) on learner cognitive development without looking at Bloom's Revised Taxonomy based on the work of Anderson and Krathwohl (2001). Bloom's Revised Taxonomy is a useful tool in assisting teachers in developing classroom assessment activities that recognise the cognitive abilities of learners (Kilbane & Milman, 2014:8). The taxonomy highlights important cognitive skills learners must acquire in the learning process, and how teachers can help them improve such skills through learning and assessment. One application of the Revised Bloom's Taxonomy in AfL is that it should assist a teacher to cater to various mathematical capabilities of learners in assessment (Price & Nelson, 2014:24). In AfL, which is a learner-centred assessment approach, this taxonomy provides teaching-learning strategies that are effective for assessment (Jacobs & Gawe, 1996:176).

Connectivism theory in this study is based on the interconnectedness of society as well as the role played by technology to fulfil the advancement of information distribution. Siemens (2004:4) suggests that people and groups can easily use technological tools such as computers and other social networks to acquire and share information as a way of improving their lives. The use of network technologies is also important in stimulating the culture of thinking creatively by offering solutions to problems in ways that are not usually possible. This theory was used in this study because both learners and teachers are part of a society exposed to current

technologies. The researcher views the use of technologies as a strategy to assist classroom instruction to improve the implementation of AfL in Mathematics knowledge development.

Pedagogical Content Knowledge (PCK) was originally coined by Shulman in 1987 and was defined in terms of interrelated activities embodied in the teacher's knowledge of the curricular goals. Koehler and Mishra in 2006 later extended PCK with the inclusion digital technologies to form TPCK (Ward & Benson, 2010:483). According to Koehler and Mishra (2006:129) and Roblyer and Doering, (2014:8), the Technological Pedagogical and Content Knowledge (TPACK) framework emphasises teachers' knowledge on the incorporation of technology in classroom instruction to achieve and/or improve academic learning goals. For this study, TPACK is broken down into six components. Technological Content Knowledge (TCK) focuses on how teachers could benefit from taking advantage of available technology in AfL in Mathematics. Subject Content Knowledge (SCK) is identified as the teacher's knowledge of Mathematics and how this knowledge is used for AfL in Mathematics. Pedagogical Content Knowledge (PCK) is focused on teacher knowledge of AfL methods and types used in the assessment of Mathematics. The Technological Pedagogical Knowledge (TPK) focuses on teachers' knowledge in using available technology to enhance and improve assessment to drive the teaching process (Ward & Benson, 2010:484). Technological Content Knowledge (TCK) discusses how technology can be used in the assessment to influence how Mathematics content is learnt and finally, the Pedagogical Content Knowledge (PCK) looks at how teachers relate subject content and teaching strategies (Koehler & Mishra, 2006:1048).

The social justice theory applied to this study is based on John Rawls' view of justice. According to Rawls (1971:17), social institutions like schools, are established based on the understanding that justice will be their guiding principle to bring equality between learners. Social justice in this study is used in contexts where people recognise social justice to be about fairness (RSA, 1994), implying that the ability of a teacher is in finding the optimum balanced social arrangements to improve equality in classroom instruction through assessment of learners. The implication of social justice in AfL is that individual learners are provided with fair opportunities in developing their

capabilities in an environment that recognises their academic and learning needs (Emmanuel, 2014:8).

Another theory underpinning this study is constructivism, as the researcher believes the theory draws a teacher's attention to the principal elements influencing the assessment process in schools. The learning theory of constructivism in this study was applied based on the work of Jean Piaget (1964) as well as that of Lev Vygotsky (1926). Constructivism was chosen based on the notion that it is viewed as a theory of learning that looks at how to create conducive classroom environments and learning activities that meet learners' educational goals (Yilmaz, 2008:165). In a constructivist point of view, the teacher's role in assessment for learning is to facilitate as well as assist a learner towards a mathematical conclusion based on their understanding, rather than a teacher dictating how things need to be done (Major, 2012:140). Bada (2015:66) explains that constructivism acknowledges that knowledge can only exist within the learner's mind and that it does not have to match any real-world reality.

1.8 RESEARCH DESIGN AND METHODS

This section offers a brief outline of the paradigm and approach that were followed in the study. It provides a brief description of the research paradigm, research approach, research type and research methods which are described more fully in Chapter 4.

1.8.1 Research Paradigm

A research paradigm describes a system that influences the action for research (Kivunja & Kuyini, 2017:26) thus providing a philosophical framework to establish research traditions in a particular discipline (Collis & Hussey, 2009:55). Bakkabulindi (2017:21) proposes that a paradigm represents a side on which a researcher builds his/her philosophical assumptions and worldview. Five research paradigms have been widely discussed, namely, positivism, interpretivism, critical inquiry, feminism, and postmodernism and are considered the most commonly used paradigms in research (Cohen, Manion & Morrison, 2018:21).

A positivist paradigm views a phenomenon under study through the scientific method of investigation (Kivunja & Kuyini, 2017:30). Researchers using this paradigm aim to provide scientific explanations for a phenomenon to make general conclusions through observation and measurement (Bakkabulindi, 2017: 21). According to Kivunja and Kuyini (2017:31), positivist results of one study in context should apply to other situations. The critical research paradigm, on the other hand, situates its research on social practice issues, with its findings being used to address social ills (Kivunja & Kuyini, 2017:35). Mack (2010:9) argues that the results of critical paradigm research are used to influence the change in societal behaviour. Feminist paradigm approaches study how gender shapes human consciousness (Creswell, 2013:29). Creswell further points out that under feminism, gender is seen as a principle that is used to organise and shape social structure. In other words, feminist studies are aimed at exposing patriarchal dominance to balance gender distortions. The postmodernist paradigm is concerned with the deconstruction of social practices exposing how the value systems and social interests are formed (Gray, 2014:29). This view is supported by Creswell (2013:27) who alluded that this paradigm aims to demystify the conditions of the world as we experience it through the justifiable perspectives of class, gender, race and diverse groups.

The researcher, however, adopted the interpretivist paradigm (*cf.* 4.4) since this study paid particular attention to exploring current views of Mathematics teachers related to the application of AfL in Grade 6 primary schools (McMillan & Schumacher, 2010:5-6). The study was undertaken in an effort for teachers to attach meaning to their actions and in the process refine individual use of their practices and experiences (Creswell, 2007:20). In so doing, they are in a continuous process that will assist them in creating and redefining their daily actions (Babbie & Mouton, 2008:23). This research focused on exploring the complexity surrounding assessment for learning in Mathematics in primary schools through understanding and interpreting teacher practices and experiences (Rubin & Babbie, 2011:15). These paradigms are discussed in more detail in Chapter 4 section 4.

1.8.2 Research Approach

Any research must have an approach, in which a plan is formulated for the researcher to utilise in the process of data collection and its analysis to answer the research questions (Ragin & Amoroso, 2011:28). Quantitative and qualitative research have been identified as the two main divisions of research designs (Scotland, 2012:9), but increasingly researchers are tending to use a mixed-method research approach (McMillan & Schumacher, 2010:267). A qualitative research methodology approach was applicable to this study primarily as it centred on exploring the views of the participant teachers and the observation of their first-hand experiences on AfL in their context (Leedy & Ormrod, 2006:144). The method offered an effective way of gaining a holistic view of teacher practices through semi-structured interviews (*cf.* 4.7.5.1), non-participant observation (*cf.* 4.7.5.2) and analysis of documents (*cf.* 4.7.5.3) related to the application of AfL in the teaching and learning of Mathematics (Denscombe, 2010:304).

1.8.3 Research Type

A research design describes the world views and techniques that are implemented in the study allowing the researcher to answer the research question (Oun & Bach, 2014:253). Khaldi (2017:16) approaches design as a description of several aspects of a study that include data collection procedures, participants' selection and data analysis methods. In other words, the research design assists the researcher in solving the problem and answer questions posed. A case study was deemed appropriate for this study because it intended to explore and develop an extensive understanding of teacher practices (Creswell, 2013:97), within a real-life setting through using multiple data sources (van Wyk & Taole, 2017:171).

Intrinsic case studies, instrumental case studies and multiple/collective case studies have been identified as various types of case studies (Cohen *et al.*, 2018:378; Creswell, 2013:99; Gray, 2018:270). The case under study was a bounded system of Grade 6 Mathematics teachers in primary schools in Alexandra Township, South Africa (Yazan, 2015:139). The researcher chose an instrumental case study design to contextualise a social context and the understanding of the social world of the

participants under study (Dawidowicz, 2011:8) who were currently teaching Grade 6 Mathematics. The data collected through semi-structured interviews, document analysis and observation strategies were detailed and in the form of words directly linked to the research topic. The fieldwork conducted by the researcher in their workplaces following a schedule discussed and agreed upon with the participants for this study was done within the timeframes specified by DBE.

1.9 RESEARCH METHODS

In this section, a discussion on the methods used to choose the study participants, research procedures and methods used are presented.

1.9.1 Study Population

Lumadi (2017:224), describes a population as the total number of people from which the sample for the scientific query is selected. As the phenomenon to be investigated was identified in schools, the study, therefore, targeted Mathematics teachers teaching Grade 6. In this case, the population was represented by the total number of participants teaching Mathematics in Grade 6 in primary schools in Alexandra Township, South Africa. The target population identified met the specified criterion for the research investigation (Alvi, 2016:11).

1.9.2 Sampling Procedures

Sampling is a process used to identify suitable participants that will best answer the research questions from a population (Bryman & Bell, 2007:182). In research, two distinct sampling techniques have been identified namely: the probability sampling and non-probability sampling (Showkat & Parveen, 2017:2). According to Showkat and Parveen, probability sampling is when participants in a population are given an equal chance of being chosen. Its sampling methods include simple random sampling, stratified random sampling, systematic random sampling, cluster sampling and multistage systematic sampling. On the other hand, non-probability sampling uses the non-randomised method to identify participants, allowing the researcher to have easy

access to the study participants. The non-probability sampling is categorised into purposive sampling, convenience sampling, snowball sampling, and quota sampling.

This study used a convenience-purposive sampling technique and nine Grade 6 Mathematics teachers were conveniently and purposively sampled from primary schools in Alexandra Township, South Africa. The researcher used the proximity rule as well as accessibility to sample the participants for this study (Rahi, 2017:3). Participants were sampled based on the following qualities: participants should be currently teaching Mathematics in Grade 6 and should have at least a Primary Teacher's Diploma as a minimum qualification (Alvi, 2016:11; Etikan, Musa & Alkassim, 2016:2). Age and gender of the participants were not part of the selection criteria.

The researcher believes that the selected participants were rich in knowledge based on their experience in teaching Grade 6 and would be able to provide valuable, relevant and adequate information regarding the application of assessment for learning in Mathematics teaching. Sampling procedures are discussed in detail in Chapter 4 section 4.6.

1.9.3 Data Collection Procedures

Procedures for collecting data include all important interdependent activities directed at collecting suitable information to respond to the research questions (Creswell, 2007:41). In this research, data were collected from participants using semi-structured interviews, non-participatory observation and document analysis. Using the above-mentioned strategies of collecting data assisted the researcher in triangulating research results and supported the interpretation of data (Lazar, Feng & Hochheiser, 2010:295; Yin, 2016:337). Data were collected from ten primary school teachers teaching in Alexandra Township situated in the Johannesburg East District. The data collection continued until the researcher was satisfied that saturation had been reached. This saturation occurred when the new data that was emerging repeated what had already been conveyed in the previously collected data of the same sample (Saunders *et al.*, 2018:1897).

1.9.3.1 Semi-structured interviews

Interviews are a powerful tool in extracting narrative data that permits the researcher to investigate people's perspectives intensely. Through interviews, the researcher was able to gather the understanding of the lifeworld and experiences of the participants concerning the meanings attached to AfL (Tuckman, 2001:216). The interviews were used to access deeper understanding and variety of information on approaches teachers use when applying assessment for learning in Mathematics in their natural environment and/or context.

The researcher used self-designed semi-structured interviews schedules to conduct the interviews, as discussed in Chapter 4 (*cf.* 4.5.5). The qualitative interviews in this study aimed at gaining insights into teachers' experiences and get a deeper understanding of their views on AfL practices (Gill, Stewart, Treasure & Chadwick, 2008:292). Face-to-face interviews were conducted by the researcher and audio-recorded to ensure that accurate information was captured. All interview sessions were carried out with permission from participants who agreed to be audio-taped. Interviews allowed the researcher to obtain a deep understanding of participants' reactions and attitudes about assessment for learning in Mathematics (McMillan & Schumacher, 2010:360; Schischka, 2013:540).

1.9.3.2 Non-participatory observation

Non-participatory observation is one of the truthful and reliable tools used in research for data collection when using qualitative research (Creswell, 2013:166). Through observation, the researcher can socially interact with participants to access data from an objective view and to identify those practices the respondents were unaware of in their day-to-day experiences (Morgan *et al.*, 2017:1061).

For this study, the non-participatory observation was deemed fit to collect the required data. The researcher did not have any relationship with the observed group (Morgan, *et al.*, 2017:1061) but remained a non-member, giving him valuable time to take field notes (Creswell, 2013:167). The non-participatory observation allowed the researcher to observe teachers in their classrooms interacting and assessing learners. The

observation also assisted the researcher in identifying dynamics in the application of assessment for learning and contextual factors that limit its effectiveness. All participants were observed using an observation guideline with questions to determine how they applied assessment for learning in Mathematics when informally assessing learners.

1.9.3.3 Document analysis

Document analysis is a systematic approach towards examining existing documents used by participants in the application of AfL in Mathematics (Bowen, 2009:27-40; Lavery, 2016:13). Several important documents such as Mathematics CAPS documents, the school-based assessment plan, Mathematics lesson plans and AfL activities, were analysed to determine how these documents are used by teachers to plan and administer further assessment for learning activities. The researcher viewed the selected documents as capable of answering the research questions. These are discussed in detail in Chapter 4 section 4.7.

1.9.4 Data Analysis

For this research study, qualitative content analysis was relevant in analysing data collected. It included the procedures that were applied to message mediums such as text and the spoken word to identify what was being communicated by teachers (Elo & Kyngäs, 2008:109; Newby, 2010:484). The researcher used data analysis to delineate a phenomenon under study in detail looking at what participants report on the practices regarding AfL (Flick, 2013:5-6). The content analysis, based on the definitions, was used to bring together similar data within the scope of concepts and themes and to interpret these data by arranging them in a comprehensible order (Feza, 2017:464).

In this research, data were obtained through different instruments namely: semi-structured interviews, observations and specific document analysis. Thereafter, identified practices and beliefs on teachers' views of AfL Mathematics were processed, coded, and categorised into themes. Content analysis can assist researchers in

creating a structure used for coding based on how the researcher interprets and identifies meanings in a message being communicated (Newby, 2010:485).

1.10 ASSUMPTIONS ABOUT THE STUDY

The researcher's assumptions informed the convenient-purposive sampling of Mathematics teachers and these following assumptions informed the study:

- i) Teaching is a complex profession and teachers have all the necessary skills and resources to implement assessment for learning in Mathematics.
- ii) There are challenges experienced by Mathematics teachers in the implementation of AfL, and these challenges influence the effectiveness of its use.
- iii) Teachers have the necessary mathematical pedagogical and content knowledge of AfL Mathematics

1.11 TRUSTWORTHINESS

Drawing meaningful conclusions about a phenomenon with the use of the research instrument is mostly influenced by the issues of validity and reliability (Leedy & Ormrod, 2005:882). To address possible threats regarding validity as well as reliability, the researcher sampled relevant participants who are rich with knowledge on the assessment of learning Mathematics in primary schools (Leedy & Ormrod, 2005:880-894). The researcher believes that if a similar study, with the same research methods and instruments, is used to conduct the same study in a similar context, comparable results would be yielded (Joppe, 2000).

Given, Winkler and Willson (2014:9) and De Vos, Strydom, Fouché and Delpont (2011:419) have identified credibility, transferability, dependability and conformability as important issues that underpin trustworthiness (*cf.* 4.9). The researcher initially visited all primary schools in Alexandra Township to establish a working agreement to safeguard trustworthiness. Thereafter, a teacher that met the set research criteria to provide data that responds to research questions, were selected as participants.

1.12 ETHICAL MEASURES

The researcher considered detailed ethical procedures when conducting this study. An application for ethical clearance was made to The University of South Africa's (UNISA) Ethics Committee and permission was requested from the Gauteng Department of Education to collect data through participant interviews and observation as well as document analysis from participants teaching in selected primary schools in Alexandra Township. Obtaining ethical clearance was a way of eliminating problems associated with morality forming the basis of the research process (Babbie, 2001:118). The researcher took into cognisance the protection of all the participants, in a manner that did not cause any harm during the investigation. Being aware of what is a prerequisite in carrying out this undertaking and the involvement of Mathematics teachers in Grade 6, the researcher was compelled to have the integrity as well as the security of all the participants protected. The consent from all the participants was requested and the participants were assured of anonymity and confidentiality during and after the research was concluded. Because the classroom observation included the presence of learners during teaching and learning, the researcher requested the consent from learners' parents/guardians as well.

1.13 CLARIFICATION OF TERMS IN THE CONTEXT OF THIS STUDY

Definitions of terms in this study were necessary for giving a background of what is relevant to research. For this research study, the key terms are discussed in the following sections.

1.13.1 Assessment

Assessment should be understood as the process of documenting learners' acquisition and proficiency in knowledge, skills and competencies to make informed decisions about the next steps in an educational process. This process implies the consideration of learners' aptitudes, attitudes, learning styles, progressions and outcomes (Clarke, 2011:4). The assessment gives information that assists in decision-making as well as supporting and enhancing learning, determining achievement, and providing accountability (Dreyer, 2014:7). In this study, assessment is seen as a tool

used by the teacher in measuring the extent to which the teaching methods are effective.

1.13.2 Assessment for Learning (AfL)

Assessment for learning is an activity used during classroom instruction that provides feedback for the adjustment of teaching and learning to improve learner achievement related to instructional objectives (Kilbane & Milman, 2014:72). Throughout this study, AfL is used to depict a tool to provide the teacher with valuable feedback concerning learners' abilities towards fulfilling desired learning intentions.

1.13.3 Assessment of Learning (AoL)

Assessment of learning is an assessment that takes place at the end of the learning cycle, and its purpose is to document learner performance after teaching is completed (McMillan, 1997:106). The ultimate goal of teaching and learning is achieving the stipulated level outcome. While a variety of explications of the term assessment of learning have been suggested, this study will use the definition as suggested by Taras (2005:471), who sees it as a judgement which sums up all the evidence to finality.

1.13.4 Assessment Methods

Assessment methods are methods used in teaching and learning practices to assist a learner in making a judgement of their own learning through assessment processes. The methods are learner-centred, providing opportunities to learners to reflect on both their learning abilities and processes (Ndoye, 2017:255). The DBE has identified self-assessment, peer assessment, group assessment, observation and oral questioning and answering as important methods to aid learning (DBE, 2011a: 294).

1.13.5 Learner Performance

Learner performance describes the observable or measurable behaviour of a learner in a particular situation such as an experimental situation (Wesslen & Maria, 2005:27). Performance measures the aspect of learner behaviour that can be observed at a

specific period towards meeting academic goals (Mason, 2017:282). In this study, learner performance refers to the ability of a learner in participating in classroom instruction and engagement with Mathematics materials such as informal and formal assessments towards meeting the policy-stipulated learning goals.

1.13.6 Curriculum and Assessment Policy Statement (CAPS)

The Curriculum and Assessment Policy Statement is a policy document, which prescribes what is to be taught and how it is taught in a specific grade in a schooling system (Maskew Miller Longman, 2012:1). CAPS stipulates how the National Curriculum Statement (R-12) is to be implemented and replaces National Curriculum Statements Grades R-9 and National Curriculum Statements Grades 10-12 (DBE, 2011a:2). The CAPS document policy provides the subjects to be taught in each phase and indicates instructional time allocation for each subject. Found in the CAPS document of each subject is the annual teaching plan (ATP), providing concepts that need to be covered in each term indicating the building up of the concepts between grades in a phase (DBE, 2011a: 8).

1.13.7 Department of Basic Education (DBE)

The Department of Basic Education (DBE) is a ministry that manages schools from Grades R to 12, including adult literacy programmes. Its mandate is to develop policies that maintain and support the South African school education system for the 21st century (Republic of South Africa, 2017: 134).

1.14 DIVISION OF CHAPTERS

The study was structured in chapters under general headings.

Chapter 1 presented an outline of the orientation and study background. The theories that were deemed significant were presented and the problem statement was articulated. Chapter 1 provided the main research question, the study aims, and objectives as well as research purpose. The research design and methods that are used in the empirical part of the study were briefly outlined in this chapter. Lastly, the

terms relevant to the study were defined followed by a summary to conclude the chapter.

Chapter 2 explains the important educational theories that support the use of AfL in improving classroom instruction. The chapter unpacks and discusses constructivism, social justice, connectivism and Technological and Pedagogical Content Knowledge and their importance in AfL, highlighting the Mathematics teacher's role in the application of AfL practices. The chapter also presents the relationship between Bloom's Revised Taxonomy and the Cognitive Levels, as presented in the Intermediate Phase CAPS document.

Chapter 3 contains a review of literature that relates to assessment in schools through discussing different types of classroom assessment and their importance in teaching and learning. This review is followed by unpacking teacher experiences that hamper the implementation of AfL practices in Mathematics. Global views relating to AfL is discussed through different countries of the world. The chapter also discusses important policies that highlight the implementation of AfL in the South African context. The chapter concludes with a discussion of how national education policies affect the implementation of AfL in classroom practices.

Chapter 4 explains the research methodology used in the study. The discussion in this chapter covered the different research paradigms, research designs and methods in research undertakings. This is followed by a discussion on the research methods highlighting the sampling procures, data collection strategies, and data analysis and reasons for the particular choice. The chapter concludes by explaining the ethical approach to ensuring the study's trustworthiness.

Chapter 5 deals with the presentation, interpretation, as well as analysis of data as guided by qualitative data analysis procedures. The chapter discusses the findings emerging from data collection strategies, that is, semi-structured interviews, non-participatory observation and document analyses.

Chapter 6 is the concluding chapter of the study, containing the synopsis of each chapter, the summary of the main research findings, recommendations to different

stakeholders regarding the AfL in Mathematics and limitations of the study. The chapter presents a suggested model for teacher application of AfL in Mathematics. The chapter finally offers suggestions for further research that could be undertaken relating to AfL practices and application in Mathematics.

1.15 CHAPTER SUMMARY

As the primary intention of this research study was to explore the teacher's views regarding assessment for learning Mathematics in Grade 6 at selected primary schools, this chapter introduced the study and gave a concise background. This background and overview of the study justified why AfL is essential in the acquiring of Mathematics knowledge and skills to improve learner performance. Chapter 1 also provided an understanding of the problem to be investigated, identified the study aims and its objectives. It also outlined the significance of the study focusing briefly on the research methodology paying particular attention to the relevant research paradigm, the research design, the identified population and its sample, as well as data collection and analysis strategies. Ethical issues that guide the research undertakings were also highlighted. Lastly, the chapter gave a brief description of the key terms related to this study, the organisation of the study and a conclusion. The next chapter is the theoretical framework, it discusses different theories that support the application of AfL in the assessment of Mathematics in Grade 6.

CHAPTER 2

THEORETICAL FRAMEWORK

2.1 INTRODUCTION

The previous chapter provided an overview of what the researcher intended to explore with regards to AfL application in Mathematics in Grade 6 primary schools. The purpose of Chapter 2 is to provide an outline of various educational theories that underpinned this study and the classroom application of assessment for learning (AfL) in Mathematics. The focus is placed on the significance of constructivism, social justice, connectivism, the Technological Pedagogical Content Knowledge conceptual framework and Bloom's Revised Taxonomy to the study. The theories together are discussed to address the research questions outlined in Chapter 1.

The discussion of each theory based on the literature is followed by the implication it has on AfL application in a Mathematics classroom. This discussion is important as it highlights the Mathematics teacher's role in developing assessment activities based on justified philosophical practices. This chapter begins with a brief discussion of the concept of a theoretical framework and is followed by the theory that underpinned this study.

2.2 DEFINING A THEORETICAL FRAMEWORK

A theoretical framework is a researcher's guide of research using existing theories with which the researcher builds a research inquiry (Adom, Hussein & Joe, 2018:438) and lays the foundation on which the study is developed. Casanave and Yongyan (2015:107) suggest that a theoretical framework justifies why and how the study is undertaken and assists the reader in understanding that the researcher has used existing philosophical knowledge in established theories to determine the variables being measured. Casanave and Yongyan (2015) elaborate that the use of theory in a study affords the researcher to support as well as interpret their research findings, connecting their work to larger ideas outside the constraints of the study.

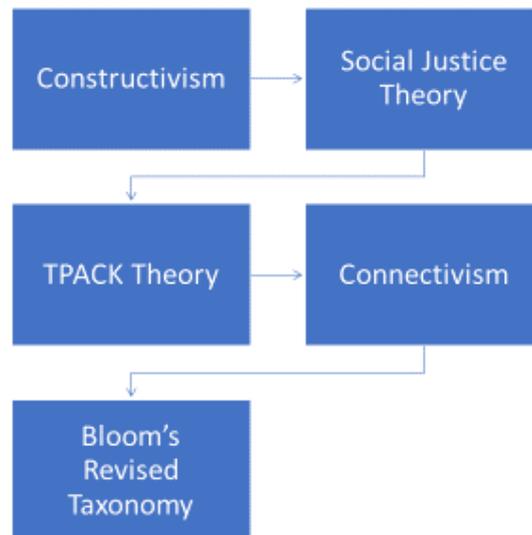


Figure 2.1: An overview of theories that support assessment for learning

In this study, therefore, the use of concepts within the research topic was informed by established theories. As this study was positioned within the context of classroom practice, it was important to understand the view of theories which have shaped the concept of classroom assessment. Figure 3.1 below represents the theories that the researcher used in describing the application of AfL in the teaching and learning of Mathematics in Grade 6.

Each of these theories is presented and discussed in the subsequent sections beginning with the constructivist theory.

2.3 THE CONSTRUCTIVIST THEORY

Constructivism is a theory that explicates the process of how learning takes place (Fosnot, 2005:29) and proposes that learners should be allowed to actively participate to construct and attach individual experiences to the content matter (Horn, 2009:515). These views are supported by Merriam and Caffarella (1999:260) who state that in a constructivist stance, learning is about constructing meaning to make sense of experience. Central to the principles of constructivism is the view that learners develop knowledge by being active, wherein they are given space to apply their everyday knowledge as well as past experiences to find meaning for their current experiences

in a classroom (Vygotsky, 1926:47). Therefore, it holds that given enabling social and physical environments, learners are encouraged to be involved in classroom instruction with the idea of preventing direct teaching as it does not improve understanding.

Bhowmik (2015:10) posits that in a constructivist theory principle, classroom practices should encourage learners to confront, construct and develop new knowledge. Effective constructivist environments combine the cognitive and social constructivist approaches to aid the learning process (Powel & Kalina, 2009:241). Mvududu and Thiel-Burgess (2012:111) note that the constructivist approach to teaching is effective in improving assessment results, increasing learner participation and retention of learnt material. Learners internalise their learning (Black & Wiliam, 2018:559) and are empowered to construct their own understanding, with their processing skill being guided and facilitated by the teacher (Bada, 2015:67). The suggestion here is that a constructivist teacher uses AfL practices to probe for learners' Mathematics content knowledge allowing the learner to put what they know into practice. AfL activity should be an assessment task whose purpose is to promote or improve the learning process (Higgins, 2014:2). Therefore, according to the constructivist approach, the teacher has a role to play, that is, to create an environment that supports and develops cooperative problem-solving abilities.

In this study, the constructivist theory was used to help the researcher understand how teachers approach the application of AfL in Grade 6 Mathematics. The DBE recommends that teachers use a learner-centred approach towards teaching, learning and learner assessment in all South African Schools (De Jager, 2013:81). This suggests that teachers should adopt a constructivist approach when designing assessment for learning activities in Mathematics as it has been found to contribute to a learner-centred approach towards assessment of Mathematics to meet and enhance learners' competencies in Mathematics by shifting emphasis from teaching to learning (Alam, 2016:52).

According to Duncan and Buskirk-Cohen (2011:247), learners are likely to dedicate more time to learning and those assessment activities that make sense to them and relate to their environment. A constructivist approach to assessment, therefore, shifts

the role of assessment from evaluating learners' comprehension of factual knowledge to a process that fosters the learning process (Webber & Tschepikow, 2013:188). Assessment for learning, therefore, as a learner-centred approach, can promote increased expectations in the learning environment, taking into account diverse learning styles and promoting individual learner's educational experience.

According to Aljohani (2017:99), two schools of constructivism have over the years emerged, namely Individual Cognitive Constructivism and Social Constructivism and each of these theories are presented and discussed below.

2.3.1 Piaget's Individual Cognitive Constructivism

Jean Piaget proposes that constructivism should be seen as a learning theory that defines a process by which learners come to know, that is, the ability to create and apply internalised knowledge (Bada, 2015:66; Bhattacharjee, 2015:66). Piaget referred to this knowledge formation as a cognitive development process which symbolises the development of the thought process (Ahmad, Hussain Ch, Batool, Sittar & Malik, 2016:72). Piaget also identified four stages of development that learners pass through sequentially to reach cognitive maturity. As the learners grow and develop, they pass through the sensory-motor, the preoperational, the concrete operations and the formal operational stages (Simatwa, 2010:367). Piaget's general theory of knowledge focused on how learners, as active participants in learning, interact with the environment and represent their world through the processes of assimilation and accommodation (Lutz & Huitt, 2004:2). During assimilation, the learner fits the new information into existing knowledge to extend their knowledge, whilst, accommodation symbolises the ability of the learner to adjust his/her cognitive structures to fit new information (Baken, 2014:3-4).

The researcher employed Piaget's concrete operations stage to examine learners' cognitive level of understanding of mathematical concepts and application of logical thinking. The South African Schools Act (SASA) (RSA, 1996) puts Grade 6 learners at the concrete operations stage, which are the ages seven to eleven. Learners in this stage according to Piaget, begin to transform their thinking abilities through conservation, classification and ranking of material being learnt (Bakir, & Öztekin-

Biçer, 2015:150). The curriculum through assessment and other classroom practices, therefore, reflects such developmental changes and helps the learner acquire fundamental skills in calculating arithmetic problems (Simatwa, 2010:368). Burns and Silbey (2000:55) concur by articulating that to foster the cognitive development at this stage, Mathematics teachers should provide hands-on activities that allow multiple processes of representing a mathematical solution.

Drijvers (2017:34) proposes that classroom practices should help learners raise questions about what they are engaged in rather than answering questions and finding the correct solution to the Mathematics problem. The engagement process encourages learners to take the initiative and use their experiences that show their initial understanding of mathematical concepts. Therefore, learners should be given enough time to think and should be allowed to explain their reasoning, affording them a chance to share their development in the understanding of mathematical concepts being taught. Both the Mathematics teacher and learner are then able to pay close attention to how the learner solves problems encouraging the dialogue between them. Because the CAPS document encourages the progression that is, the building up of mathematical concepts and terms between grades (DBE, 2011a:12), AfL activities in Grade 6 should, therefore, assist the learner in linking their experiences, allowing them to show their understanding and identifying their misconceptions (Piaget, 1964a:103).

2.3.2 Vygotsky's Social Constructivism

Social constructivism theory emphasizes social interaction as an essential aspect in teaching and learning (Vygotsky, 1978: 57). According to Vygotsky (1930:9), learners master their environment prior understanding their own behaviour. The social constructivist theory is built on Piaget's notion of a learner's ability to develop understanding jointly in a coordinated social level (Amineh & Asl, 2015:13). It explains the importance of quality interaction between the teacher and the learner, emphasising the necessity and the importance of social interaction over the teacher's intervention in learning (Verenikina, 2010:27). Social interaction is particularly beneficial because it allows the learners to communicate their understanding based on their experiences with the teacher and other learners in class (Amineh & Asl, 2015:11). The teacher is

thus able to identify the knowledge gaps and use such feedback to adjust the planning and the teaching strategies to meet learner academic needs.

According to Topçiu and Myftiu (2015:172), social constructivism supports the educational idea that the social factor can affect, facilitate and help to accelerate the socio-cognitive development of a learner. Seen from this point of view, social interaction should promote deep communication among teachers and learners and between learners themselves as social beings to accelerate the improvement in Mathematics learning. Under social constructivism's view of learning, cognitive development begins with social engagement moving towards individual learner independence (Amineh & Asli, 2015:15). Therefore, through assessment of learning activities in Mathematics, teachers should facilitate the knowledge building process by creating an environment in which a learner is guided to arrive at a mathematical solution based on their own understanding. Dialogue ensures that the learner articulates how they arrived at the final answer, and this enables the teacher to make an adjustment in knowledge gaps identified.

According to Vygotsky (1978:24), cognitive development comes with the blending of physical development and cultural heritage which exists amongst learners and the physical world. This suggests that learners bring knowledge built through their context to the class and this knowledge should be taken into consideration in classroom instruction. This view is supported by Lutz and Huitt (2004:5) who state that interactions that are activated through social engagements play a significant role in learner's cognitive development, which relates to what is being learnt, and when and how learning occurs in the classroom. Cognitive development advocates what learners can do at different stages of their learning, suggesting that teachers should consider the implication of the learner cognitive development stage when developing an assessment for learning activities.

The term Zone of Proximal Development (ZPD) is one of the well-known ideas that can be linked to Vygotsky's social constructivism approach to assessment. The ZPD should be understood as highlighting the difference that exists between those activities that a learner can perform without external help and what he/she can achieve with help (Verenikina, 2010:18; Vygotsky, 1978:86). In other words, the ZPD advocates the creation of space that allows the sharing of knowledge amongst the learners by

encouraging increased participation in the classroom. The responsibility of the teacher is therefore to create an environment in which individual views are accepted and debated without the person being judged. The definition proposes the view of a learner as an independent thinker and capable of finding solutions to assessment activities (Harland, 2003:265). Besides, given guidance by the teacher or by the more capable peers through social interaction, the learner can build on current competencies to reach their potential.

The conception by Vygotsky (1978) is that learners' cognitive and problem solving abilities fall into three categories. The abilities are categorised as those that the learner can perform independently, those that the learner is assisted to perform and those that the learner cannot perform even with assistance (Siyepu, 2013:5), which implies that the teacher should facilitate learner understanding by developing assessment activities beginning with what learners can do independently based on mastered mathematical skills. This process assists the learner in gaining confidence in completing Mathematics assessment tasks independently and helps them discover a way of attempting to find solutions to problems they were unable to solve with or without assistance.

2.3.3 The Role of Zone of Proximal Development in Mathematics Assessment

Teachers use assessment for learning in Mathematics activities to obtain feedback that indicates what skills the learner has mastered, what skills need development and how to assist the learner in the acquisition of knowledge and skills (Katege, 2013:2-3). The teachers' knowledge of ZPD in this regard becomes imperative because it can assist in bridging the Mathematics knowledge gap between what the learner can do without help and what the learner can do with external help in Mathematics (Siyepu, 2013:3).

An overview of the benefits of the use of ZPD in knowledge development is presented in Table 2.1 below.

Table 2.1: Overview of the benefits of assessing in the ZPD for teachers and learners (adapted from Lui, 2012)

Learners receive:	Teachers can:
<ul style="list-style-type: none"> • assessment for learning tasks that challenge their reasoning, stimulate thinking, and motivate their efforts in learning Mathematics • meaningful feedback that helps drive improved instruction to aid further development of Mathematics skills at the learner’s pace • a classroom environment in which they are valued, belonging to a class in which individual development in Mathematics is taken into account • a learning environment where they are allowed to be creative and how they think in Mathematics problem solving is acknowledged and accepted 	<ul style="list-style-type: none"> • use feedback from assessment to planning Mathematics learning experiences that meet individual learner and class Mathematics needs • increase social interaction among learners to closely manage Mathematics skills development thus improving learning • gain a better understanding of learners as individuals, and their mathematical abilities in a community of learners • closely monitor how individual learner can apply learnt skills in solving Mathematics problems

AfL activities should, therefore, aim at both the actual development and the level of potential development in the learning of Mathematics; that is, building on what the learner already knows and can do, towards meeting the learning intentions and goals.

2.3.4 The Teacher’s Role according to a Constructivist Approach in Assessment for Learning

In line with the constructivist theory, teachers should be guided by learners and their ability and levels in how AfL Mathematics activities are structured and how teaching unfolds in the Mathematics classroom. Because constructivism is a learner-centred approach, teachers should create assessment for learning (AfL) activities that relate to learners’ experiences in context (Aljohani, 2017:99), which implies that assessment activities should reflect learners’ social environment and realities, exhibiting mathematical problems relevant to the learners.

According to Mvududu and Thiel-Burgess (2012:110), in constructivism, teachers should consider that learners possess the knowledge and that Mathematics assessment activities should be presented in such a way that learners put their acquired knowledge into practice. The implication is that classroom assessment for learning activities should promote learner independence and identify any inconsistencies in learners' current knowledge and their subjective experiences in deriving solutions in the assessment. Assessment for learning activities should assist the learner in applying modified acquired knowledge in assessment activities and teachers should take into account learners' points of view as it reflects their reasoning.

Bhowmik (2015:11-12) proposes four roles of a constructivist teacher in developing AfL activities in Mathematics. First, the teacher uses these activities to ascertain learners' mathematical prior knowledge, ideas, concepts understanding and analyse questions raised by learners as they complete the activity. In other words, learners should be assessed in context, bringing positive experience which helps them to know who they are and what they should do to improve their learning. Secondly, teachers should understand how the learners' new mathematical knowledge interacts with prior knowledge, which Piaget referred to as assimilation (Baken, 2014:3). Thirdly, AfL should discover how learners construct mathematical meaning and their thought processes rather than a definitive answer. Teachers should allow learners to explain how they reached the solution without being judged. Fourthly, assessment activities should measure learners' mathematical understanding rather than recalling of mathematical procedures.

Each of the above roles has a major contribution to offer assessment activity development. Initially, the teacher should use assessment activities to determine existing Mathematics knowledge that learners have acquired over the various years that the concept was taught. Assessment activities should allow the learner to link previous knowledge with new knowledge to move the learning process forward. This process is achieved by the teacher encouraging the learner to use their experiences to come to a mathematical solution based on their understanding rather than rote learning.

2.3.5 Constructivist Assessment for Learning Practices

Assessment practices are directed towards developing feedback that ultimately drives learning and teaching towards concept development (Panhoon & Wongwanich, 2013: 4126). The advantage of using AfL practices in Mathematics classrooms within constructivist ideologies can assist teachers in meeting learners' academic needs. Figure 2.2 below illustrates an overview of a constructivist learning environment wherein assessment and feedback play a critical role in learning.

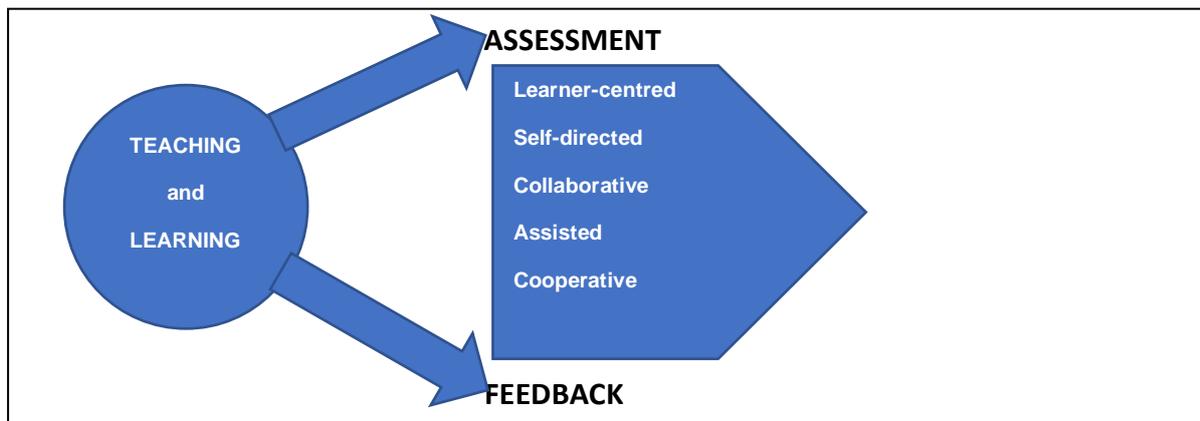


Figure 2.2: Overview of constructivist assessment environment

To create a conducive learning environment, the relationship between instruction and assessment, proper planning should be taken into cognisance when designing assessment for learning activities. The teacher should match Mathematics assessment activities to what is taught in class, by clearly defining the steps to be followed in concluding a mathematical solution. Teachers should use a variety of Mathematics assessment measures considering different learning styles and teacher final judgement of learning should accommodate and give space for learners to demonstrate their learning.. This affords the learner space and opportunity to display their understanding of the mathematical concept being taught through assessment. Individual learner support is highly prioritised to give a fair judgment of learner Mathematics concept development and the teacher should assist the learner in completing a given task. The class atmosphere should encourage increased socially adjusted interaction between the Mathematics teacher and their learners as well as amongst learners. Sharing of knowledge during the completion of the assessment for

learning activity should not be therefore limited to the teacher, but learner contribution should be encouraged as well (Pettit, 2012:75). After each Mathematics AfL activity, the teacher must provide and discuss the feedback from the outcomes of assessment results. The intention of providing constructive feedback is to help the learner identify gaps in learning. The teacher together with the learners should adequately interpret the assessment results appropriately highlighting areas of improvement that both need to attend to in meeting learning outcomes.

The notion of AfL is based on its ability to assist the learning process by providing teachers with the necessary knowledge about learners' stages in knowledge development (DBE, 2012:293). Bada (2015:68) acknowledges crucial Mathematics benefits that learners gain when a constructivism approach is implemented in classroom activities. According to Bada, a teacher who uses a constructivist approach in classroom instruction creates an environment wherein learners are encouraged to articulate their views and understanding of the Mathematics concept under study without being judged and thus actively participate in classroom activities. This approach, therefore, discourages rote learning and memorisation of standard mathematical procedures in deriving a mathematical solution to problems. This can be seen as beneficial since learners are encouraged to apply their minds and invest time in finding mathematical solutions to problems, and as a result, they begin to own knowledge gained in the process. Because constructivism is learner-centred, self-directed and promotes collaborative learning, the teacher and learners, therefore, work together in support of building mathematical knowledge (see Figure 2.2). Assessment for learning activities should be used to contextualise Mathematics learning, such that learners relate what they learn in the Mathematics classroom to their environment and experiences.

Application of a constructivist approach to AfL is based on the premise that learners are given the opportunity of finding their own solutions to mathematical activities (Bada, 2015:66). In other words, assessment for learning (AfL) promotes a self-regulatory approach to the learning of Mathematics in which learners monitor the learning process and adjust for future learning through analysing feedback (Effeney, Carroll & Bahr, 2013:58). Despite the acceptance of constructivism as a learning

theory that supports learning, there are however, a few objections have been voiced against it.

Kirschner, Sweller and Clark (2006:78) posit that most learners can solve Mathematics problems if they had been given enough information on mathematical procedures in problem solving. Therefore, relegating the responsibility of a teacher to facilitator during the completion of assessment activities enhances learner ability in solving problems. The learner must develop the ability to self-direct the learning process which largely depends on their awareness in influencing the mental structure on the intention to learn (Gojkov, 2011:23). Constructivist practices do not benefit learners who require well-structured learning environments that enable them to function and excel. Learners need adequate information without it they become frustrated, which means that removing the teacher from taking the centre role may lead to unnecessary delays in the teaching process.

Another disadvantage is that constructivist practices can lead to learner frustration in cases where they cannot find a relationship and abstraction between what they know and the mathematical problem they need to solve (Kirschner *et al.*, 2006:79). It is, therefore, the responsibility of the Mathematics teacher to not create assessment activities that are cognitively detrimental to the learning process.

The possibility of dominant learners taking over the learning process through social interaction has been criticised for neglecting the individuality of learners (Alanazi, 2016:3). Therefore, because Grade 6 learners have not fully developed negotiation skills, average negotiators might be left behind because the context and the environment do not favour their learning. Gojkov (2011:27) contends that by placing the ability of knowledge development on cognitive abilities alone, the constructivist approach has minimised contextual factors related to knowledge development.

This section of Chapter 2 discussed the importance of implementing constructivism theory in the assessment of Mathematics through an AfL approach. It highlighted the importance of Piaget's Cognitive Development and role-played Vygotsky's Social Interaction in the completion of AfL activities. The researcher is of the view that constructivism has a major role to play in knowledge development and Mathematics

teachers should understand the impact this theory has on mathematical concept development.

2.4 SOCIAL JUSTICE THEORY

The current South African Education system based on the Constitution (RSA, 1996) guarantees equitable development and equal educational rights for all learners (DoE, 1995:19). At the centre of all educational assessment practices in South Africa is an underlying need for Mathematics teachers to advocate for socially-just practices, learner inclusivity in teaching, learning and assessment processes (Ayala, Hage & Lantz, 2011:2795). Based on this constitutional premise, one would expect that all learners in places of teaching and learning are treated equally and fairly, regardless of their learning abilities. Maguire (2019:299) argues that social justice is a step towards building a society that shares equal opportunities and increased access to resources. In a school context, this notion implies that teachers should employ a variety of learning strategies as well as different assessment methods to reduce any disadvantage learners may experience. The fact that AfL is at the centre of all classroom practices in schools (Beets & van Louw, 2011:306), its activities should treat learners with fairness, and it should benefit both the learner and the teacher in planning instructional processes (Stobart, 2005: 276).

In developing the concept of social justice theory, Rawls (1999:3) proclaims justice as fairness. To illustrate the notion of fairness, Rawls (1999:53-54) espouses two basic principles of justice: the individual's right to political liberty, prescribing the freedom of thought, speech and integrity. In other words, learners are allowed to think and develop mathematical concepts in a way that makes sense to them. They are given the right to verbally question their thinking processes without being judged. Because assessment for learning activities are learner-centred and informal, increased communication in classroom interaction should be encouraged. The second principle concerns social and economic arrangements which are to be re-arranged in the manner for the least advantaged to benefit. The discussion on social justice in the assessment for learning Mathematics activities in this context becomes imperative given the prevailing inequalities in practices (Beets & van Louw, 2011:306).

Paramount to the social justice theory is a concern about how societal needs can be re-arranged and properly regulated so that individual members have equal opportunities (Hlalele, 2014:465). On the other hand, Bell (2007:1) emphasises that in social justice, societal re-arrangements meet the needs of individuals to maximise equitable participation. Both definitions above arrive at the same conclusion that in social justice, learner needs are met by increased equitable participation when assessing them. It is for this reason that assessment for learning should be viewed as just in practice because it emphasises the need to actively engage learners in their learning to assist the teacher in future planning teaching and learning strategies (Looney, 2011:5).

For this study though, social justice in the assessment of Mathematics is defined as the process of inclusive assessment to attain and meet learners' education goals. The role of a teacher in socially just assessment is to design assessment for learning activities that focus on accessibility for all learners that participate in the assessment (Thurlow, Lazarus, Christensen & Shyyan, 2016:8). Teachers should implement the notion of 'no learner left behind' in the design of assessment for learning Mathematics activities. These activities should, therefore, reflect the academic needs of individual learners that participate in the completion of the assessment activity. AfL activities should provide feedback that informs purposive planning for future teaching.

Two important concepts emerge in the discussion of social justice in assessment processes and that is equality (Hlalele, 2014:465) and fairness (Ayala *et al.*, 2011:2795). The researcher believes both concepts are important in this study as they address issues of justice in the assessment for learning practices. Pettifor and Saklofske (2012:101) highlight these two concepts as built on treating the learners with dignity and their developmental learning well-being guaranteed. Equality in and fairness of socially just assessment should be identifiable in assessment goals; that is, what is assessed, who is being assessed, when and where assessment occurs and why learners are being assessed (Pettifor & Saklofske, 201:90). Pettifor and Saklofske's insightful perspective suggests an enhancement of the quality in ethical assessment for learning practices.

2.4.1 Equality and Fairness in Assessment for Learning

The idea of equality in assessment is grounded on the premise that educational arrangement should be developed to give equal consideration to all learners (Terzi, 2014:484). The implication is that the Mathematics teacher looks attentively at the assessment needs of each learner in the class so that all learners are treated with dignity. Terzi's view is that assessment activities should be able to enact on individual learners the right to learning (2014:484). Terzi (2014:485) alludes that equality practices prompt teachers to provide learners with equal and beneficial opportunities to learn. A suggestion made is that equality in assessment limits a scope where learners are deprived and disadvantaged because of their cognitive and social differences (Terzi, 2014:488). Based on these literature insights, it is a clear indication that equality as a principle of social justice promulgates the placing of learner well-being at the centre of educational practices such as assessment for learning in Mathematics.

Each learner in a class has a right to learn and to an assessment that addresses their learning needs (Scott, Webber, Lupart, Aitken & Scott, 2014:57). This implies that classroom assessment for learning activities in Mathematics should not deny the learner the opportunity to learn irrespective of educational skills level. A fair assessment is an assessment that does not present any barriers to learning and it is responsive to individual learner development (Poehner, 2011:104), providing a learner with the opportunity to demonstrate the scope and level of their learning. Teachers should be mindful that it is a learner's constitutional right to be treated fairly and be supported through the learning process (Dreyer, 2014:91).

Suskie (2000:7-8) presents a seven-step guide to fair assessment for learning practices in which learners are given an equitable opportunity to demonstrate what they can do. The author points out that teachers should assess learners by using methods and procedures that best suit their learning styles. The author acknowledges that creating a custom-tailored assessment activity for each learner is never an easy task and almost impractical but believes the steps will assist in making assessment procedures fair. According to Suskie (2000:9), teachers should not rush the creation and development of the assessment, but plan assessments carefully by assessing key

learning goals and balancing questions on basic conceptual understanding with questions assessing evaluation skills. Teachers should ensure that assessment activities provide an explicit learning outcome, wherein learners understand what is expected of them and that the questions are clear and easy to understand. Teachers should guard against unintended bias by using contexts that are equally familiar to all and uses words that have common meanings to all. Finally, it is suggested that teachers ask a variety of people with diverse perspectives to review assessment tools to ensure that the tools are clear, that they appear to assess what the teacher wants them to assess, and that they do not favour students of a particular background. All the concepts and skills covered in the assessment should be well-articulated to learners, as this will help learners find value in what they are engaged.

2.4.2 The Educational Values of the Social Justice Theory in this Study

To align education for social justice the DoE released White Paper 6 in July of 2001, aimed to bring awareness and attention to learners with special educational needs and suggesting inclusion as an approach to expand educational access for learners with learning barriers (DoE, 2001:10). According to White Paper 6, inclusivity education acknowledges that all South African learners, if given the necessary support, can learn which means that teachers should take the necessary steps in providing the support learners need (DoE, 2001:12). Teachers should, therefore, use assessment for learning to identify different learning styles present in their classrooms so that proper instructional support can be provided. The educational structures, classroom system and learning methodologies should assist in meeting the needs of learners in acquiring skills and in meeting acceptable standards of knowledge acquisition. In other words, how teachers conduct their lessons should be of great benefit to the learner because it is based on assessment feedback derived from assessment activities, thereby understand that assessment is an integral part of the teaching and learning process.

White Paper 6, therefore, proposes that teachers should plan and take into cognisance the Mathematics needs of their learners (DoE, 2001:16). For this reason, Mathematics teachers should work towards creating an environment that shows respect and for acknowledgement of existing learner differences and that AfL activities are used to

drive the teaching process. To broaden the scope of the role of the environment, learner external social experiences and societal arrangements should be acknowledged and be brought into classroom practices. The learner should see the link between their classroom assessment activities and community practices. Therefore, maximising learner participation to expose their mathematical experiences and barriers should be prioritised if Mathematics teachers are to make an impact (DoE, 2001:6-7).

Since the above-mentioned strategies were directed towards addressing the learning needs of learners with disabilities for educational justice, the view of the researcher is that they should apply to all learners in South African schools. In this regard, assessment for learning (AfL) in Mathematics should be able to identify learning opportunities, allocate resources to areas that need improvement, thus providing equitable opportunities (McInerney, 2004:50). The strategies should be able to assist the teacher to plan for and introduce classroom interventions to cope with diverse learning and teaching needs (DoE, 2001:10).

Social justice should be seen as important to the pursuit of meaningful learning and should therefore also be central to classroom assessment practices. Taking into account the massive impact of the family and community circumstances, the provision of poor-quality education cannot be underestimated. It is also true that unfair assessment practices remain an important influence in the deterioration of social justice in the South African Mathematics classroom. The assessment used formatively, that is, in support of more effective learning and teaching, can entrench a socially just practice in which ways can be found to ensure that all learners are afforded fair treatment as well as impartiality in sharing of the benefits of the learning (Beets & van Louw, 2011:314). The goal of social justice in assessment should be that of increased mass participation of learners in assessment for learning activities to meet individual learner learning needs (Francis & le Roux, 2011:301).

As Keddie (2012:26) highlights, the justice in assessment for learning is in its ability to assist the teachers to understand their learners, recognising their learning capabilities and work towards providing learning support in addressing these needs. This view is supported by Fraser (2007:27), who analyses justice as social arrangements that

assist in disassembling institutionalised interferences that hinder the full participation and academic achievement of learners.

The link that exists between a constructivist approach to assessment and socially just assessment practices cannot be overemphasised. The researcher believes the attainment of Mathematics learning goals can be attributed to the teacher's knowledge infusing both constructivism practices and socially just approaches to AfL activities. This practice of assessment is an integral part of the teaching and learning process, will enable both the teacher and the learner to share feedback that they both developed, opening trustworthy discussions on how to move forward.

2.5 CONNECTIVISM

Connectivism, a theory proposed by George Siemens, caters for learners in the digital age (Siemens, 2004:1). Siemens defines connectivism as incorporating technology and socialisation to influence the learning process (2006:4) and suggests that educational needs and theories should be reflective of social changes. Duke, Harper and Johnston (2013:6) on the other hand, state that connectivism should be viewed as social networked learning, while McCarroll and Curran (2013:3) highlight the fact that social networking encourages class participation and collective contribution to the sharing of information.

Siemens (2004:4) articulates certain principles that the researcher believes apply to this study. The teacher should recognise that knowledge rests in the classrooms' diverse individual learners and that social interaction and the use of technology can enhance learning. The Mathematics teacher should work towards connecting the different information sources to support learning. Therefore, deciding how learners are to engage and complete Mathematics assessment for learning activities in the class is important. In other words, the teacher should decide on the flow and the sharing of Mathematics information through interaction.

Connectivism promotes the initialisation of knowledge by the learner (Goldie, 2016:1065). The teacher through Mathematics assessment for learning activities

should allow the learner to interact and share knowledge with others through learner classroom discussions and increased use of available technologies.

Connectivism highlights that knowledge is derived from a diversity of sources (Duke, Harper & Johnston, 2013:6) and as such, the teacher should guide the learner in making the connection between the information sources at their disposal. Goldie (2016:1068) supports this view, by arguing that connectivism espouses that learning is when a learner activates knowledge due to their participating and connecting in a learning community. Goldie (2016:1069) points out that connectivism describes the learning community as nodes which are represented by diverse sources of information. These learning nodes may be represented by sources of information such as organisations, libraries, websites, journals or databases and in the classroom set-up, the teacher and other learners.

How a teacher uses different educational nodes such as books, database, computers websites and others in assessment to aid learning becomes critical. Learner participation in a network of connections between individuals, societies, organisation, and the technologies may tap into the vast knowledge stored in these communities assisting in building individual understanding. Connectivism contributes to the body of knowledge that promotes diversity of learning needs (Dreyer, 2014:41), contributes to a learner-centred approach towards assessment and teaching of Mathematics to meet and enhance learners' competencies in Mathematics by shifting emphasis from teaching to learning (Alam, 2016:52) and what the learner can do with external help in Mathematics (Siyepu, 2013).

In this study, connectivism was used to understand the ability of Mathematics teachers to integrate technology as well as classroom socialisation in Mathematics AfL activities. As delimited above, connectivism promotes the interconnected and dissemination of mathematical understanding amongst teachers and learners to promote increased participation of learners (Goldie, 2016:1068). This implies the ability of teachers and learners to synthesise knowledge and information gained through various sources in Mathematics assessment. It, therefore, becomes increasingly vital that teachers adapt assessment for learning in Mathematics to the use of technological and social tools at their disposal.

2.6 THE TECHNOLOGICAL PEDAGOGICAL AND CONTENT KNOWLEDGE FRAMEWORK AND ITS COMPONENTS

The TPACK framework developed by Koehler and Mishra (2006:1019) illustrates the educational benefits through the use of available technology, teacher's pedagogical knowledge of technology, and Mathematics knowledge of content to be taught. TPACK was developed by making adjustments to Shulman's work of 1986, that is, Subject Content Knowledge (SCK) and Pedagogical Content Knowledge (PCK) on which Koehler and Mishra (2009:1) built their TPACK by including the use of technology to improve classroom instruction. The inclusion of TPACK is based on the idea that the teaching and learning processes have become complex activities in which different kinds of knowledge are interconnected (Koehler & Mishra (2006:1020). Primarily, available technology stores enormous information that repeatedly calls for important and current approaches to assessment, teaching and learning environments. The central concern of TPACK is associated with the integration of technology in classroom activities such as assessment of learners.

The TPACK framework was created with technology, pedagogy and content components intersecting, thus producing special knowledge required by Mathematics teachers through integrating technology to influence learner performance (Chai, Koh & Tsai, 2013:32; Hulya & Karamete, 2015:777). The TPACK thus presents a framework for identifying the knowledge teachers (that is, content, pedagogical and technological) must possess to be able to integrate technology into classroom practices such as assessment (Schmidt *et al.*, 2009:125). The introduction of the TPACK framework highlights the skills that Mathematics teachers need to master effectively in order to carry out classroom activities by integrating the use of technology to assist in the assessment process. In the context of this study, TPACK demonstrates the interconnectedness of AfL with Mathematics content, teacher's content, pedagogical and technological knowledge, and how this knowledge is used in designing AfL activities in the classroom context (Willermark, 2018:316).

Figure 2.1 below represents the TPACK framework as well as the different knowledge domains needed by the Mathematics teachers in the assessment of Mathematics in Grade 6.

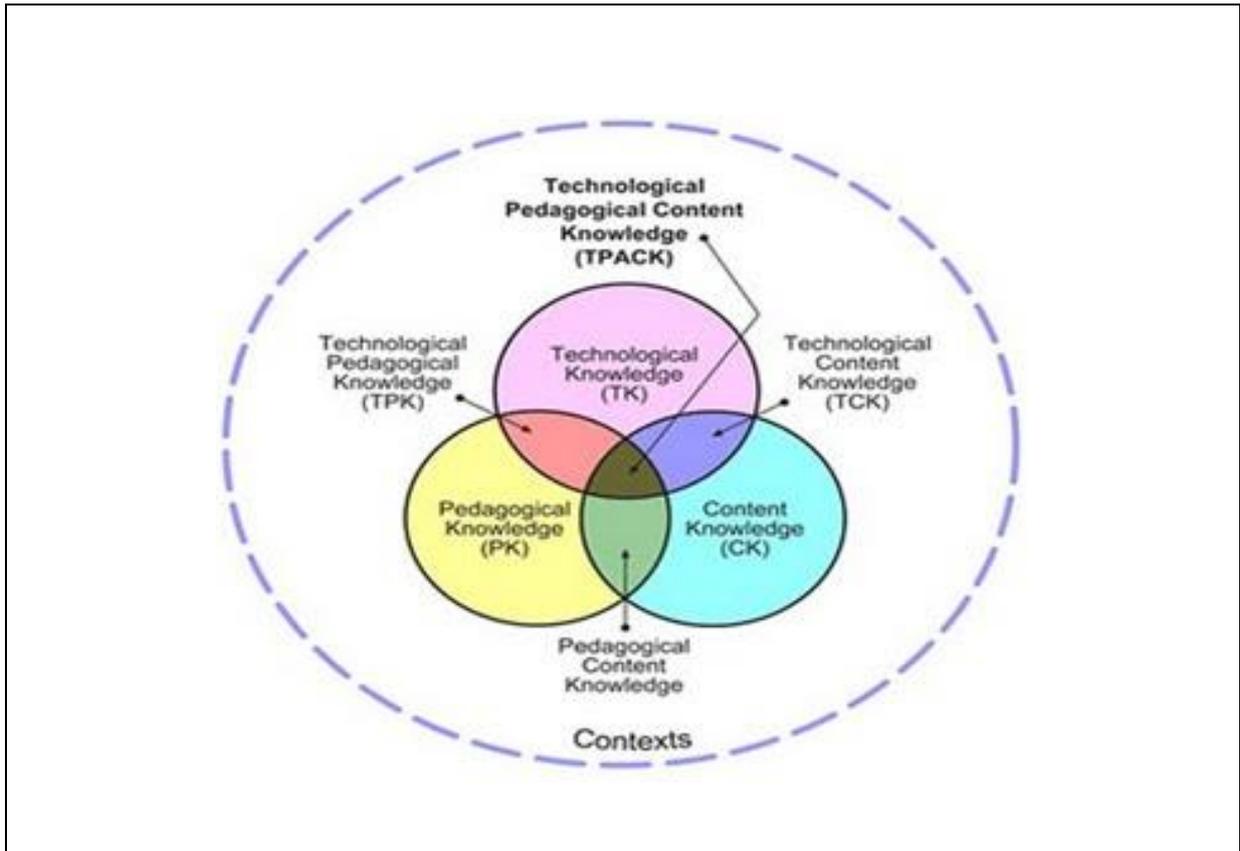


Figure 2.3: Representation of The TPACK Framework (adapted from Koehler & Mishra, 2008)

The TPACK framework comprises numerous components as a result of intersections between pedagogical knowledge, the content knowledge as well as technological knowledge (Koehler & Mishra, 2006:1025). The overlapping domains give rise to technological content knowledge, pedagogical content knowledge, technological pedagogical knowledge and the technological pedagogical content knowledge. The TPACK components are discussed below, giving a reference to how teachers can apply each component in the assessment of Mathematics to develop feedback to improve the classroom practices.

2.6.1 Technological Knowledge (TK)

Technological Knowledge (TK) represents various technologies that a teacher could use to enhance classroom practice in the assessment of Mathematics. Teacher knowledge on standard technologies such as textbooks and chalkboard as well as the

inclusion of the advanced technologies such the use of data projector, desktop and laptops computers, internet, software applications (Koehler & Mishra, 2009:4) and tablets (Algoufi, 2016:115), is required to assist teachers in structuring their teaching and assessment activities to aid the learning process. The use of technology in teaching and assessment should not be viewed as an add-on tool, teachers should know and thoroughly plan when, how and why to package its use and ensure it is part of the teaching and learning process.

Various Mathematics software such as GeoGebra, Dr Geo, Euklides, calque3D, Cinderella, Cabri and Geometric Sketchpad (Kirikçilar & Yildiz, 2018:102) and Khan Academy (Light & Pierson, 2014:104) is currently in use in teaching. Essentially, Mathematics teachers should develop knowledge and skill of how to use these available technologies in assessment contexts. In the context of this study, the researcher observed how teachers best chose suitable technological tools in driving a mathematical concept development during teaching and assessment.

2.6.2 Content Knowledge (CK)

According to Koehler and Mishra (2006:4), Content Knowledge (CK) is the deep knowledge a teacher possesses of a subject he/she teaches. This means that a Mathematics teacher must know concepts that are central to the knowledge learners should gain in a particular grade. CK forms the base of how teaching and learning should unfold in class and enables the teacher to use mathematical content to develop AfL activities that aid learning. For this study, the researcher wanted to observe how Mathematics teachers linked the subject content with the use of available technologies in AfL activities.

2.6.3 Pedagogical Knowledge (PK)

Pedagogical Knowledge (PK) is the acquired knowledge a Mathematics teacher possesses regarding the important applicable processes and practices or methods of teaching and assessing Mathematics to promote and influence the learning process (Koehler, Mishra, Kereluik, Seob & Graham, 2014:102; Koehler & Mishra, 2006:1026; Koehler & Mishra, 2009:64;). According to Koehler & Mishra (2009:64), teachers use

this knowledge to manage their classes, develop lesson plans, assess learners, understand the nature of learners in the classroom and evaluate the effectiveness of their teaching.

König, Blömeke, Paine, Schmidt, and Hsieh (2011) highlight and offer clarity on the application of the main components of pedagogical knowledge. König *et al.*, (2011:190) thus highlight a progressive development of classroom instruction starting from classroom management, which illustrates the teacher's ability to maximise the quantity of instructional time. The teacher has to demonstrate the effective handling of all classroom activities by maintaining clear objectives of their lessons. Secondly, teachers should possess the knowledge of classroom assessment and should be able to plan and implement different forms of assessment (that is, formative, summative, baseline and diagnostic) for the benefit of the learners. Lastly, classroom activities, that is, assessment and teaching should be adapted to meet the different learning needs present in the classroom.

PK is seen as different AfL strategies used by teachers to drive the teaching and learning of Mathematics and mathematical concept development, which could be enhanced with the use of technology. assist the learner in

2.6.4 Technological Pedagogical Knowledge (TPK)

The Technological Pedagogical Knowledge (TPK) is formed when technology and pedagogy intersect as indicated in the TPACK figure above (see Figure 2.3). The TPK refers to the knowledge that teachers have in using technological tools to enhance concept development through assessment, and how these tools are used may influence the way Mathematics assessment unfolds (Koehler, Mishra & Cain, 2013:16; Schmidt *et al.*, 2009:125). TPK describes the teacher's ability to find a specific technology and uses it to transform how teaching, learning and assessment unfold in the Mathematics classroom.

2.6.5 Technological Content Knowledge (TCK)

Technological Content Knowledge (TCK) is the knowledge Mathematics teachers possess concerning understanding a specific effect technology has on a subject and its content (Koehler & Mishra, 2006:1028). Technology allows the teacher to assess Mathematics content in new ways (Koehler, Mishra, Akcaoglu & Rosenberg, 2013:4). In other words, the subject content matter should influence a teacher in identifying suitable technology that will best drive the understanding of the subject matter and concepts being learnt. The use of technology can, therefore, aid the teacher in transforming what is learnt in class to be better understood by learners.

Although the technological landscape of the use of technology has impacted society, a question might be posed pertaining to its use in the assessment of Mathematics. The researcher believes that technology has a major influence to play in driving mathematical concept development through the assessment of learners. The researcher is also aware of the complexities of technology integration and scarcity of resources in the South African context that needs to drive the use of technology in Mathematics. In this study, the researcher is interested to observe how teachers use of technology in assessment to influence learning.

2.6.6 Pedagogical Content Knowledge (PCK)

Pedagogical Content Knowledge (PCK) describes the teacher's understanding of different assessment approaches to assist in delivering mathematical subject content and arranging the content to aid teaching (Koehler & Mishra, 2006:1028). Teachers who have acquired and developed PCK concept can explore different strategies to deliver the mathematical content by choosing appropriate assessment approaches as well as technology that would facilitate learners' knowledge and concept development (Mutanga, Nezandoynyi & Bhukuvhani, 2018:40). Teachers understand that learners learn well when her/she adapts his/her teaching approaches to meet learners' needs (Chai *et al.*, 2013:33; Ward & Benson, 2010:484). In this study, the researcher views PCK as core to learning and is keen to observe how participant's methods of assessment influence the learning process.

2.7 BLOOM'S REVISED TAXONOMY (BRT)

The taxonomy of cognitive objectives was developed by a group of academics led by Benjamin Bloom in the 1950s (Nayef, Yaacob & Ismail, 2013:165). Bloom's Taxonomy was developed to offer teachers a classroom planning tool, illustrating how hierarchical thinking should be organised (Pohl, 2000:7-8). Initially, the six cognitive objectives were organised on six levels of increasing demand, namely: knowledge, comprehension, application, analysis, synthesis and evaluation.

Bloom's Revised Taxonomy (BRT) is an extension of Bloom's Taxonomy (BT). The BRT represents a shift of focus from assessment emphasising the use of the taxonomy to align curriculum planning, instruction and assessment (Mathumbu, Rauscher, & Braun, 2014:3). It contributes to Bloom's Taxonomy by placing together the cognitive process and knowledge dimensions (Kilbane & Milman, 2014:8-9; Krathwohl, 2002:215). According to Krathwohl (2002:216), the cognitive process dimension represents the six cognitive level with changes from nouns to verbs; thus, renamed remembering, understanding, applying, analysing, evaluating and creating. Mathumbu *et al.* (2014:3) point out that the knowledge dimension is made up of Factual Knowledge, Conceptual Knowledge, Procedural Knowledge as well as the Meta-Cognitive Knowledge indicating knowledge development from concrete to abstract. Table 2.2 illustrates the general structure of the revised taxonomy.

Table 2.2: A Taxonomy for Learning, Teaching and Assessing: A revision of Bloom’s Taxonomy of Educational Objectives (adapted from Anderson & Krathwohl, 2001)

The Knowledge Dimension	The Cognitive Process Dimension					
	Remembering	Understanding	Applying	Analysing	Evaluating	Creating
Factual Knowledge						
Conceptual Knowledge						
Procedural Knowledge						
Meta-Cognitive Knowledge						

Krathwohl (2002:214) describes the sections of the knowledge dimensions as follows:

- i) Factual knowledge comprises those basic elements that learners need to know to be acquainted with Mathematics to enable them to solve problems. These elements may include the basic terminology used in Mathematics and knowledge of specific mathematical symbols and notations.
- ii) Conceptual knowledge represents the mathematical interrelationships between the basic elements within a larger structure that allows them to function together.
- iii) Procedural knowledge includes the knowledge of using mathematical specific skills and techniques in finding solutions to mathematical problems.
- iv) Meta-cognitive knowledge is an individual learner’s way of thinking which allows him or her to remember facts as well as problem-solving strategies.

The BRT is a practical tool that can be utilised by teachers in developing an assessment for learning activities in Mathematics that supports knowledge development through cognitive process dimensions (Kilbane & Milman, 2014:9). The BRT was used in this study to help the researcher analyse and categorise the assessment for learning activities and group them into knowledge and cognitive dimensions (Mathumbu *et al.*, 2014:5). The application of the BRT in assessment for learning activities highlights teachers’ goals for the activities. Each Mathematics

activity is analysed and placed in a cell in Krathwohl's (2002:216) Taxonomy Table by using a verb for the cognitive level and a noun to indicate the mathematical content level. This demonstrates teacher's intention for the activity, that is, to assess cognitive levels at low order or high order and/or factual right through to the metacognitive knowledge level (Mathumbu *et al.*, 2014:7).

To illustrate the need for the application of Bloom's Taxonomy, the DBE has provided the cognitive levels that teachers should plan to achieve in the teaching and learning of Mathematics (DBE, 2011a:296).

2.7.1 Cognitive Levels as presented by Curriculum Assessment Policy Statement (CAPS) in Mathematics

The Curriculum Assessment Policy Statement (CAPS) document provides and clarifies the content that should be taught in Grade 6 Mathematics (DBE, 2011a:213), and also, provides the cognitive levels and skills to be demonstrated by learners which link with Bloom's Revised Taxonomy (DBE, 2011a:296). Taole (2013:40) contends that the Mathematics teacher's role in helping the learner attain the required skills cannot be overemphasised. The author maintains that success in the learners' skill development depends on teachers' classroom practices such as teaching and assessment (Taole, 2013:41). Therefore, the transfer of skills from paper (as outlined in the CAPS document) to the learner, depends on the Mathematics teacher's ability in interpreting the cognitive levels, classroom teaching as well as an assessment of learners in Mathematics.

Stobaugh (2013:14) illustrates the difference between retention and transfer of knowledge in teaching and learning. The author explains retention as merely recalling of facts and is represented by the lowest levels of BRT which cannot help learners find solutions to unfamiliar or complex problems. On the other hand, the benefits of information transfer allow learners to apply information to new situations. Stobaugh suggests that for deep learning to occur, learners should become engaged in cognitively demanding activities found at higher levels of BRT. This suggests that the teachers' role in the assessment for learning should affect the learning process through activities that challenge the cognitive abilities of learners. These activities

should promote experiences that assist the learner in mastering the mathematical concepts being discussed (Kilbane & Milman, 2014:9).

The DBE has listed four cognitive levels that learners should achieve through different skills that should be demonstrated. Table 2.3 indicates the cognitive levels of Mathematics which should be attained at the Grade 6 level, as stipulated by CAPS (DBE, 2011a:296).

Table 2.3: An overview of cognitive levels for Grade 6 Mathematics (adapted from CAPS, DBE, 2011a)

Cognitive Level	Description of skill to be demonstrated
Knowledge	<ul style="list-style-type: none"> • Estimate and appropriate rounding off of numbers • Straight recall • Identification and direct use of correct formula • Use of mathematical facts • Appropriate use of mathematical vocabulary
Routine Procedures	<ul style="list-style-type: none"> • Perform well-known procedures • Simple applications and calculations, which might involve many steps • Derivation from given information involved • Identification and use of correct formula generally similar to those encountered in class
Complex Procedures	<ul style="list-style-type: none"> • Problems involving complex calculations and/or high order reasoning • Investigations to describe rules and relations – there is often not an obvious route to the solution • Problems not based on a real-world context – could involve making significant connections between different representations • Conceptual understanding
Problem-Solving	<ul style="list-style-type: none"> • Unseen, non-routine problems (which are not difficult) • Higher-order understanding, and processes involved • Might require the ability to break the problem down into its constituent parts

Table 2.4 is a combination of the Revised Bloom's Taxonomy and cognitive levels as prescribed by the CAPS Policy. The allocation of elements in Table 2.4 is based on the researcher's understanding of descriptions of skills to demonstrated by learners in the CAPS document (DBE: 2011a). The researcher believes the table has the ability to illustrate the teacher's ability to develop AfL activities by indicating which knowledge and cognitive is being assessed in Mathematics. In this study, the researcher uses the table below to explore how Mathematics teachers develop an assessment for learning activities in Mathematics.

Table 2.4: Application of BRT in the assessment of Mathematics in Grade 6

The Knowledge Dimension	The Cognitive Process Dimension			
	Knowledge	Routine Procedures	Complex Procedures	Problem-solving
Factual Knowledge	Straight recall	Perform well-known procedures	Conceptual understanding	Unseen, non-routine problems (which are not difficult)
Conceptual Knowledge	Appropriate use of mathematical vocabulary	Simple applications and calculations, which might involve many steps	Problems involving complex calculations and/or high order reasoning	Higher-order understanding, and processes involved
Procedural Knowledge	Identification and direct use of correct formula	Identification and use of correct formula generally similar to those encountered in class	Problems not based on a real-world context – could involve making significant connections between different representations	Might require the ability to break the problem down into its constituent parts
Meta-Cognitive Knowledge	Use of mathematical facts	Derivation from given information involved	Investigations to describe rules and relations – there is often not an obvious route to the solution	

The BRT emphasises the development of knowledge from basic to abstract and suggests a procedure that indicates how Mathematics teachers should be designing their AfL activities. The researcher linked the BRT with the Mathematics cognitive level as presented in the CAPS document, thus developing Table 2.4 in which Mathematics skills that learners should demonstrate were placed in specific knowledge dimensions under specific cognitive process dimensions. The table illustrates how the knowledge dimension influences the cognitive process or vice versa. This procedure will help the

researcher analyse the AfL activities developed and administered by teachers in their Mathematics classrooms. Also, the table will assist the researcher in understanding how teachers attempt to develop the Mathematics skills that learners need to demonstrate. The researcher believes the use of BRT will enable the teacher to receive the desired feedback, which is the fundamental aim of AfL, that will move classroom instruction forward.

2.8 THE THEORETICAL FRAMEWORK

How Mathematics teachers utilise educational theories in developing AfL activities is of great importance as each theory brings its own dynamics as discussed above. Central to the use of theories is the implementation of AfL practices to enhance teaching and learning Mathematics in Grade 6. Figure 2.4 below illustrates the theoretical knowledge underpinning the implementation of AfL in Mathematics in Grade 6.

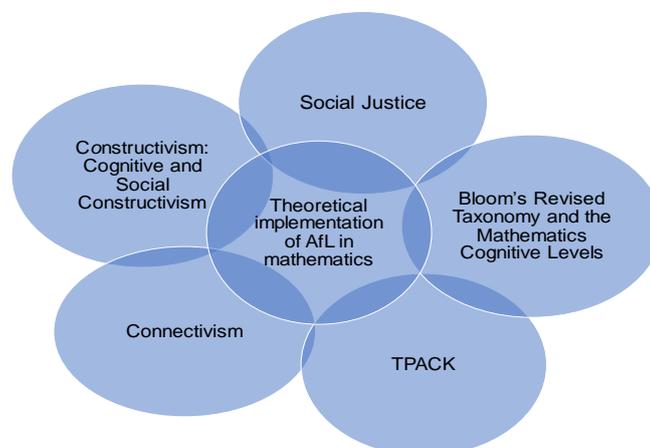


Figure 2.4: Theoretical framework for AfL in Mathematics

Theories underpinning the study were presented and discussed with their implication in classroom practices regarding the implementation of assessment for learning (AfL). These theories make up the Theoretical Framework for the study and comprise Constructivism, Social Justice theory, Connectivism and the TPACK concept.

Constructivism, a theory that supports the study, was defined based on the work of Piaget (Individual Cognitive Development) and Vygotsky (Social Constructivism) and it was illustrated how constructivism supports a learner-centred approach in assessment for learning. The findings of the literature on the constructivist approach to assessment suggest that Mathematics teachers have to develop assessment activities that allow the learners to take a leading role in knowledge development. Both the individual cognitive development and classroom social interactions are paramount in helping the teacher elicit feedback that will assist in developing specific learning goals to meet learners needs.

The Social Justice theory relates to the South African Constitution and White Paper 6 in which equity and inclusion are fundamental rights of all learners in South African schools. Findings suggest that learners should be afforded equal opportunities to learn. The academic well-being of a learner should take centre stage in educational practices through the use of AfL activities that do not deny learners the opportunity to learn irrespective of educational skills level.

The Connectivism theory correlates with the network of information that teachers could use to drive the learning process. The literature on connectivism suggests that Mathematics teachers should acknowledge the role played by the diversity of sources for knowledge development and also, it emphasises the importance of the learner connection with external nodes within the learning setup.

The TPACK concept explains how teachers with the help of technology can improve their assessment pedagogy and content knowledge in the assessment of Mathematics. The TPACK components were discussed giving reference to how teachers can apply the framework in the assessment of Mathematics. The literature suggests that the Mathematics content knowledge, as well as assessment pedagogical knowledge, are essential in assisting the teacher in choosing technologies to enhance the assessment process. Lastly, Bloom's Revised Taxonomy and Mathematics Cognitive Levels as presented in the Mathematics CAPS document highlight Mathematics skills that need to be learnt and how to develop AfL activities in assessing those skills. The literature suggests that learners should engage in cognitively demanding activities found on the higher level of BRT. Mathematics

teacher should, on the other hand, be cognisance of the learning needs in their classrooms, using AfL activities to promote learner experiences in mastering mathematical concept taught.

2.9 CHAPTER SUMMARY

In this chapter, various theories were discussed in detail which related to assessment for learning in Mathematics. Each of these theories was then used to develop a theoretical framework which underpins the study and provides a lens through which the findings of the research can be viewed.

In Chapter 3, a review of the literature offers a clearer idea of the concept of assessment in Mathematics taking a closer look at the different types of assessment and their impact on learner performance in Mathematics.

CHAPTER 3

LITERATURE REVIEW

3.1 INTRODUCTION

A review of the literature allows the researcher an opportunity to refer to the collection of knowledge in the form of essays to present important issues relevant to the task under investigation. According to Gasa, Mafora and Maphalala (2017:133), a literature review allows the researcher to critically review existing knowledge that relates to their topic of investigation.

The focus of this chapter is on reviewing the literature on AfL as it is applied in the teaching and learning of Mathematics based on the research undertaken. The literature review involved bringing to light issues of the implementation of AfL and how it affects classroom instruction. It is an important element of this study as a foundation is built to view how different countries apply assessment for learning (AfL) of Mathematics in the classroom. The focus of this chapter is on reviewing the assessment and its purpose, types of classroom assessments and their importance, the benefits and challenges of applying AfL in Mathematics, the use of learning intentions to create a productive environment and assessment interventions to improve teachers' proficiency in the application of AfL in Mathematics.

3.2 CONCEPTUALISATION OF ASSESSMENT AND ITS PURPOSE

Assessment plays a central role in the teaching and learning process because it assists teachers in investigating what learners know and can do. Assessment is done to measure the extent of learning (Siebörger & McIntosh, 2002:5). According to the DBE (2012:3), assessment should be used as a mechanism to assist teachers in collecting, analysing and interpreting information to make decisions, shape teaching and learning practices. In other words, assessment assists teachers in eliciting and document learners' Mathematics competencies to streamline their teaching methods to meet learners' academic needs. Stiggins and Chappuis (2005:12) assert that

assessment should not be a stumbling block to learning and must assist in rekindling the hope of achievement among learners.

The definition of assessment as an ongoing process that assists teachers in gathering and discussing information from diverse sources (Dreyer, 2014:6), suggests that teacher competencies in designing and implementing assessment strategies are imperative (Koloi-Keaikitse, 2017:2). To illustrate the need for assessment as an integral part of the process of teaching and learning, Brown and Abeywickrama (2010:22) suggest ways that assessment practices are useful. Their suggestions include the idea that assessment has the ability to increase learner motivation, aid in the reinforcement and retention of information, promote learner autonomy through self-evaluation of their progress, assist the learner in setting targets as well as teacher's evaluation of their teaching effectiveness.

Classroom assessment is undertaken through an assessment of learning (summative) and assessment for learning (formative). The assessment outcomes have different uses for teachers and learners. According to Dreyer (2014:7), classroom assessment helps teachers give feedback to learners, gather information for reporting purposes, identify the academic level of learners, determine whether the learner meets the required standards and motivate learners to do their work. This means that it assists the learner in understanding what is expected of them and what needs to be done to make improvements to their academic performance.

In the teacher conceptualisation of assessment, Hanover Research (2014) notes the link between the learning intention, assessment and an increase in self-regulated learning. According to Nicol and Macfarlane-Dick (2006:7) learners who understand why they are being assessed, are self-regulated and tend to be more effective through being confident and persistent, as learners are able to measure their success against feedback that is linked to their intentions.

A reflection of the above discussion highlights that assessment is an important practice in teaching and learning and teachers should possess a sound pedagogical knowledge concerning its application. Assessment, which incorporates many types,

should be well planned, taking into consideration its pivotal role in creating an opportunity for learners to learn through feedback.

3.3 TYPES OF CLASSROOM ASSESSMENT IN MATHEMATICS

This section presents the different types of assessments as applied in the assessment of Mathematics. These varied classroom assessments are used by Mathematics teachers to collect academic information of learners, which is then analysed to make an informed decision about the next step in classroom instruction (Dreyer, 2014:17). Therefore, it is of paramount importance that teachers understand the different types and implement them in various stages of the teaching and learning process, using their results to the benefit of the learner. Figure 3.1 below presents an overview of the type of assessments used in Mathematics.

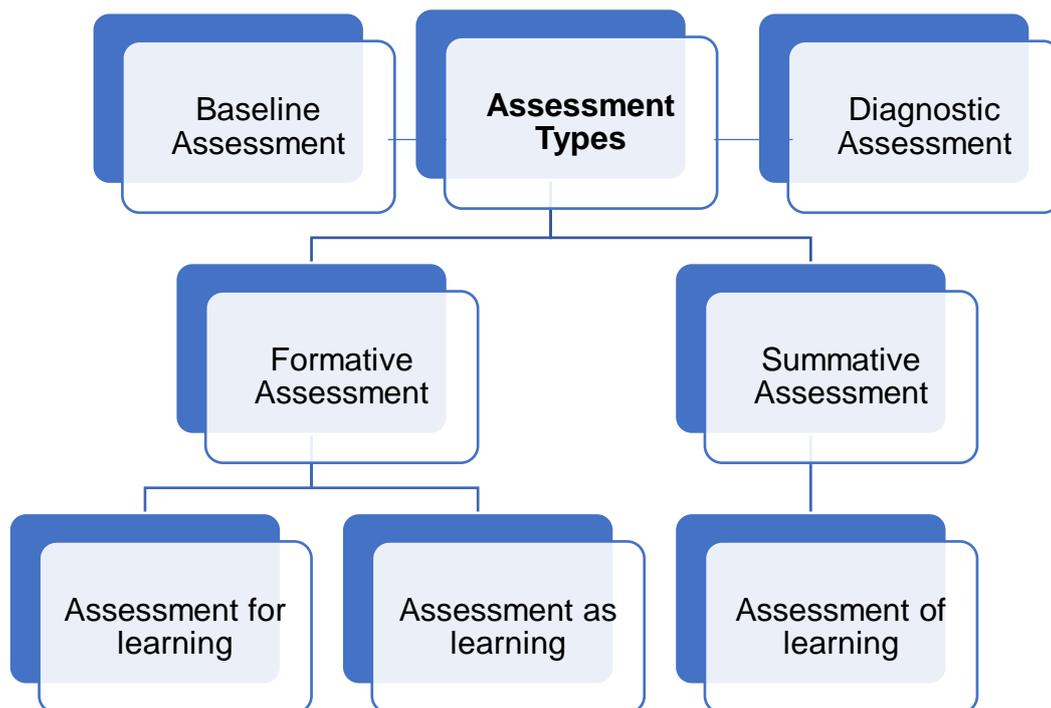


Figure 3.1: An overview of types of classroom assessment (adapted from Dreyer & Mawela 2020: 12,17)

3.3.1 Baseline Assessment

The baseline assessment is given to learners before learning commences and it assists the teacher in finding out what learners know and can do (Dreyer, 2014:17). The feedback informs the teacher in planning how teaching should unfold in Mathematics based on the skills identified. To further expatiate the purpose, Wildschut, Moodley and Aronstam (2016:4) suggest that baseline assessment be used to determine the level of learners, identifying learners with special academic needs and comparing the progress of learners. According to the DBE (2011a; 293), one of the important points of baseline assessment is to offer to the teacher a picture of how teaching and learning should proceed in the class. Using baseline assessment feedback, a teacher can set targets and realistic goals for the learners.

According to International Federation of Red Cross (IFRC, 2013:3), feedback from baseline assessment assists Mathematics teachers in setting realistic academic goals and measuring the progress towards attainment, maintaining accountability, paying closer attention to certain issues and increasing learner participation. Both the teacher and the learners can reflect on progress made along the way, by observing where they are coming from and progress made thus far.

3.3.2 Diagnostic Assessment

Diagnostic assessment contributes significantly in eliciting feedback that identifies difficulties in learning (Dreyer, 2014:47). Zhao (2013:43) also alludes to the fact that diagnostic assessment is utilised in classrooms to bring to light academic strengths and weaknesses a learner might encounter. On the other hand, Shim, Shakawi and Azizan (2017:365) explain diagnostic assessment as an assessment that provides valuable insight about the learner's mastery of previous experiences and skills along with preconception or misconception of the learned material. From the preceding statements, one can deduce that diagnostic assessment provides information about the learning needs to be fulfilled by teachers. It, therefore, directs teacher practice such as planning as well as the teaching of Mathematics to meet learner needs. The work of Black and Wiliam (1998b:13) indicates an important role played by descriptive diagnostic feedback, and how it influences teaching and learning. Such feedback

provides detailed information about the learner's current state of accomplishment concerning stipulated learning goals (Jang & Wagner, 2013:4).

Zhao (2013:43) suggests several guidelines assist teachers in developing a diagnostic assessment. The activities should be designed to specifically focus on weaknesses by identifying the cause and nature of barriers to learning, providing clear feedback to the teacher and learner indicating areas that need immediate attention. The feedback from such activities should assist the teacher in planning for remediation through planned teaching. According to Shim et al. (2017:365) diagnostic assessment in Mathematics is beneficial in assisting the teacher and the learner in moving forward. It can assist the teacher in developing effective instructional approaches to Mathematics teaching, taking into account learners' cognitive and academic needs and highlighting the overall competency of learners in Mathematics. Diagnostic assessment is therefore beneficial to the teacher because it helps guides the next step of action to be taken whilst highlighting information gaps to which a learner needs.

3.3.3 Summative Assessment

Summative assessment is formal, is used to determine the overall academic attainment of the learner (Dreyer, 2014:17) and to summarise the learning process at the end of the learning cycle (Guo & Zi Yan, 2019:3). Current studies refer to summative assessment as the AoL.

3.3.3.1 Assessment of learning

Traditionally, assessment of learning (AoL) has for many years been at the pinnacle and heart of classroom instruction. AoL allows teachers to give an overall picture of learner performance by giving summarised feedback to parents, learners themselves and the education department (Chong, 2017:3). The teacher uses this assessment as a final stage in the learning process to give the cumulative growth in classroom activities (Dreyer, 2014:17). To give a good picture of individual progress, AoL affords a learner the chance to work on their own in deriving mathematical solutions to problems. The feedback from AoL is used to officially document what the learner is able to do (Capraro *et al.*, 2012:4), and after a series of AoL activities, the final

judgement is made whether a learner is promoted to the next grade or not (Dreyer, 2017:65). To make such important final judgements, AoL should, therefore, be designed to measure the depth of learning affording the learner space and opportunity to display knowledge and skills acquired and developed (Logaw, 2017:4).

3.3.4 Formative Assessment

Pinger, Rakoczy, Besser and Kleine (2018:161) define formative assessment as a process that assists the teacher in eliciting information on learner performance to provide constructive feedback to learners and/or improve the planning process. According to Looney (2005:21), formative assessment assisting the teacher in identifying learning needs to adjust the teaching and learning process. Therefore, teachers and their learners use feedback towards developing a classroom environment that responds to learner needs. Amua-Sekyi (2016:1) asserts that formative assessment can eliminate the teacher-learner hierarchical relationship as the dialogue can be used as a mechanism for knowledge transfer. The Mathematics teacher systematically uses formative assessment to observe and monitor learners' ongoing progress. Figure 3.2 provides two kinds of formative assessment that are discussed in this study and how they impact the teaching and learning process in Mathematics.

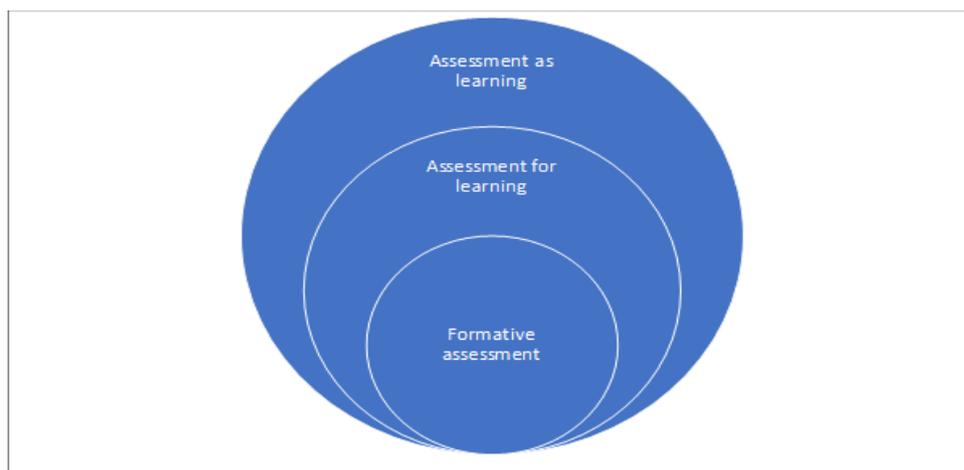


Figure 3.2: Types of formative assessment (adapted from Heritage, 2010:2)

Assessment for Learning (AfL) and Assessment as Learning (AaL) as part of formative assessment, is presented and discussed in the subsequent sections.

3.3.4.1 Assessment for learning

Whereas formative assessment measures learner understanding of concepts, AfL serves the purpose of promoting learning through teacher and learner accountability (Black, Harrison, Lee, Marshall & Wiliam, 2004:10). Recent evidence posits that AfL assists the teacher in better understanding of how learners are learning and using feedback to plan to meet their academic needs (Cambridge Assessment International Education, 2017:1). The learner uses information from the AfL to help plan what is needed to be done next in the learning process (Higgins, 2014:12). Because AfL is conducted on day-to-day classroom practice, teachers and learners are given space to reflect on the outcome and plan on the next course of action. This assessment is different from the assessment that is used to hold only teachers accountable for what is happening in class.

According to Wu and Jessop (2016:3), AfL practices assist the learners in the processing of learning in the long-term memory and with a promise of developing deep learning (Hattie, 2009:260). This is particularly of great significance in teaching and learning practices because it promises that learning becomes sustainable which is beneficial to learner development. Therefore, AfL provides a link where the learner is in terms of knowledge development and shared learning goals.

AfL allows both intrapersonal and interpersonal dialogues about the learning intentions (Black, 2015:169). The learner is allowed to be an active participant, suggesting that the individual learner personalise learning, and have a conversation to identify what needs to be done. This is particularly in-line with Vygotsky's notion of social constructivism which suggests that learning arises with the interaction between two or more people (Schunk, 2012:231). The emphasis is on the learner managing the learning process with the assistance of a teacher or another more competent learner. The research on AfL by Paul Black and Dylan Wiliam (1998), *Inside the Black Box*, concluded that AfL should be made an integral part of how Mathematics teaching and learning unfolds in Mathematics classrooms and secondly, the evidence derived from the assessment should assist the teacher in modifying teaching to meet learners' academic needs and improve learning. Two types of assessment for learning (AfL)

practices have been identified as formal and informal AfL (Shevelson, Young, Ayala, Brandon & Furtak, 2008:300; Vingsle, 2014:9) and are discussed below.

(a) Formal, planned assessment for learning

Formal AfL is a planned assessment undertaking wherein the teacher focuses on getting information from the teaching process. The teacher has planned questions/ activities that are given to learners to complete to elicit information on current learning patterns (Vingsle, 2014:9). The planned activity is given to the learners during instruction, marked and both the teacher and the learners receive immediate feedback on instruction (Heritage, 2007:142). The process is a deliberate action by the teacher to uncover the level of knowledge learners possess at the time of instruction. Because formal AfL activities are completed by the learner, they are documented and easily accessible to provide timely feedback. The corrections are given after the completion of the activity which assists the learner and the teacher to have a clear understanding of current knowledge and what the learner still needs to learn.

(b) Informal, unplanned assessment for learning

Through informal, unplanned AfL, learners have the opportunity to learn about themselves as individual learners and become aware of how they learn, that is, knowledge of their thought processes (Saefurrohman, 2015:55). The informal assessment helps the teacher to obtain information about a learner whenever a need arises promoting learner-teacher conversations. Shevelson *et al.* (2008:300) refer to this form of assessment as “on-the-fly” assessment and is prompted by a teachable moment that arises requiring immediate correction of learner misconception. Such opportunities arise when teachers observe learners perform a task and sharing an incorrect idea or a learner requesting an explanation from the teacher and on follow up, the teacher notices that the learner has the wrong idea about the concept. The feedback allows the teacher to use an impromptu lesson that assists in clearing the misconception before moving forward with instruction.

3.3.4.1.1 Elements of assessment for learning in Mathematics

Linked to AfL practices are elements that are important in assisting the Mathematics teachers in applying AfL in their classrooms. Figure 3.3 represents the elements of AfL as suggested by the OECD (2008:7). Each element is explained based on its importance in the application of AfL in Mathematics.

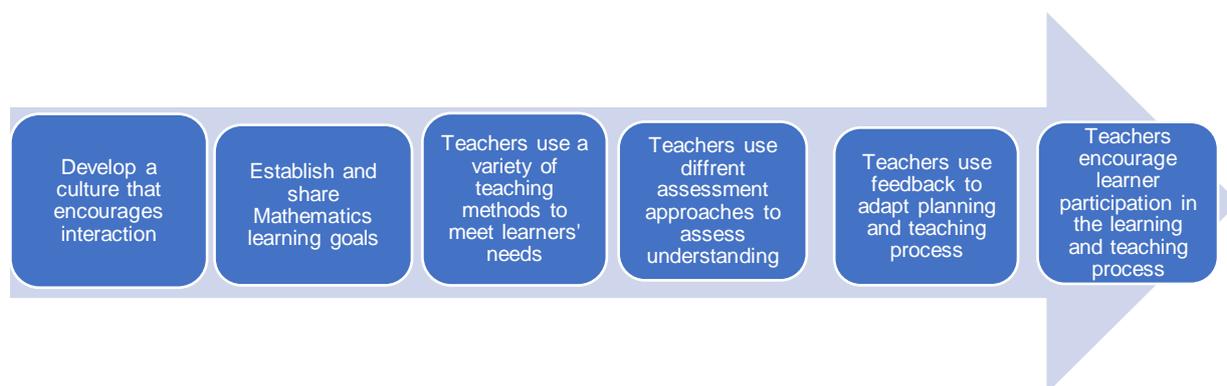


Figure 3.3: Elements of AfL (adapted from OECD, 2008:7)

Element 1: *Development of a classroom culture that encourages teacher-learner interaction.* The Mathematics teacher must create a safe environment that encourages interaction and motivates learners to take risks and even make mistakes so that what they know and do not know is identified and dealt with (Bhowmik, 2015:10). The environment should encourage learners to communicate with teachers and other learners concerning their learning and what they need to do to improve (Amineh & Asl, 2015:13). Interaction is a key component in teaching and learning as it promotes teacher-learner dialogue and engagement in discussing the next step in the learning process (cf. 2.3.2.1)

Element 2: *Establish and share Mathematics learning goals.* Teachers and learners should share Mathematics expectations and agree on the route towards meeting the learning goals. The tracking of progress should assist them in knowing if they are meeting the set standards towards achieving the learning goals (Scott et al., 2014:57). The learner should, therefore, be allowed to reflect on the learning goals to identify the gaps in mathematical concepts being learnt and together with the teacher, device a plan on how to meet the desired outcome.

Element 3: *Teachers use a variety of teaching methods to meet diverse learner needs.* Using feedback, teachers should find ways of adjusting their teaching practice to accommodate classroom needs. Teachers should realise that learners' experiences and beliefs play a vital role in knowledge construction (Bada, 2015:66). This is particularly central to the constructivist view of learning which promotes the recognition of learners' context and experiences in the learning process (Aljohani, 2017:99).

Element 4: *Mathematics teachers use different assessment approaches to assess understanding.* Learners learn differently using varied styles of learning and using multiple intelligences (MI) and, as such, assessment activities should depict such differences (Bosman & Schulze, 2018:1; Dreyer, 2014:85). Bosman and Schulze (2018:1) point out that teachers' neglect of learning styles found in Mathematics classrooms contributes to the poor performance of learners. Generally, assessment activities should, therefore, reflect activities for a visual learning style where learners prefer to present information through the use of diagrams (Fleming, 2015:1). It should also cater for auditory learners who prefer to work in groups and use spoken words to reflect their learning (Juškevičienė & Kurilovas, 2014:20). Lastly, assessment activities should cater to kinaesthetic learners who prefer to move and act (Juškevičienė & Kurilovas, 2014:20).

Element 5: *Teachers use feedback to adapt their planning and teaching process to be responsive to the needs of learners.* The role and the influence of feedback in AfL cannot be overstressed. Isabwe, Reichert, Carlsen and Lian (2014:30) maintain that feedback should make learners aware regarding their learning and Mathematics concept development towards meeting learning objectives, in other words, making them take responsibility for their learning. The DBE (2011a:293) suggests that the feedback given to learners should be constant, regular and assist in the learners' learning experiences. Therefore, feedback should be meaningful, which means that the learner can use it in identifying learning gaps that need to be attended to.

Elements 6: *Teachers should encourage maximum learner participation in the teaching and learning process of Mathematics.* Learners should be allowed to construct their knowledge through learner-centred assessment activities (Bada, 2015:68). The use of self-assessment allows the learner to make judgements about

their own work (Dreyer, 2014:107). Learner participation helps the learner to open up to the teacher about their learning needs, assisting the teacher in taking necessary steps towards providing support (*cf.* Chapter 2, section 2.5.3).

Assessment as learning (AaL) and its importance towards improving the learning of Mathematics.

3.3.4.2 Assessment as learning

Whereas Mathematics teachers use AfL to gather and document learner performance to develop feedback to move the teaching and learning process forward, in AaL learners take ownership of their learning through self-reflection (Li, 2018:50). In other words, the learner uses feedback to identify learning areas that need improvement and plan on how to move forward towards meeting the learning goals. Li (2018) continues to point out that AaL is consistent with self-assessment principles in which learning is identified as autonomous, self-directed and life-long. Learning does not end with classroom feedback provided to the learners; it is a process in which learners make adjustments in taking charge of the changes to be implemented.

Torrance (2007:282) advocates for a steady move in assessment application which means that Mathematics teachers should strive to move the assessment of learning through assessment for learning to assessment as learning. This move recommends an approach to assessment in which learning experiences are based on self-directed learning. AaL, therefore, involves the learners asking questions about their learning towards the actualisation of knowledge (Reeve, 2012:165) through linking the Mathematics requirements with the learning process (Dann, 2014:149). This practice is in line with the grounding theory of this study which is a constructivist approach to learning (*cf.* Chapter 2, section 2.3.1). First, AaL acknowledges the learner as an active participant through cognitive self-regulatory adjustments towards meeting learning goals in Mathematics. Secondly, it proposes the role that the teacher should be playing in helping the learner realise Mathematics requirements through feedback.

3.4 METHODS OF ASSESSMENT USED IN ASSESSMENT FOR LEARNING

AfL practices are designed to make value judgements of learner performance in which the main focus is the learner-centred approach in developing and giving feedback that supports learning (Weurlander, Söderberg, Scheja, Hult & Wernerson, 2012:747). To achieve this aim, different assessment methods, namely, self-, peer- and group-assessments are the proposed methods that could be used in helping learners make judgements about their work (Dreyer, 2014:107). While learners are central in these strategies, Mathematics teachers should provide clear criteria and standards to be used in making judgements of their classroom activities (Wylie & Lyon, 2015:143). A criterion provides measurable characteristics by which quality in assessment is maintained in making judgement standards of the completed work (Sadler, 1987:194).

In trying to elaborate on the importance of different assessment methods, William (2013:16) presents what is called the key strategies of formative assessment. The researcher postulates that both the Mathematics teachers and the learner should be able to distinguish between where the learner is, where they need to be and how to get there in terms of their learning. The researcher's presentation of the strategies links the relationship between the teacher, the learner and peers in the Mathematics classroom (William, 2013:16). The idea of the key strategies is of great importance to this study as it advocates for the importance of teacher-learner relationship (*cf.* 2.3.2). Figure 3.4 below presents the key strategies of assessment for learning, indicating the role of the Mathematics teacher, peers and the individual learner in classroom instruction.

Table 3.1: Key strategies of formative assessment (adapted from William, 2013:16)

	Where the learner is going?	Where is the learner right now?	How to get there
Teacher	Teacher and learners share Mathematics learning intentions and goals.	Mathematics teacher skillfully arranges discussion through creating tasks that elicit the evidence of learning	The teacher and the learner discuss feedback, identify learning gaps and plan the next step
Peer		Teacher and learners create an environment that promotes classroom interaction and unpacks what needs to be done	
Learner		The Mathematics teacher, through discussion, actuates the individual learner to take responsibility for their own learning	

William (2013:19) draws our attention to the fact that learners have an upper hand with classroom instructional decisions. Their increased engagement with the teacher and classroom activities provides the Mathematics teacher with an opportunity to plan to meet their individual needs. On the other side of the coin, the teacher's disengagement denies them the space in assisting learning. Therefore, the triad relationship the individual learner has with the teacher, as well as other learners, may be key in advancing and improving the learning process.

Figure 3.4 below represents different methods of assessment; the triangular representation symbolises the importance and the value that should be attached to each method.

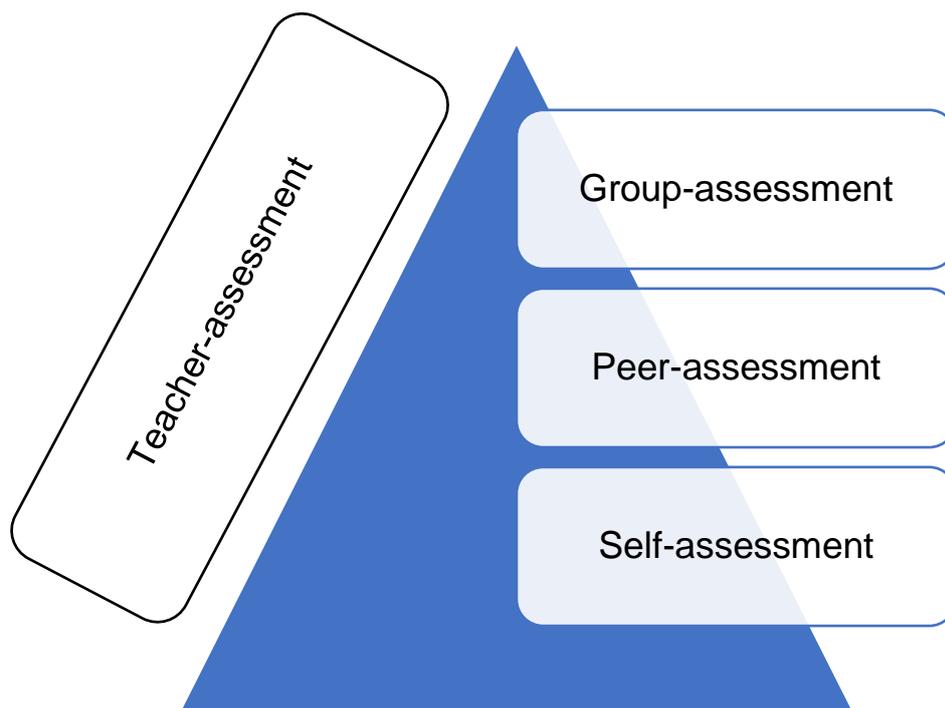


Figure 3.4: Methods of assessment (adapted from Dreyer & Mawela 2020:46)

In the following section, all methods of assessment listed in Figure 3.4 and their importance in AfL practices in Mathematics are presented and discussed.

3.4.1 Teacher-assessment

Teachers use AfL strategies to pose questions to understand how learning takes place (Vingsle, 2014:10). To gain access to learner development, teachers use both planned and unplanned AfL methods (*cf.* 3.3.4.1) to elicit information that can be used to understand and evaluate how Mathematics curriculum concepts are delivered (Heritage, 2007:142). Teacher-assessment, therefore, assists in creating space for instructional dialogues to increase learner participation by interacting with individuals or groups of learners. The teacher uses instructional dialogue to respond to learner's academic needs as questions are posed by the teacher or initiated by the learner (Ruiz-Primo & Furtak, 2006:17). Understanding where the learner is with his/her learning allows the teacher to make valuable adjustments in their mathematical concept planning and future teaching (William, 2013:18).

3.4.2 Self-assessment

Self-assessment is a classroom practice in which learners are made to reflect on their performance by making judgements of their own work (Dreyer, 2014:108). This view is supported by Birjandi and Tamjid (2012:515) who states that this method may assist the learner in internalising knowledge and take responsibility as well as autonomy in determining what needs to be done next. The learner is given autonomy to assess their progress towards meeting the learning intentions and goals (Wylie & Lyon, 2015:143). It, therefore, provides learners with the opportunity to do introspection on mathematical aspects that they need to improve without being compared to other learners in the classroom. Because the learners in Grade 6 are still young, they may try to cheat to get high marks and it is the responsibility of the teacher to ask the learner to justify how marks were allocated.

Embedded in self-assessment is assessment as learning (AaL), through which the learner reflects on what they have learnt, in the process identifying strengths and knowledge gaps (Fletcher, 2016:401). AaL is consistent with learner-centred approaches to teaching and learning as it allows the learner to critically analyse progress in meeting the learning goals (Li, 2018:50; *cf.* Chapter 2, section:2.5.3). In other words, learners assume a responsibility to be self-critical of their learning and work towards connecting their learning experiences to monitor their mathematical concept development.

Therefore, self-assessment promotes self-regulation, which is an active and constructive process by which the learner sets targets and goals towards their achievement (Ergen & Kanadli, 2017:56). Self-regulating learners can maximise their time by planning on improvement, participation and focus on instruction as well as practising through using social sources effectively (Erdogan, 2018:1478). Zimmerman (2002:65) posits that self-regulated learning is an individual action undertaken to transform learner mental abilities into academic skills by taking the initiative in learning.

In the context of Mathematics teaching, learning and assessment, assessment for learning (AfL) should, therefore, be designed to assist learners in identifying their current state of learning by using feedback to model their performance. Suffice to say

that self-regulating learners tend to be more effective in mathematical concept development (Zimmerman, 2013:137).

3.4.3 Peer-assessment

Peer-assessment involves learners marking each other's work and providing feedback (Omar, Shahrill & Sajali, 2018:204) and learning from each other, which is less intimidating (Dreyer, 2014:108). Omar *et al.* (2018:204). continue to highlight that peer assessment positively affects how learners view Mathematics by improving their reasoning skills and cognitive knowledge such as conceptual and procedural knowledge. Ndoye (2017:256) suggests that peer assessment should be done anonymously by minimising the contact between the assessor and the learner being assessed. While the learner are focused on judging peer's work, he/she is given space to reflect on his/her work and how he/she can improve on concept development. Therefore, the learner becomes critical of his/her work and it might assist in altering the attitude towards Mathematics learning.

Gielen, Dochy, Onghena, Struyven and Smeets (2011:721) refers to different specific goals of peer assessment that are important to AfL practices. Goal one suggests that peer assessment should be viewed as a social control tool (*cf.* Chapter 2, section 2.4.3). The researchers posit that when learners know that their work is to be assessed by peers that may act as an external motivator for them to work harder. Goal two says peer assessment could be used as an assessment tool through learners rating each other's work. They then articulate goal three in which peer assessment could be used as a learning tool. The authors propose that feedback could be used to promote interaction between peers, which in turn increases the learning process. As they assess and learn from their peers' work, each learner begins to reflect on their work and learning intentions. Goal four advocates for peer assessment as it presents to the learner the skill to assess. Gielen *et al.*, (2011:729) propose that with practice, peer assessment can instil lifelong learning as learners develop a criterion to assess their own work in the absence of a teacher. Goal five advances the need for active learner participation in the learning of Mathematics through peer assessment (Horn, 2009:515). Therefore, peer assessment can help the learners to look closely at their own Mathematics, in a more democratic environment. The learners then begin to

critique their own work having been given feedback by peers and this practice positions the learning process at a learner-centred approach to learning Mathematics.

3.4.4 Group-assessment

The term group-assessment entails the process in which learners assess their contribution towards a mathematical activity product, or learners assessing the work they have produced or other groups (Dreyer, 2014:109). According to Ndoye (2017:258), learners begin to take their work seriously in a group because they are being supported and thus promoting mutual and collaborative learning. Learner collaboration with more capable learners has been found to assist in increasing learner performance (Bae & Kokka, 2016:6; *cf.* Chapter 2, section: 2.3.2).

The various methods of assessment, which form part of AfL, are discussed in the next section taking into account learning intentions and how they link with classroom assessment to develop feedback that moves teaching and learning forward.

3.5 THE VALUE OF LEARNING INTENTIONS IN ASSESSMENT FOR LEARNING IN MATHEMATICS

The Hanover Research Report (2014:11) postulates that Mathematics learning intentions are a vital component of AfL practices. The report suggests that learning intentions help the learners visualise the link between the lesson being delivered and the classroom assessment. Therefore, the learning intention is at the centre of all classroom instruction including the development and application of assessment activities. Figure 3.4 below represents the characteristics of learning intentions

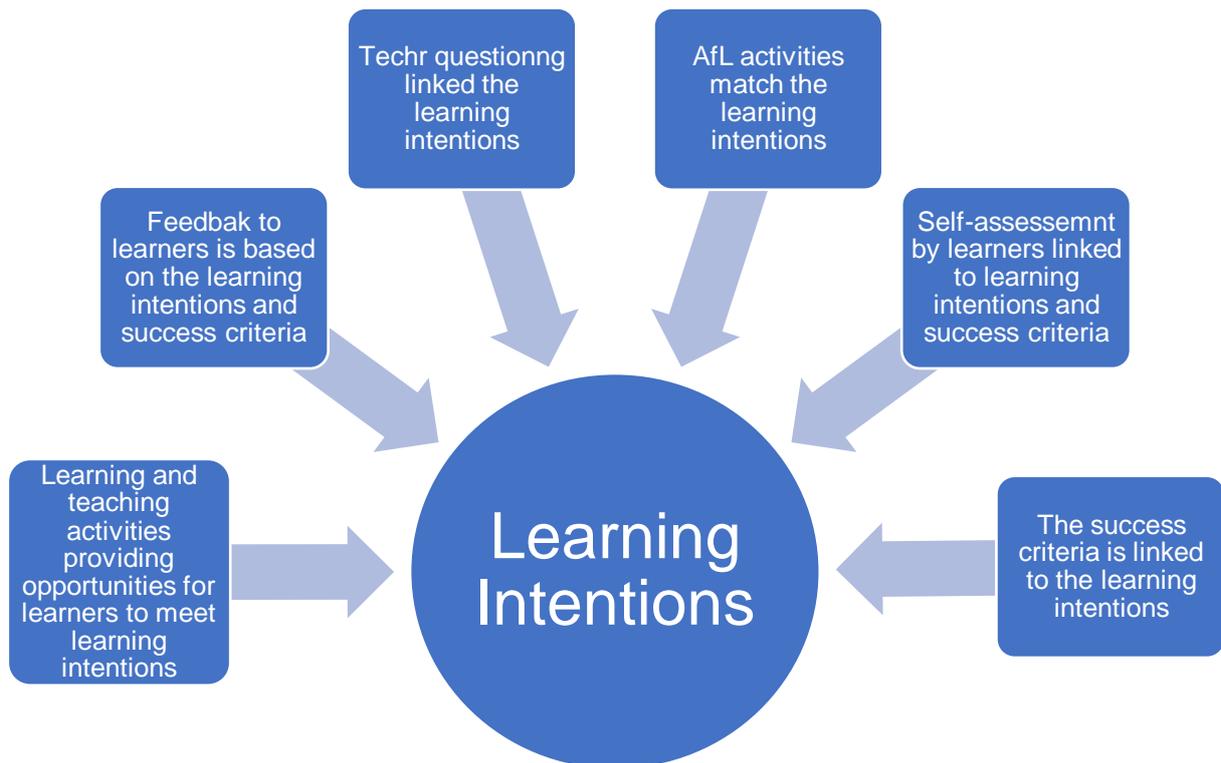


Figure 3.5: Learning intentions in classroom instruction (adapted from Hanover Research Report, 2014:12)

In explaining the learning intentions, William (2011:46) suggests that Mathematics teachers should clarify the conditions for success and engage learners in mathematical activities that provide evidence of learning. The feedback derived from the assessment is analysed based on shared learning intentions. The learners should, therefore, be allowed to own their learning as well as demonstrate their thinking. The researcher believes that the learning intentions synergises the understanding of what is going on in the class by showcasing the signposts towards Mathematics success. The learners know what is expected of them towards meeting Mathematics targets and are allowed to self-assess engage the teacher and other learners.

3.6 THE BENEFITS OF ASSESSMENT FOR LEARNING PRACTICES IN MATHEMATICS

The application of AfL in Mathematics instruction is founded on the constructive view of learning which proposes a learner-centred approach to teaching, learning and

assessment (DBE, 2012:4). The focus of constructivism moves from the premise that assessment should be used for teaching purposes to be structured to affect learning with a view that learning should be an active process (Alam, 2016:52). It is through active learning that the purpose of AfL, that of providing feedback, that can be used by both teachers and learners to change classroom instruction is realised (Dreyer, 2014:12). Therefore, teachers and learners benefit from a learner-centred approach to assessment because it promotes learner engagement, which in turn, provides important feedback to drive the process forward.

As has previously been alluded, feedback derived from assessment for learning (AfL) practices has major implications on how Mathematics teaching and learning unfolds in the classroom (*cf.* 2.3.2). Organised feedback has the potential to support teaching and learning, simplify learner self-assessment towards meeting learning goals and independence, inspire positive motivation towards addressing performance and provide an opportunity for a meaningful dialogue between the teacher and the learner as the next step (Ahea, Ahea & Rahman, 2016:38-39; Lui, 2012:5). Mathematics teachers use feedback derived from AfL activities for planning purposes (Lui, 2012) to close the learning gaps between the current and desired learner performance (Ahea *et al.*, 2016:39). Consequently, teachers become aware of the learners' mathematical needs and plan towards supporting the learner in meeting the learning goals. Learners, on the other hand, become aware of their own learning and what is expected of them (Ahea *et al.*, 2016:39). Therefore, feedback assists the learner in self-regulating their progress towards meeting specific skills in Mathematics. Lui (2012:5) suggests that Mathematics should develop AfL activities that challenge learner's reasoning and stimulate their thinking, that is, to motivate their efforts in learning Mathematics. However, the activities should not be punitive and discourage learners in learning Mathematics, but instead provide feedback on learner progress and achievement (Richmond, 2016:9). Therefore, the need for linking Mathematics learning goals to AfL becomes imperative, so that learners understand the role played by assessment activities in identifying and closing learning gaps. Figure 3.6 below illustrates the link between teacher-learner Mathematics learning goals, learner-teacher dialogue based on AfL results which directs how teaching and learning should proceed.

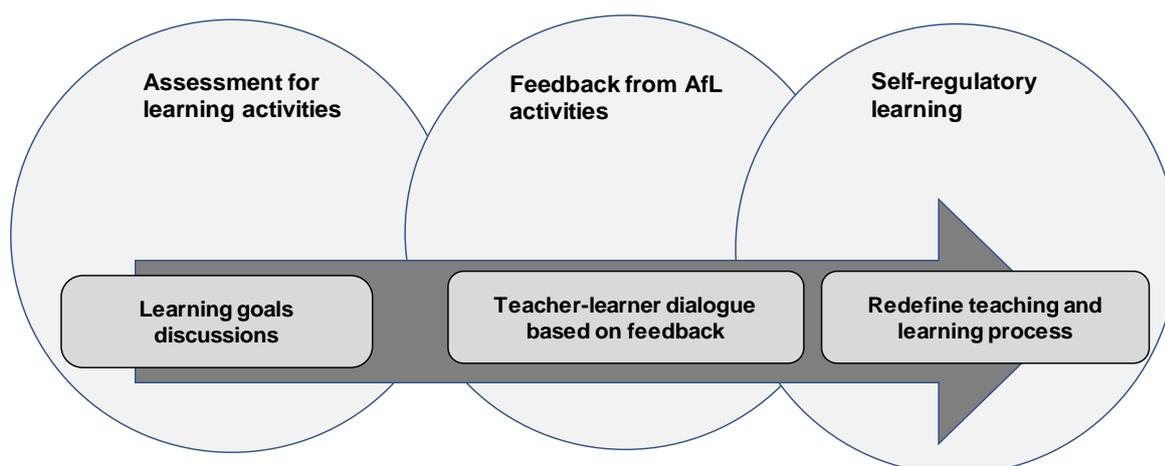


Figure 3.6: An illustration of the process of AfL practise (adapted from Banta, Lund, Black & Oblander, 1996:54-55)

Teachers and learners, therefore, should always bear in mind that assessment is ongoing and directed at developing feedback to redefine and improve classroom instruction. For AfL to achieve such status, certain values should drive their practices for the benefit of the learners. Banta *et al.* (1996:54-55) identify important principles that are important in driving good practices in AfL. The authors indicate that assessment is likely to be successful in practice if the teacher base it on educational values. Teachers should administer assessment based on shared goals, in which both the teacher and the learner are committed to mathematical tasks that reflect complex classroom learning styles as well as using multiple assessment methods that measure how the learning process is unfolding. The goal of Mathematics assessment must be well articulated so that both the teacher and the learner find time to value the impact it plays in the teaching and learning process. Teachers should, therefore, dedicate time to the planning process, thus developing assessments that can track learning experiences that provide feedback that will lead to an improvement in teaching. In other words, assessment when correctly administered could assist the teacher in making important adjustments in their teaching strategies based on the learning capabilities of the learners (Thomas, Allman & Beech, 2004:15).

Đurišić and Bunijevac (2017) present the argument that good assessment practice should reflect assessment as an ongoing practice that evolves over time and is embedded in the classroom learning culture. It helps the teacher develop a true

reflection of learner ability towards meeting the desired performance. (Alufohai & Akinlosotu, 2016:71). It should indicate to learners the sense of urgency to take advantage of assessment feedback towards meeting their educational needs through appropriate teacher planning. Teachers and learners should use assessment as a tracking mechanism for learner development towards the achievement of educational goals.

The involvement of parents in assessment is of paramount importance. Whether the assessment activities take place in school or at home, parental involvement informs the parent of the development of the learner towards meeting the academic goals (Đurišić & Bunijevac, 2017:144). Learners and parents should be informed when, why and how the assessment will take place. This means that parents should know what is expected from learners in a particular moment of the academic year and being involved in the build-up towards that goal allows them to contribute to the achievement. This process requires close monitoring of the learner's work and increased teacher-learner-parent interviews to ensure enhanced learner performance.

However, teachers are challenged in the application of assessment for learning and a review of the literature on the challenges in the successful implementation of AfL practices in Mathematics in Grade 6 is presented in the following next section.

3.7 CHALLENGES HINDERING THE APPLICATION OF ASSESSMENT FOR LEARNING

This section discusses some of the challenges that teachers experience in the application of AfL in Mathematics in Grade 6. The researcher is of the view that the identified challenges if attended to by relevant stakeholders, can improve how teachers and learners view assessment for learning.

3.7.1 School Physical Facilities

Several factors can limit the effective implementation of assessment for learning when considering teachers' practices. Khumalo and Mji (2014:1523) identify the availability of infrastructure as a vital ingredient in improving the application of AfL in classroom

instruction. They view infrastructure as an integral component for the implementation of assessment practices that enables teachers and learners to access both human and material resources to support AfL application. Limon (2016:46) believes that the performance of learners can be attributed to the condition of the school infrastructure. A poor infrastructure that threatens the safety of teachers and learners is, therefore, seen as a precondition that influences how well classroom practices like AfL unfolds. Because of poor infrastructure, South Africa learners are at risk and as a result, is seen as an infringement of the basic right to an environment that is not harmful to their wellbeing (The Constitution, Section 24, 1996:9).

Apart from the physical structure of the classroom Cheryan, Ziegler, Plaut and Meltzoff (2014:5-6) have identified class lighting, temperature and air quality as some of the contributory factors to learner performance. Learners who are exposed to natural daylight are found to perform better. In other words, classrooms should be designed in a way that allows natural light to permeate the room without causing any visual discomfort (Benya, 2001:1). Excessive high or low temperatures cause discomfort and lower learner performance. Kausar, Kiyani and Suleman (2017:58) note that extreme temperature adversely influences learner attentiveness in completing classroom assessment tasks. Air is an important denominator when it comes to increased brain functioning and is linked to health. Stafford (2015:36) points out that improved classroom ventilation affects the speed at which learners perform in numerical tasks. Poorly ventilated rooms pose a health risk which may increase the chance of learners not performing to expected levels in Mathematics assessment for learning activities.

3.7.2 Overcrowding of Classrooms

Many studies have shown that classroom overcrowding adversely affects classroom instruction. According to Matshipi, Mulaudzi and Mashau (2017:110), teachers working in overcrowded classrooms experience serious problems when compared to smaller classes, such as dealing with the disruptive behaviour of learners which could occur. In such situations, teachers spend time demanding learner attention instead of assessing (Marius, 2016:3), which is in line with Mustafa, Mahmoud, Assaf, Al-Hamad & Abdulhamid's (2014:3) assertion that learner behaviour becomes disruptive in overcrowded classrooms and adversely affect how teachers and learners interact

towards the completion of activities. As a result, learners pay little attention to classroom instruction and the intensity of participation in assessment activities is lessened. The teacher is therefore unable to derive learner feedback to inform future planning and teaching practices.

Findings from a study conducted by Khan and Iqbal (2012:10164) suggest that assessment is not possible in overcrowded classes due to learner discipline. This point is supported by Ayeni and Olowe (2016:65) who reported that in larger classes teachers find it hard to spot assessment challenges, giving feedback and identifying individual learner needs. Because AfL practices are based on increased learner-teacher and learner-learner interaction, its implementation becomes strained and impractical (Matshipi *et al.*, 2017:111). From what has been presented from the review of literature, it is evident that overcrowded classrooms impede the creation of conditions that foster the implementation of AfL practices.

To attend to the escalating need of the classroom size debate, the Education Labour Relation Council (ELRC Resolution 4 of 1995) provided a guideline on learner-teacher ratio for ordinary primary school at forty to one (40:1). The proposed number of learners in a classroom allows the teacher and learners room for easy access for better interaction, allowing learner participation in AfL activities. Teaching strategies allow the teacher to personalise classroom activities to meet the academic needs of learners by giving feedback that moves learning forward (Onwu & Stoffels, 2005:79).

3.7.3 Teacher attitudes towards Assessment for Learning Practices

Teachers have the opportunity of making a lasting impression concerning assessment importance in learners. Their assessment practices in Mathematics can shape and influence how learners view their individual and collective Mathematics abilities towards achieving educational goals (Salema, 2015:32). Such impeccable influence is dampened by assessment requirements such as marking of learners' work and providing feedback (Bramwell-Lalor & Rainford, 2016:380). Researchers continue to suggest that the success or failure in the implementation of AfL in the classroom, may be due to the attitude a teacher has towards it. An attitude is seen as a behavioural pattern of an individual in responding favourably or unfavourably towards an issue

(Siobamcha, 2016:103). In other words, the behaviour of a teacher will either be positive (for) or negative (anti) implementation of AfL in Mathematics.

Assessment for learning (AfL) is found to play a crucial contribution in driving classroom teaching and learning process suggesting that the teacher's attitude towards it is vital (*cf.* Chapter 3, section: 3.3.4.1). Teachers who have been exposed to traditional assessment culture and employ the summative role of assessment may have resentment in the application of AfL practices (Bramwell-Lalor & Rainford, 2016:381). The negative disposition held by the teacher towards AfL may degrade the importance or the influence that it might have in influencing classroom practices (Zaidi, 2015:46).

Chamundeswari (2018:16) mentions cognitive, affective and behavioural as three components of attitude formation in teachers. The author's explanation suggests that the cognitive component describes the knowledge and assumptions a teacher holds towards AfL and its implications for Mathematics teaching and learning. The knowledge base depends on the training the teacher received from the Department of Basic Education as part of in-service training. The knowledge acquisition influences how the teacher acts towards the use of AfL and the feeling they have towards its application. From the knowledge they have acquired, teachers develop positive, negative or neutral attitudes and views about the implementation of AfL practices (DBE, 2011a:7). Mathematics teachers' attitudes are then translated into specific classroom assessment practices that affect learner performance (Cook, 2002:263). The three components, therefore, help the teacher in creating an environment that acts as a stimulus towards fuelling productive or counter-productive professional attitude towards AfL implementation in Mathematics. According to Zaidi (2016:47) regular and continuous teacher in-service training assist in improving teacher attitude towards the implementation of AfL practices.

3.7.4 Teacher Workload

Mathematics is a demanding subject that needs teacher and learner commitment and increased work ethics, and Mathematics teacher workload needs to be viewed in terms of the demands of the subject. Teacher workload is the total of all academic and non-

academic work assigned to the teacher to perform to meet educational goals and it includes subjects they have to prepare for and teach, administrative duties and learner supervision and other school-related activities (Nkweke & Dollah, 2011:27). The workload has been found to have a direct impact on teacher-learner performance. Teachers' lack of time because of a variety of activities they have to perform, including assessment, teaching and learning impair their ability to monitor learner performance (Ndioho & Chuku, 2017:91).

The primary task of a teacher is classroom teaching, yet non-academic responsibilities such co-curricular activities are allocated to teachers (Harun, Omar, Idris & Basri, 2015:401). The workload pressure felt by teachers has led to unpleasant outcomes related to teacher and overall learner performance. Noticeable are teacher behaviours that include low enthusiasm, reduced effectiveness, absenteeism and decreased commitment to classroom instruction (Harun *et al.*, 2015). Due to the reduced classroom input by teachers, assessment for learning practices suffer and its impact on planning, teaching and learning is impaired. If the issue of workload continues unabated, it leads to teachers' low self-esteem, stress and incomplete tasks (Raman & Othman, 2017:8). Therefore, when teachers perceive their workload as unfair and excessively demanding, they become dissatisfied and their commitment is eroded.

Teacher assessment planning abilities and knowledge of AfL practices are central to the positive impact assessment have on teaching and learning process as well as improved learner performance.

3.7.5 Language of Learning and Teaching in AfL activities

The language used in Mathematics assessment is relevant because when attending primary schools, the language of learning and teaching (LoLT) usually differs from learners' Home Language (HL). It is assumed that by the time the learner reaches Grade 6 that proficiency in the LoLT has been reached if not, this aspect could affect learner performance. This statement aligns with that Henderson and Wellington (1998:36) who point to the link between the language used in the Mathematics assessment and the quality of learners' work. On the other hand, Wellington and Osborne (2001:6) have identified a link between the development of a language and

mathematical concept formation. Both Henderson and Wellington (1998) and Wellington and Osborne (2001) research findings indicate the importance of language usage in Mathematics AfL activities. How teachers use the language in the assessment activities and how learners understand the language, can inadvertently affect how learners respond in providing mathematical solutions to questions.

Based on the constructivist view that AfL is a learner-centred approach to teaching and learning, learners should be able to listen, talk and complete assessment activities with the teacher as a facilitator (Sharma & Nuttal, 2016:142). For learners to succeed in classroom discussions they need to be proficient in the LoLT and be familiar with multiple mathematical registers (Setati, 2002:10). Mathematical register refers to how teachers can use everyday language to express mathematical meanings of life in teaching Mathematics (Lee, 2006:15). In other words, the ability of learners to demonstrate the pluralism of word meanings will assist them in using them correctly in Mathematics. To minimise barriers related to Mathematics language development, Riccomini, Smith, Hughes Fries, (2015:239) suggest that Mathematics teachers must systematically teach and facilitate the understanding of essential vocabulary in Mathematics.

3.7.6 Availability of Resources

The use of relevant resources in assessment and teaching of Mathematics can make a difference in concept development (Yusta, Karugu, Muthee & Tekle, 2016:13). According to Orodho, Waweru, Ndichu and Nthinguri, (2013:4), the availability of adequate and relevant resources helps in enhancing concept development in Mathematics. Resources assist learners to be hands-on and therefore, stimulate their interest and actively engage learners in the subject matter. The scarcity of teaching and learning resources, therefore, contributes to teacher effectiveness in delivering Mathematics content (Mupa & Chinooneka, 2015:125). A conclusion made by Mupa and Chinooneka (2015:128) is that teacher effectiveness is ignited by the relevant availability of resources that assist in not only the teaching and learning process but also in the assessment of learners. How Mathematics teachers use teaching and learning resources, including textbooks, visual and technological (*cf.* Section 2.6.5), becomes important in mathematical concept development and assessment practices.

With an understanding of the different types of assessment, the following sections bring to light how different countries have adopted AfL through policy design and improvements or challenges they face.

3.8 GLOBAL APPLICATION OF ASSESSMENT FOR LEARNING IN MATHEMATICS

World countries are restructuring their education system so that it meets international demands of improving the learning process (Popham, 2000:1). To realise and fulfil these changes, Black and Wiliam (1998b:1) suggest that assessment should be at the heart of the teaching and learning process providing learners with effective opportunities to learn. The new paradigm in Mathematics assessment is based on the constructivist view of education which proposes a learner-centred approach to assessment undertakings. The assessment evolution is shifting towards diversifying the practice through learner inclusivity (OECD, 2015:123; Buhagiar, 2007:41). The adoption and application of assessment for learning (AfL) practices are discussed by looking at Singapore, Australia, Zimbabwe and South Africa, with the discussion focusing on each country's assessment policy as well as its experiences based on the literature presented.

3.8.1 Application of AfL in Mathematics in Singapore

The OECD (2015: 177) Mathematics results placed Singapore as the best-performing country, having achieved 70 points above the average of participating countries. The 2018 PISA results show China overtaking Singapore to take the top spot (OECD, 2018: 18). Significantly, Singapore's mean Mathematics performance improved by points (Smith, 2019). According to Lee (2017:2), this achievement can be attributed to differentiated learning pathways that Singapore has undertaken in catering to different classroom learning needs. The system acknowledges that learners are different and are placed in an environment that supports their learning styles. The Singapore Education System allows for the implementation of different approaches that allow learners to bridge and ladder academic development (Lee, 2017:3). The ultimate

product of the system is to produce learners that are self-directed, confident, concerned citizens and active contributors (Lee, 2017:6).

Singapore uses The Singapore Mathematics Curriculum Framework (SMCF) as its policy in teaching and assessment of Mathematics (Dindyal, 2014:181). According to Dindyal, the Mathematics curriculum implementation is closely monitored, and schools are well resourced coupled with highly trained teachers who are subject specialists. The curriculum is centred around teaching problem-solving skills and learners are assessed on hard problems. To meet teaching and assessment demands, teachers are expected to undergo 100 hours of teacher development per year. Dindyal (2006:183) indicates that Mathematics teachers have also been provided with online platforms to share ideas and support each other on the best assessment practices. Singaporean Mathematics teachers are therefore kept abreast with the latest local and international assessment practices.

The classroom assessment of learners in Singapore is based on a Mathematics problem-solving cycle model (Singapore Ministry of Education (SMoE), 2012:18). The model takes into account the integration of Mathematics in the real world, that is, learner experiences (Jan & Rodrigues, 2012:137). Teachers use AfL activities to teach learners how to solve mathematical problems using representations through text, pictures and symbols (Ng & Lee, 2009:284). Learners who do not cope with the Mathematics load are attended to by specially trained Mathematics teachers in small groups (Kaur *et al.*, 2015:313). Figure 3.4 below illustrates the Singaporean model used in of the mathematical modelling process as used in Singapore when teachers and students are solving real-world problems. It can be used to support assessment for learning (AfL).

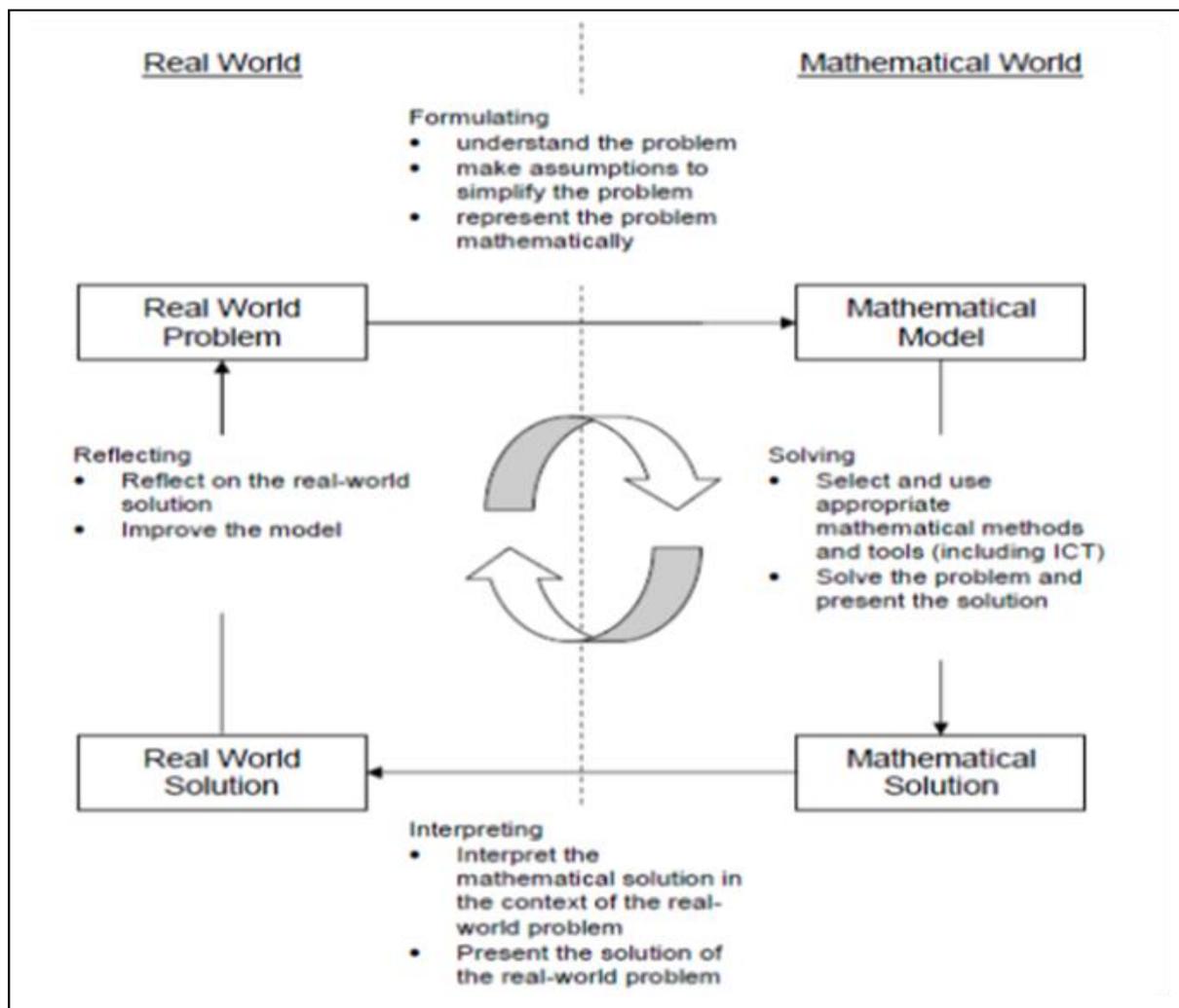


Figure 3.7: Singaporean model of the mathematical modelling process (SMoE, 2012:18)

The model presented above assists teachers in concentrating on Mathematics skills that learners have to acquire (Norton & O'Connor, 2016:18) to solve the problems. The model requires learners to make a connection between the mathematical world and the real world in a problem solving. The model proposes the use of authentic assessment which means that use of real-life problems Mathematics is needed (Vos, 2018:9). According to Yarhands, Owusu and Asiedu-Addo (2018:66), the disconnection between mathematical learning and real-life experiences may lead learners struggling with mathematical concepts. Therefore, the model encourages the learning of Mathematics concepts through connections with their immediate environment (Yarhands *et al.*, 2017 312).

3.8.2 Application of AfL in Mathematics in Australia

Unlike South Africa which has a centralised education system, the Australian education system has been decentralised to six states and two Commonwealth of Australia territories (Cumming & Maxwell, 2004:90). Each state has been mandated to develop its curriculum frameworks that guide the assessment of learners. As Luke *et al.*, (2011:310) point out, AoL is still a dominant assessment strategy as teachers work towards meeting accountability demands imposed. As AfL becomes popular, Australian states began adopting this type of assessment, trimming it to meet its curricular goals. For example, the state of New South Wales has developed its key AfL characteristics. Its teachers should view learning in which assessment assists in the learning process and includes clear goals for instructional activities. AfL should be inclusive for all the learners and must provide constructive and effective feedback that motivates learners (Birenbaun *et al.*, 2015:121). The implementation of assessment is illustrated in the Ministerial Council on Education, Employment, Training and Youth Affairs (MCEETYA, 2008:13-14), which was adopted to create a world-class assessment by adopting AfL, AaL and AoL as approaches to assessment in Australia. The key application strategy is that Mathematics teachers share the learning intentions to learners and provide ongoing feedback on how learners could attain the prescribed goals (OECD, 2011:51).

The implementation of assessment for learning (AfL) practices has come with few challenges as Van der Kleij, Cumming and Looney (2018:622-623) observe. The first challenge has to do with the simplistic adoption process which did not do justice to attend to the complexities of the classroom. The second challenge is teacher support towards developing the understanding that AfL is directly linked to other teacher activities such as Mathematics curriculum, planning, pedagogy and learning. As Heitink, Van der Kleij, Veldkamp, Schildkamp, & Kippers (2016:59) observed, the integration and alignment of AfL practice with the Australian curriculum and learning goals were vital in achieving its intended outcomes. Heitink *et al.* (2016: 56) continue to note that teacher beliefs and attitudes played a pivotal role in AfL implementation. The final challenge to the successful implementation was the nature of the Australian curriculum. The development of consultative documents developed by the National Curriculum Board the Australian Curriculum, Assessment and Reporting Authority

(ACARA 2012) is seen as an important step in deepening the understanding and implementation of AfL practices (Van der Kleij *et al.*, 2018:627).

The OECD (2015:192) acknowledges the educational assessment reforms being implemented which are directed at improving AfL practices by providing clear strategies on areas needing improvement. The Australian Curriculum (ACARA, 2017) views formative assessment as a core classroom practice assisting in monitoring as well as providing feedback on how teaching and learning are unfolding. Teachers use the evidence they have collected from the formative assessment to improve the learning process (Van der Kleij *et al.*, 2018:621). It allows the teacher and the learner to work towards meeting shared learning expectations and develop appropriate feedback to learners (Baird, Hopfenbeck, Newton, Stobart & Steen-Utheim, 2014:34).

The use of technology in Australian Mathematics classrooms has been acknowledged. The Australian Association of Mathematics Teachers (AAMT, 2015) advocates that access to basic calculators is a requirement for all learners as a means of introducing and developing number sense. The need for the use of calculators in Australia is to help learners improve their attitude and confidence in Mathematics learning. However, the overuse of calculators and other digital technologies have been found to impede and interfere with learners understanding and their ability to do basic Mathematics procedures (Norton & O'Connor, 2016:21). Mathematics teachers are therefore cautioned in overreliance on technology in the teaching and assessment of Mathematics.

Closely related to formative assessment in the Australian assessment context are AfL and AaL practices (Cumming, Van Der Kleij & Adie, 2019:8). According to Birenbaun *et al.* (2015:119), Education Services Australia (ESA) has developed an AfL project for Mathematics teachers intended for teacher development concerning effective classroom assessment. The workshop programme focuses on an introduction to AfL, learning intentions, success criteria and rubrics, effective teacher feedback; strategic questioning, peer feedback, learner self-assessment and formative use of summative assessment. AfL allows the teacher to use information about learners' academic progress to inform how they plan and teach, whereas AaL enables learners to reflect and monitor their progress (Van der Kleij *et al.*, 2018:621). Teachers use self- and

peer- assessment to help learners reflect on the learning gaps that exist and provide guidance on how to work towards closing them (Santiago, Donaldson, Herman& Shewbridge, 2011:52).

Therefore, the key characteristics of AfL have been interpreted as teachers viewing learning wherein assessment assists learners in learning better. Teachers should at all times use both informal and formal Mathematics assessment in informing their future planning. Mathematics teachers should clearly define goals for learning activities. Feedback provided to learners should motivate and lead to learner improvement. Mathematics teachers are encouraged to use both self and peer assessments as part of the classroom routine to help learners reflect on their learning process.

The preceding sections discussed AfL in countries situated in South East Asia and Australasia, the next section discusses AfL as it applies in an African context, that is in Zimbabwe.

3.8.3 Application of AfL in Mathematics in Zimbabwe

The education system in Zimbabwe falls under the Ministry of Education and Culture which is responsible for all the administration and supervision (Tichagwa, 2012:37). To attend to the educational and learning needs of its citizens, the Ministry of Primary and Secondary Education (MoPSE) has recently adopted the Zimbabwe Curriculum Blueprint 2015-2022. This education reform is aimed at promoting a competency-based curriculum, which focuses on a learners' ability to applying knowledge (Chitate, 2016:31).

The Curriculum Framework for Primary and Secondary Education 2015-2022 (Zimbabwe MoPSE, 2014:51) adopted a holistic approach to assessment in which learner competencies are assessed continuously. The Ministry has adopted AfL as a strategy to be used in Mathematics classrooms to help teachers support ongoing teaching and learning (Zimbabwe MoPSE, 2014:52). Teachers should use assessment to provide feedback to modify or personalise classroom instruction, to assess a broad range of traits, skills and abilities, and make assessment a learning

experience engaging learners with the Mathematics content. Two of the classroom-based assessments include learner self-assessment and peer assessment (Zimbabwe MoPSE, 2014:54). Self-assessment requires the learners to judge their own work to improve their performance as they identify discrepancies between current and desired outcome. During peer assessment learners give feedback to other learners about the quality of their work.

A study carried out by Kurebwa and Nyaruwata (2013:344) revealed that teachers in Zimbabwe lacked effective strategies in carrying out classroom assessment for learning. Mathematics teachers were found to concentrate on the demands of summative assessment, mostly, rote learning approaches because no attention was given to teacher development. The lack of proper resources to implement assessment practices hampered the progress towards meeting the educational goals in Mathematics. Teacher attitude towards forced assessment policies meant Mathematics teachers were reluctant to implement such policies which are coupled with overcrowded classrooms.

What Zimbabwe teachers experienced is in line with the report by Bethel (2016:107) who found that in most countries in Sub-Saharan Africa classroom AfL practices are found to be weak because of teacher domination of assessment, poor quality of teacher qualifications; large classrooms, poor infrastructure, the influence of summative assessment and shortage of proper assessment material.

Armed with the knowledge of what is happening in first and third world countries, the next section discusses assessment in the South African context.

3.9 NATIONAL APPLICATION OF ASSESSMENT FOR LEARNING IN MATHEMATICS

3.9.1 Assessment Transformation in South Africa

South Africa has been following global trends in assessment reforms which are symbolised by a major transmission into a constructivist paradigm in the assessment of learning and teaching of Mathematics (Rambuda & Fraser, 2004:10). The aim of

the radical changes in assessment procedures is meant to facilitate a supportive environment to improved educational experiences of learners (Darling-Hammond, Flook, Cook-Harvey, Baron & Osher, 2019:3). Assessment designed for improvement in learner performance should assist the teacher in identifying ineffective assessment classroom practices that do not benefit the learning process.

South Africa does not have a model that drives the application of assessment for learning (AfL) but instead is guided by important principles contained in the National Curriculum Statement R – 12 (DBE, 2011a&b:4) and the Curriculum and Assessment Policy Statement (CAPS), released in 2011, the Department of Basic Education's response to overhauling classroom assessment in South Africa (Spaull, 2013:7). These principles provide clear guidelines on how Mathematics teachers through AfL should respond to the learning environment. The first principle suggests that teachers should assess for social transformation by redressing educational imbalances as they occur in their classrooms, thus giving all learners equal opportunity to succeed. In this case, AfL activities in Mathematics should not create barriers and but instead minimise challenges to Mathematics learning and should be developed in a way that transforms how learners view the learning of Mathematics. Every endeavour should be undertaken to maximize knowledge development.

The second principle proposes active participation of learners in learning and critical learning. Active participation in classroom activities allows teachers and learners to have a conversation aimed at assisting the learner in constructing meaning to the mathematical concept being taught (Hoadley & Jansen, 2012:125). The AfL activities should reflect learner interest wherein rote learning is discouraged and learners are encouraged to reflect on the learning process through feedback. Mathematics teachers should allow productive classroom arguments wherein learners are encouraged to demonstrate the process skills in Mathematics.

The third principle talks to the progression of learners through mathematical concept teaching. The intermediate phase CAPS document (DBE, 2011a:12) discusses the specification of content between the grades and the concept development through the progression of skills development of the concept between Grades 4 to 6. The teacher through AfL activities should show the advancement of the concept from simple to

complex, giving learners a chance to progress towards meeting the Mathematics skills required in Grade 6. The learner-centred approach should, therefore, assist the learner in moving from what they know to the more complex activities as they move through the grades.

The fourth principle raises the issue of Mathematics standards that teachers need to set in the assessment. CAPS refer to this as high knowledge and high skills which learners have to demonstrate through a series of continuous assessment being done in class. To produce learners who are competitive, creative and critical, Mathematics assessment should be developed to highlight high-order thinking skills (Abu, Abdullah & Alhassora, 2017:51). The CAPS policy document (DBE, 2011a:296) provides the list of cognitive levels and skills that learners need to demonstrate in Mathematics. The cognitive is arranged as low order including knowledge and routine procedures to high order comprising complex and problem-solving. Therefore, the teacher should take into cognisance the importance of cognitive levels and skills when designing classroom activities to meet the curricular goals in Mathematics teaching and learning.

The fifth principle highlights important human rights such as inclusivity, environment and social justice in the assessment of Mathematics. The Constitution of the Republic of South Africa is sensitive particularly to the issues of alleviating a range of social ills such as poverty, inequality, race, gender, language, age and others. For Mathematics to make sense to learners, AfL activities should create extended opportunities for learners to explore broader social engagements in problem-solving. Therefore, the teacher should create a classroom environment in which each learner is valued and begins to appreciate the importance of classroom interaction to learn (DBE, 2015:9). Goal 2 of the Action Plan to 2019 (DBE, 2015) implies the need to increase the number of learners who are taught to master required competencies in Mathematics in Grade 6. If this goal is to be met, then, AfL activities must be socially just in driving how learning unfolds in the Mathematics classrooms, that is, it should be fair to the needs of learners (McArthur, 2016:968).

Recognition of prior knowledge is the sixth principle, and it emphasises that learners should be allowed to match and use their acquired knowledge together with the current knowledge to solve Mathematics problems. Teachers should use feedback from

learner prior knowledge to plan and address knowledge gaps (Snyman & van den Berg, 2018:25). The last principle recognises the value of indigenous knowledge systems in classroom instruction. It suggests therefore that Mathematics teachers acknowledge the presence of different knowledge that exists in their classrooms. AfL activities should be designed to meet the academic needs of the learners by incorporating the use of indigenous knowledge in problem solving (Cherinda, 2015:3). AfL activities provide the space for increased participation in which learners are encouraged to use their experiences or knowledge in finding solutions to mathematical activities.

The implementation of the above-discussed principles is meant to benefit learners' experiences in the learning of Mathematics (DBE, 2011a:12). The principles are meant to improve learner access to an assessment that suits their needs so that no learner is disadvantaged by any strategy used in the assessment of Mathematics. They also highlight teacher accountability in supporting learners' classroom abilities by integrating assessment into classroom instruction. Therefore, learners are allowed to show their knowledge in concept development through an assessment that is authentic in the provision for multiple abilities of learners.

3.9.2 AfL in a South African Context

The application of AfL is guided by legislation comprising The Constitution, National Education Policy Act, 1996 (No. 27 of 1996), the South African Schools Act, 1996 (Act No. 84 of 1996) and implemented through the CAPS, the NPA and the NPPPPR (*cf.* 1.2). Used in collaboration with the above-mentioned documents is Whitepaper 6 (WP6), which was developed to transform the provision of educational experiences for learners by attending to their learning needs (DBE, 2001:11). The DBE advocates for an inclusive initiative that focuses on implementing a full range of assessment methods that accommodate the diverse needs of learners (DBE, 2001: 32). Citing the Department (DBE, 2015), Aziz (2015:2) notes a lack of tangible improvement towards realising the goals of WP6, which can be viewed as catastrophic in that the educational needs of the Mathematics of the majority of learners in Grade 6 have been 'violated'. The researcher echoes the sentiments of the DBE (2015:7) that learners should be treated fairly and that Mathematics classrooms should develop programmes that

respond to their education as well as learning needs. To improve how teachers implement inclusive education in Mathematics, the DBE (2015:73) recommends a change in attitude for Mathematics teachers and commitment towards using alternative assessment such as AfL to attend to learner needs.

3.9.3 Using Cognitive Levels in AfL Activities

This section discusses the Mathematics cognitive levels teachers need to attend to when designing AfL activities in Grade 6 (DBE, 2011a:296). The CAPS document highlights a group of specific aims and skills in Mathematics that Grade 6 learners and teachers need to acquire and develop to meet the required performance levels. According to DBE (2011a:8), the teaching of Mathematics aims to develop a critical awareness of how mathematical relationships are used in social, environmental, cultural and economic relations and learners should thus develop confidence and competence to deal with any mathematical situation without being hindered by a fear of Mathematics. Learning of Mathematics should be mediated through listening, communicating, reasoning and application of knowledge acquired (DBE, 2011a:9).

To achieve the above, the DBE provides cognitive levels and skills that learners need to develop through assessment, teaching and learning (DBE 2011a:296). Linked to each cognitive level is the percentage amount each level should be represented in an assessment activity. According to CAPS, the knowledge level should comprise 25% of the task, and learners are expected to demonstrate estimation skills, recall, direct use of formula and correct use of vocabulary. The routine procedures consist of 45% of the task and learners are expected to demonstrate simple application and calculation using formula. The complex procedures should make up 20% of the task in which learners should be involved in problem-solving that requires learners to make connections between representations. Lastly, the problem-solving constitutes 10% of the activity which requires learners to break down the problem into its components before finding a solution.

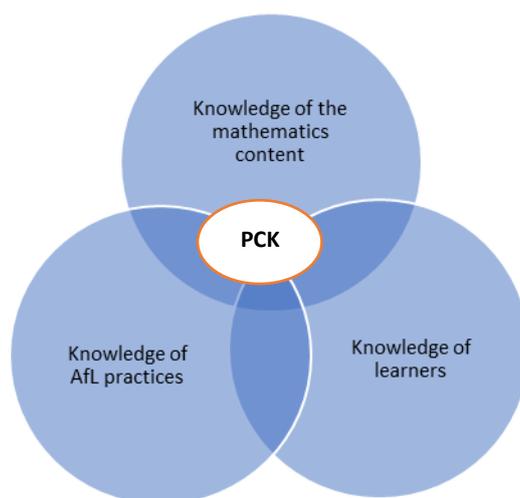
The knowledge and understanding of the mathematical cognitive levels and how to apply them in developing AfL activities would limit unnecessary duplication of skills without neglecting others. It allows the Mathematics teachers to identify specific skills

that need attention and plan according to the needs of the learners. As Sinay and Nahornick (2016:3) suggest, Mathematics teachers should use assessment feedback to create an engaging classroom environment, aimed at bridging the skills gap. Teachers should clearly articulate the importance of collaborative classroom communication in which learners are not restricted in engaging and connecting with the classroom community (Suurtamm *et al.*, 2015:3).

Salihi, Aro and Räsänen (2018:1024) bring another dimension to Mathematics skills development, with the suggestion of the a between Mathematics development and the learner's ability to read. Citing TIMSS & PIRLS reports, they report that for learners to acquire fundamental Mathematics skills, the development of basic reading abilities is necessary and any difficulty in reading is a risk to Mathematics achievement. Therefore, Mathematics teachers should be mindful of the language used in the assessment as it may impact Mathematics skills development. This needs special attention when the LoLT in Mathematics is not that of the learners' Home Language (HL) (Daly & Sharma, 2018:17). Teachers in the township and rural schools are expected to pay special attention to ordinary English and Mathematics, formal and informal Mathematical language, procedural and conceptual discourses and learners' HL and LoLT (Setati, 2002:9).

3.10 TEACHER'S PEDAGOGICAL CONTENT KNOWLEDGE AND ASSESSMENT OF LEARNERS IN MATHEMATICS

The PCK indicates Mathematics teachers' understanding of different teaching and assessment approaches in delivering Mathematics content (*cf.* 2.6.6). Therefore, Mathematics teachers' use of a series of assessment approaches in AfL to engage and promote learning to meet learning goals has an impact on how they plan their assessment. According to Koehler and Mishra (2006:1021). Mathematics teachers' understanding of the content to be taught and how it is taught, has a bearing on how it is assessed. Because AfL transforms teaching and learning (Chai *et al.*, 2013:33), knowledge of the Mathematics content and adaption of AfL activities according to learners' diverse needs (Shulman, 1986:8), becomes vital. Figure 3.8 presents PCK as it applies to the study.



**Figure 3.8: The pedagogical content knowledge in AfL in Mathematics
(adapted from *Koehler & Mishra, 2008*)**

Mathematics teachers should possess the knowledge and specific competencies in implementing the aims of the curriculum during classroom instruction. It is the view of the researcher that Mathematics teachers should understand the Mathematics skills specific to Grade 6, the Mathematics content to be covered, and the knowledge of using cognitive levels in developing assessment for learning (AfL) activities. This aspect points to the intersection of Knowledge of Mathematics content and Knowledge of learners and the intersection of Knowledge of Mathematics content and Knowledge of AfL practices. The teachers should continuously use AfL to collect information about learners (DBE, 2011a:294) and use it to improve how they approach classroom teaching (William, 2013:18) – represented by the intersection of Knowledge of AfL practices and Knowledge of Learners. Therefore, the pedagogical approach to assessment could be seen as pivotal in content delivery and learner engagement in the learning process, represented by the intersection of all three. Notably, creating a conducive learning environment depends on the teacher-learner interaction coupled with well-established learning goals and intentions, teacher’s knowledge of Mathematics content, and AfL practices as well as using the feedback for planning and teaching purposes.

3.11 CREATING FAIR ASSESSMENT FOR LEARNING ACTIVITIES IN MATHEMATICS

Chapter 2 of the Children's Act No. 38 of 2005 (RSA, 2005:20) dictates how children should be treated. According to the article, all children must be treated fairly and equitably and protected from unfair discrimination. This pronouncement has major implications for classroom practice such as Mathematics assessment. Mathematics teachers are obliged to provide classroom instruction for both teaching, learning and assessment that realises the right to fair practices. Fairness is an important component in the design of AfL activities (Tierney, 2016:1), as it assists in creating an environment that provides all learners with equal opportunity and the same treatment in attending to their learning needs (Kunnan, 2013:36). A primary concern in applying fairness in assessment is that Mathematics teachers should be ethical about how AfL activities treat learners (*cf.* 2.5.2).

It is the constitutional right of each learner in a Mathematics classroom to be treated equally, thus imploring Mathematics teachers to recognise the need for diversity and sensitivity when assessing learners (Dreyer, 2014:91). De Backer, Slembrouck and Van Avermaet (2018:1) argue for recognition of how the LoLT can be a stumbling block in learners' demonstration of their abilities. Although the South African Constitution, adopted in 1996, promotes the use of eleven official languages, most learners are introduced to learning Mathematics in English in Grade 4. Therefore, Grade 6 learners are at a developmental stage of English Language proficiency, learning Mathematics as Second language users (Webb & Webb, 2013:31). Cummins (1979:2) draws a direct relationship between language proficiency and academic performance of learners. Cummins theorization of cognitive/academic language proficiency (CALP) is that it could take five to seven years for learners to acquire appropriate skills required for their academic abilities (Street & Hornberger, 2008:72). Therefore, learners in Grade 6 require decontextualized language, where the teacher use explanations to build Mathematics vocabulary (Rowe, 2013:188). Mathematics teachers should be aware of constraints language can impose on classroom engagement and interaction in Mathematics AfL activities. They, therefore, need to find strategies of using assessment to connect concepts between Mathematics and reading skills in finding a solution to a Mathematics problem (Kan & Bulut, 2015:134). If language is taken into

consideration, learner participation will not be hindered by lack of mathematical language and understanding of the instruction towards finding the solution to a mathematical sum.

Planning is central to the teaching and assessment practices aimed at achieving education goals. Planning an assessment activity involves a process in which a teacher systematically decides what should be assessed and how it should be assessed (Cicek & Tok, 2015:11). Assessment planning plays an important role wherein it assists the teacher in aligning the content being taught with learning intentions and skills specified in the curriculum (Fives, Barnes, Dacey & Gillis, 2016:71). A key aspect of AfL planning is that it allows the teacher to plan the activities based on the available resources (Moon & Pattanajak, 2013:1065) and instructional goals (Fives *et al.*, 2016:72).

The constructivist view on assessment is that it should focus on the learner, that is, learner-centred, affording learners a space to construct their own understanding (Dagar & Yadav, 2016:3). Planning for Mathematics assessment, therefore, allows the teacher to link what is being taught to the assessment through creating classroom activities that are learner-centred by choosing the appropriate assessment methods. AfL activities should support learning through doing, participation and interaction (Kola, 2017:294). Learners should find value in doing AfL activities and when that happens the teacher and the learners receive prompt feedback that moves teaching and learning forward. The AfL planning process should drive classroom instruction forward being an integral part of the teaching and learning process with a vital outcome being the emerging of feedback.

3.12 USES OF FEEDBACK DERIVED FROM AfL

The primary purpose of feedback in Mathematics is for teachers to “read” what learners are thinking and plan towards improving learning and teaching practices (Assessment Reform Group, 2002; DBE, 2011a:293; Dreyer, 2014:60; Moeed, 2015:181). Feedback discussions break traditional classroom interaction symbolised by hierarchical teacher-learner relationships, providing an opportunity for an open classroom dialogue through linear sharing of knowledge (Amua-Sekyi, 2016:1). The

outcome of discussions in AfL feedback can bring awareness to learners about their learning, motivate them to improve and affect the learning process towards meeting the learning goals (Weurlander *et al.*, 2012:752).

A three-part question posed by Wiliam (2013:16) provides a vital tool for teachers and learners on the importance of classroom feedback. According to Wiliam, the feedback can highlight firstly where learners are in terms of Mathematics understanding and abilities, secondly, where the learners need to be in terms of Mathematics skills and finally, how the teacher and learners should work together in moving forward. In other words, AfL feedback highlights the specific roles the Mathematics teacher and learners should undertake to meet the learning outcomes. The teacher is, therefore, able to profile the mathematical needs and strengths of the learners to plan the support needed to meet their learning needs (Ontario Ministry of Education, 2013:34).

Teachers should always strive to provide feedback after each AfL activity which could take the form of teacher and individual learner interaction or open class discussion (Dreyer, 2014:67). Feedback should, therefore, focus on benefiting the learner achievement and assist the teacher and the learner in reflecting on their roles in the teaching and learning process.

3.13 CHAPTER SUMMARY

The review of the literature has revealed the importance of classroom assessment that measures how learning is developing (Siebörger & McIntosh, 2002:5). The unpacking of assessment revealed different types of assessments and their influence on learner cognitive and academic performance. The discussion of each type of assessment provided a need for teachers to have a better understanding of how to use assessment to develop feedback that will influence classroom practices.

The review of the literature provided the understanding of different aspects of AfL related to proper planning as well as teacher challenges related to the implementation of the practice. The literature revealed the link between Mathematics learning goals and their intentions as well as the teacher-learners' collaboration towards implementing AfL. Teacher understanding and planning of AfL activities should play a

pivotal role in its successful implementation. The literature highlighted the South African initiative of implementing AfL through the CAPS policy with cognitive levels of attainment to be attended to in Mathematics (DBE, 2011a:8).

The literature has also highlighted how AfL practices are implemented in some countries of the world. The literature has confirmed that policy structure and teacher developmental workshops are key in the effective implementation of AfL in the Mathematics classrooms. The comparisons in AfL policy development and implementation between Singapore, Australia, Zimbabwe and South Africa revealed the attitude Mathematics teachers have towards AfL (Bethel, 2016:107). Singapore, which has a specific model on implementation of AfL in Mathematics is doing very well in international Mathematics performance (OECD, 2015:177).

There is, therefore, a need for Mathematics teachers to use AfL practices to collect robust evidence of how learning takes place and use this information to re-direct the teaching process. The literature review suggests that policy on implementation should be strengthened and teachers are capacitated through thorough in-service and ongoing training.

The next chapter presents the research design and methods as they apply to this empirical study.

CHAPTER 4

RESEARCH DESIGN AND METHODS

4.1 INTRODUCTION

The previous chapter dealt with the concept of assessment and assessment for learning discussing it from a local and world perspective. The discussion that ensued was to give an insight into the practices and its application in Mathematics classrooms. The information gathered served to describe the context of the situation under investigation and the fieldwork that to be pursued.

This chapter explains the research methods and design that were used to address the study's research problem, its aims and given objectives. It begins with reiterating the research question and its sub-questions, followed by a discussion of the rationale for empirical research. Thereafter, the researcher brings the layout of the design, paradigm, research method applied as well as instruments used to gather data. Finally, issues of trustworthiness, ethical consideration and data analysis are discussed.

4.2 THE RESEARCH QUESTIONS

To address the problem statement described in Chapter one (*cf.* section 1.4), the main research question was framed as follows: *How do Mathematics teachers apply assessment for learning in Grade 6?* Out of the main research question, the following sub-research questions emerged:

- How do Grade 6 Mathematics teachers understand AfL?
- How do teachers integrate TPACK in AfL in Mathematics?
- What are the benefits and challenges faced by teachers in applying AfL in Mathematics in Grade 6?
- Which assessment intervention can be adopted to improve the quality of Mathematics teaching and learning in Grade 6?

4.3 RATIONALE FOR EMPIRICAL RESEARCH

Empirical research involves a systematic collection and analysis of data (Dan, 2017:1) assisting the researcher to present original evidence from the phenomenon under investigation (Yin, 2016:335). Quantitative research undertaking is based on experimentation and qualitative empirical research using participants' experiences to draw conclusions. The empirical qualitative undertaking allows the researcher to develop a better understanding of the problem through exploration which allows participants to express their views and experiences (Creswell, 2013:48). The rationale for conducting this empirical study is discussed below.

World countries are moving towards making classroom assessment the centre of Mathematics teaching and learning (*cf.* 3.8). The international trend in assessment practices is moving towards a learner-centred approach in the assessment of Mathematics to diversify and improve inclusive teaching and learning of Mathematics (OECD, 2015:123). Consequently, assessment for learning (AfL) in Mathematics becomes a purposeful approach of developing feedback that is discussed by the teacher and the learner in moving classroom instruction forward. Ahea *et al.* (2016:38-39) state that AfL feedback has a crucial role to play in supporting teaching and learning towards meeting learning goals because of increased dialogue between the teacher and the learner. It, therefore, makes sense that Mathematics teachers should be equipped with the necessary pedagogical skills of using the AfL approach in influencing how they teach and how learners learn.

Grade 6 Mathematics teachers should be at their best when developing AfL activities; however, studies have found that several factors suggest that AoL still takes centre stage in Mathematics assessment practices (*cf.* 1.3). It, therefore, points to teacher support that is needed to assist and equip Mathematics teachers with pedagogical skills in planning, managing AfL activities and using feedback in directing how classroom practices such as teaching, and learning unfolds in the Mathematics classrooms in Grade 6. But, before that support is designed and given to teachers, the teacher's context and practices have to be identified (Kivunja & Kuyini, 2017:33).

Currently, not enough is known about how Grade 6 Mathematics teachers apply AfL practices in their classrooms and or if their pedagogical skills and knowledge are effective in improving teaching and learning of Mathematics. It seems that Mathematics teachers have insufficient knowledge about the benefits of AfL application and its implementation in their classrooms. AfL, as a learner-centred assessment approach, has the potential of improving Mathematics instruction to learners and also, data emerging from AfL practices in Grade 6 Mathematics classrooms can assist teachers in developing programmes for in-service training towards assisting teachers to improve their implementation of AfL in Mathematics classrooms.

The next section discusses the research design that guided the research study.

4.4 RESEARCH DESIGN

This section presents a discussion of the research paradigm, approach and type to give a background structure to the research undertaking. The discussion of the paradigm is supported by philosophical assumptions.

4.4.1 Research paradigm

Research undertaken is guided by certain assumptions or beliefs concerning the world, defining what is true or real. A research paradigm describes a system that influences the action for research (Kivunja & Kuyini, 2017:26) and thus providing a philosophical framework to establish research traditions in a particular discipline (Collis & Hussey, 2009:55). Bakkabulindi (2017:21) proposes that a paradigm should represent a side on which a researcher builds philosophical assumptions and a worldview. In a nutshell, a research paradigm helps the researcher establish particular streamlined processes of engaging in research, providing lenses through which the investigation is carried (Moyo, Modiba & Simwa, 2017:59).

Cohen *et al.*, (2018:21) identify positivism, critical inquiry, feminism, postmodernism, and interpretivism as the most commonly used paradigms study in social research. Positivism as a paradigm views a phenomenon under the through the scientific method

of investigation (Kivunja & Kuyini, 2017:30), and the problem under study is usually a follow-up of a theory (Bakkabulindi, 2017: 25). Researchers using this paradigm aim to provide scientific explanations to a phenomenon to make general conclusions. According to Kivunja & Kuyini (2017:31), positivist results of one study in context should apply to other situations. Alghamdi (2015:79) highlights that the positivist paradigm is aligned with quantitative methods. Summing up the argument of a positivist approach to a study, Cohen *et al.*, (2018:22) explain that positivists view reality as based on the sensory experience, attributing to it being seen, smelt, or touched that the study should be based on scientific methods that test a theory rather than abstract suppositions and that the methodological principles deal with facts which are independent of researcher's perceptions.

The critical research paradigm is based on social practice issues with its findings being used to address social ills (Kivunja & Kuyini, 2017:35). Cohen *et al.* (2007:26) mention that this research is undertaken to expose all social imbalances to improve justice and bring emancipation. In essence, the critical paradigm attempts to closely study the use of power within social structures to assist towards emancipation. The feminist paradigm, embracing the critical paradigm, challenges the traditional masculine domination (Cohen *et al.*, 2018:58). Cohen *et al.* (2018:59) continue to highlight the fact that feminist research is undertaken to amplify the women's voice on issues of exclusion and exploitation. The implication of research undertaken, which excludes the voices of the marginalised and vulnerable, should, therefore, be seen as disempowering and detached from reality as it happens.

The postmodernist paradigm, on the other hand, is of the view that knowledge claims should be based on the parameters of the current condition of the world (Creswell, 2013:27). Cohen *et al.* (2018:24) add to this point by indicating that postmodernism advocates for a criterion of judgement relative to individuals and their environments rather than totalitarianism. Therefore, the argument presented through postmodernists is individualism and localised knowledge within a context under study. Lastly, the interpretivist paradigm seeks to help individuals understand their experiences and the world they work in (Pulla & Carter, 2018:9). Gemma (2018:9) continues to suggest that socially constructed experiences and meaning are not shared, and research should ultimately collate the views of the subjects under study. The researchers,

therefore, position themselves towards interpreting people as they attach meaning to the world as they experience it. The interpretivist approach to research is its ability to dig for subjective meanings as individuals interpret a phenomenon under study (Shah & Al-Bargi, 2013:257). Gray (2018:25) takes this argument further by pointing out that meanings derived from the study of the phenomenon arise from the close social interaction between the researcher and the participants.

Based on the descriptions of different paradigms above, this research study falls within the interpretive paradigm which assisted the researcher in collecting data to answer the research questions posed. This study is concerned with exploring how teachers apply assessment for learning in Mathematics and the researcher had to try and interpret teachers' lived experiences based on the Mathematics classroom culture (Taylor & Medina, 2013:4), to understand participants' viewpoint about the phenomenon under study (Kivunja & Kuyini, 2017:33). It is the view of the researcher that as Mathematics teachers construct and re-construct experiences, their interpretations culminate in social reality. The use of multiple data collection instruments allowed the researcher to directly interact with the participants, increasing the dialogue, giving the researcher space to question, listen, analyse and record data. In the process, it assisted the researcher in understanding the participants' viewpoints as they interpreted the world around them.

The paradigmatic stance of the researcher is based on the researcher's perception of what can be researched (ontology) and what can be known about it (epistemology) (Mack, 2010:6), with the methodology of a paradigm referring to the design, methods, approaches and procedures used in the study and all the ethical issues to be considered for the study (axiology) (Kivunja & Kuyini, 2017:27-28). This study which is grounded in interpretivism (*cf.* 1.8.1) was underpinned by certain ontology, epistemology, methodology, as presented below.

4.4.1.1 Ontological Assumptions

Ontologically, qualitative researchers view reality as subjective, allowing multiple interpretations of a phenomenon (Kamal, 2019:1390). According to (Peck & Mummery, 2017:389), realities emanate from individual perceptions based on

contextual experiences. Because realities are relative (Guba & Lincoln, 1994:110) and conflicting (Lincoln, Lynham & Guba, 2011:103), qualitative researchers engage with participants to ensure that knowledge produced in the process is the true reality of the participant. In this study, the researcher personally collected data using a variety of data collection methods (*cf.* 4.6.5). In this way, the researcher can gain access to participants' environment to explore reality and raise questions about the same reality. In the context of this study, this view relates to the subjective and objective nature of the claim about Mathematics teacher application of AfL. Pursuant to this study, one can go further and espouse that indeed the subjective reality is that Mathematics teachers in Alexandra Township are facing AfL application challenges.

4.4.1.2 Epistemological Assumptions

According to Creswell (2014:185), knowledge does not exist outside of an individual suggesting that its nature is better understood through interaction. This implies that the knowledge that exists is better understood when the researcher enters the participant's environment. In that way, the researcher is provided with lived accounts and documented accounts of the phenomenon under study (Lincoln *et al.*, 2011:104). In this study, the researcher used the Mathematics teachers as participants as the source of data to answer the research questions. The interaction with the participants allowed the researcher to establish findings to answer research questions.

4.4.1.3 Axiological Assumptions

In terms of axiology, a researcher needs to take cognisance on the role that values play in research (Wahyuni, 2012:70). The researcher agrees with Kivunja and Kuyini, (2017:28) that participants are to be treated with dignity and take into consideration human value. Hence, the individual participant teacher's input contributed equally to the understanding of the phenomenon and thus, answering the research question.

Therefore, this research study is characterised by the following assumptions:

- i) Multi-perceptions are needed to understand the social world as it unfolds and the use of ten participants for the study afforded the researcher space to

have different dimensions, depth and beliefs to the phenomenon under study.

- ii) The researcher contextualised the study by closely interacting with the individual participants in a bounded case to understand the individual participant rather than apply universalised laws that govern AfL principles (Kivunja & Kuyini, 2017:34).

4.4.2 Research approach

According to Pavan and Kulkarni (2014:169), research methodology describes a systematic approach to solving a problem. Long (2014:428) refers to the research approach as a general rational and abstract perspective of the study. It, therefore, becomes apparent that research methodology embodies the philosophical assumptions of the study, guiding the selection of effective research methods which include qualitative, quantitative and mixed-methods methodologies (Creswell, 2014:4; Cohen *et al.*, 2018:131-191).

According to Creswell (2014:4), qualitative methodology is undertaken to explore and give meaning that individuals attach to an experience. In other words, the researcher has an important role in gaining an intense understanding of the participants' perceptions of their actions. On the other hand, the quantitative research approach measures the phenomenon under study through quantifiable and statistical analysis whereas the mixed-method approaches the study through integrating the qualitative and quantitative approaches in response to research questions (Creswell, 2014: 235).

4.4.2.1 The Qualitative Approach

The qualitative research approach was seen as most suitable in assisting the researcher to realise the general aim of the study that is, exploring how teachers apply assessment for learning to enhance the quality in Mathematics teaching and learning in Grade 6.

McMillan and Schumacher (2010:320) describe qualitative research as a planned undertaking in which a researcher spends time with the participants to understand and analyse their actions based on their experiences of a social phenomenon. Cohen *et al.* (2018:289) note that subjective participants' accounts are explained through their point of view of the experience. Qualitative research is embedded in penetrating contextualised understanding and interpretations of situations as experienced. The researcher is therefore afforded the chance to subjectively investigate the worldview of the participants where their definition of the phenomenon is interpreted.

Merriam (2009:13) suggests that researchers who use qualitative research are interested in understanding the meanings people construct to comprehend their experiences. Meanings people derive from these experiences, are culture and context-bound, giving rise to multiple realities and interpretations (Cohen *et al.*, 2018:288). This view is supported by Creswell (2014:7) who espouses that viewing the phenomenon under study through the eyes of the participants, allows them to describe their experiences. In other words, qualitative research assists in understanding how people intentionally behave, based on their interpretation of their experiences.

This qualitative study was undertaken to explore in-depth in a bounded system how Mathematics teachers apply assessment for learning (AfL) in Mathematics. In the process of the application in a contextualised world, they construct meanings and act through multiple interpretations of such social encounters (Cohen *et al.*, 2018:288). The researcher aims to penetrate the social set-up of the participants, to study through multiple data collection instruments, the realities and experiences of the participants in their natural settings (Merriam, 2009:13). Besides, the qualitative mode of enquiry is applied to provide a platform for individuals or group of people to narrate and share their experiences (Creswell, 2013:48). In other words, the direct interaction between the researcher and the participants assists in amplifying their thoughts and experiences of the phenomenon under study.

Qualitative research approaches have key beneficial characteristics to the researcher in this study (Creswell, 2014:231). Firstly, the researcher was able to directly interact with the participants in their natural environment where they experience the issue under study. It allowed the researcher to closely study the behaviour of the participants

in context. Secondly, the researcher was able to collect data through various sources such as observing the behaviour of the participants, individual interviews and examining different documents used in AfL application. Thirdly, the researcher was able to make sense of the collected data by organising it into themes and categories that build patterns. Lastly, the researcher was able to closely focus on observing and studying the behaviour that participants hold concerning the issue without them attaching their meaning. The research design and methods discussed below are based on the research paradigm and approach discussed above.

4.4.3 Research type

The collection of data is preceded by the step-by-step documentation of a plan that the researcher uses in the process of collecting and analysing data (Ragin & Amoroso, 2011:28). Fouché and De Vos (2005:132), describe a research design as focusing on the logical build-up from the research problem identified until the researcher makes conclusions based on data acquired from the participants. McMillan (2012:277) conceptualises research design as a strategy a researcher uses to merge different components of the study to effectively address research questions. In other words, it highlights the path the researcher intends to follow until they reach conclusions based on the data received. It is, therefore, a path that leads to the end product emanating from the research problem which helps to direct the logic behind the research undertaking.

The researcher explored the application of AfL by Mathematics teachers in Grade 6. The exploration process was based on the quest by the researcher to answer questions raised regarding the application of AfL in Grade 6 Mathematics classrooms (Yin, 2003:16). Following a qualitative approach, the research design for this study was a case study design framed within qualitative research.

4.4.3.1 Case Study

In using a case study, researchers intend to study and analyse a case or an entity in-depth (McMillan & Schumacher, 2010:344). Studying a case allows the researcher to intensively examine a situation within a bounded context (Punch, 2009:119), and

investigate a contemporary phenomenon within its real-life context (Creswell, 2013:97; Rule & Vaughn, 2011:4). In so doing, the events that shape the experiences and beliefs of the participants are studied and explained in-depth. The case study is perceived to be proper for this study as the researcher intended to explore Mathematics teachers' practices concerning application of assessment for learning (AfL). The exploration afforded the researcher the prospect of studying the participants within a real-life context.

Creswell (2013:121-122) suggests several steps in a case study that were applied in this research study as presented below:

- a) The researcher must choose or identify a specific case for the study, and it should be bounded by the time and place. For this study, primary schools in a particular area, in Alexandra Township, Johannesburg represent the case. Teachers who were currently teaching Mathematics in Grade 6 and holding a primary teacher's diploma, were identified as a case to be explored.
- b) The intent and issues to be focused upon should be identified. Thus, the researcher was interested in exploring the teachers' application of AfL and its principles in the Mathematics classroom. To carry out the investigation, questions were asked and were related to teachers' application of AfL Mathematics in Grade 6 primary schools, the illustrations of scholarly literature on AfL in Mathematics, the specific theories foregrounding the assessment for learning in Mathematics, and benefits and challenges regarding AfL in Mathematics.
- c) The researcher should select the data source that will assist in getting information from the participants. For this study, the primary teachers who were teaching Mathematics in Grade 6 were identified as the sources of information. The use of qualitative data collection instruments such as semi-structured interviews, non-participatory observation, and document analysis, facilitated the gathering of information.

- d) Data that is collected should be interpreted and analysed, bearing in mind the context of the case. The information for this study was analysed using themes which aided in the understanding of the case under investigation. It should be noted though, that the themes derived from the data are not presented in a particular order.

The case study was chosen for this study because it offered certain strengths as presented by Cohen *et al.* (2018:379). Because case studies depict everyday occurrences and are written in a non-professional language, they are easily and better understood by wider audiences including non-academics. The attention to detail allows the reader to understand why things are the way they are. Teacher practices in the implementation of AfL were observed in practice in the real world, that is occurring within the confinements of time and space.

Case studies can capture important unique features that ultimately hold the key to understanding the situation under study. Because the researchers study the case from within or within the *emic* perspective, interacting with the participants, they can gather data that sheds light on the phenomenon under investigation. Case studies can bring out strong reality, hold close attention and harmonise the reader's experiences giving it a basis to provide generalisation. They can provide insights and understanding of cases within similar situations, assisting the reader in interpreting those case cases. The idea of using a case study is therefore directed at seeking an interpretation and understanding of a phenomenon rather than trying to obtain a definite answer to the questions posed.

Intrinsic case studies, instrumental case studies and multiple/collective case studies have been identified as various types of case studies (Cohen *et al.*, 2018:378; Creswell, 2013:99; Gray, 2018:270). A researcher uses an intrinsic case study to comprehend a particularly unique case (Creswell, 2013:99; McMillan & Schumacher, 2010:345). The use of an intrinsic case study assists the researcher in deriving understanding of the case under investigation. The multiple/collective case study focuses on several cases that are studied to gain a full understanding of a phenomenon (Cohen *et al.*, 2018:378). In other words, the researcher can gain different viewpoints about an issue. Creswell (2013:99) brings to our attention that

multiple case studies afford the researcher a chance to generalise the conclusion because of the number of representative cases used in the research study.

In this study, the researcher chose an instrumental case study, which was concerned with providing insight into an issue or a concern (Gray, 2018:270). The researcher identified the issue and selected a bounded case to encapsulate this issue (Creswell, 2013:99). This implies that the researcher was able to build a description of the case, citing elements uncovered in the study of the case. This study was a bounded case of schools in one particular location selected on the basis that they were found in close proximity and the researcher had no intention of generalizing the outcomes to other populations (Gaya & Smith, 2016:259).

4.5 RESEARCH METHODS

This section provides an overview of the study population and the sampling methods that the researcher used in the selection of the study participants. This is followed by the discussion of the data collection strategies as well as data analysis.

4.5.1 Study Population

The term population in research is synonymous with a particular group that meets specified criteria for an investigation (Alvi, 2016:10). Asiamah, Mensah and Oteng-Abiyie (2017:16) define it as a group of members that can provide information that is credible to answer research questions. Two types of the population have been identified in the research, namely: the target population as well as the accessible population. The target population is a refinement of a general population containing no attributes that might jeopardise the research goal (Asimah *et al.*, 2017:1612).

The population for this study is a subset of the target population from which the researcher drew the sample. The researcher identified topic-related teachers in the field of work based on their involvement in the teaching of Mathematics in primary schools in Alexandra Township, Johannesburg (Baškarada, 2014:1). The particular group was employed by the Department of Basic Education and the researcher believed they possessed the necessary experience and reality that could assist in

answering the research questions posed (McMillan & Schumacher, 2010:326). The sampling process, discussed in the next section, made the research process economical and assisted in the generalisability of research findings.

4.5.2 Sampling Procedures

Sampling involves a procedure used by a researcher to select subjects who will serve as a data source to answer research questions and fulfil its objectives (Sharma, 2017:749). Sampling is used in research because it conveniently allows the researcher to reduce the number of participants which could be overwhelming to analyse with limited resources (Taherdoost, 2016:18). Cohen *et al.* (2018:203) support this view by highlighting limiting factors like expense, time and accessibility and how they frequently discourage researchers from gaining the required data from the entire population. When dealing with people as the source of information, the sample is referred to as participants, as they are referred to in this study.

Two types of sampling techniques are used in research, namely probability sampling and non-probability sampling, and are depicted in Figure 4.1 below.

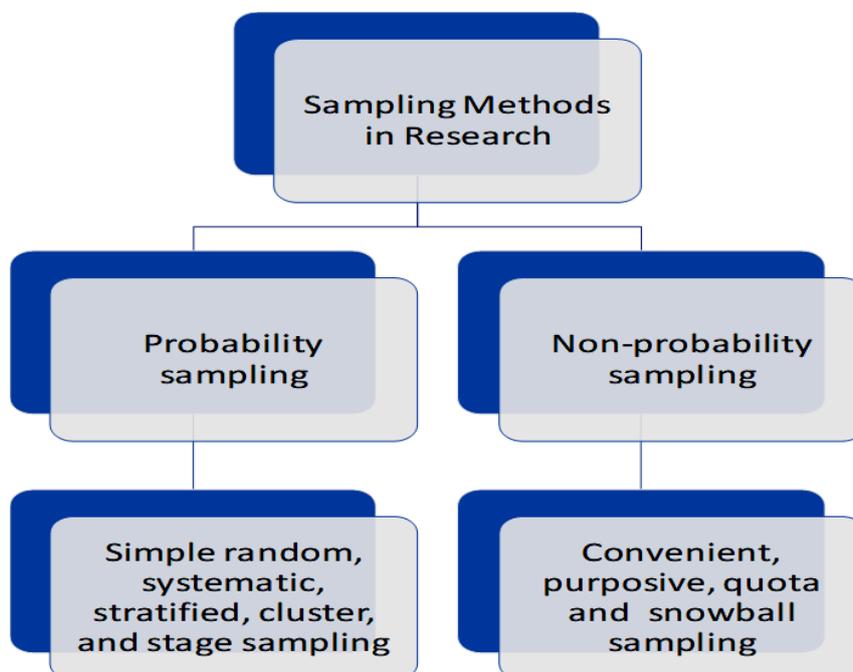


Figure 4.1: Different types of sampling methods in research (adapted from Cohen *et al.*, 2018)

Both probability and non-probability samplings are used to find potential and relevant participants that will assist the researcher in answering research questions. The probability sampling qualifies the members of the population to have an equal chance of being included in the sample, whereas, in the non-probability sampling, participants are identified based on the researcher's preconceived criteria (Etikan & Bala, 2017:215).

Alvi (2016:12-13) offers certain advantages and disadvantages of using the different sampling methods in research, as presented in Table 4.1 below.

Table 4.1: The advantages and disadvantages of probability and non-probability sampling (adapted from Alvi, 2016:13-14)

Types of sampling	Probability sampling	Non-probability sampling
Advantages	<ul style="list-style-type: none"> • Reduces systematic errors • Minimises sampling biases • Generates a better representative sample • Findings deduced are generalisable to the population 	<ul style="list-style-type: none"> • It is inexpensive to use. • The technique requires less effort. • It needs less time to finish.
Disadvantages	<ul style="list-style-type: none"> • Requires a lot of time • It is costly to apply • A lot of effort is required to do 	<ul style="list-style-type: none"> • Susceptible to experience sampling biases. • Does not give a good representation of a population. • Findings are not generalisable to the population.

Based on the description of sampling and its categories, non-probability sampling was identified as a suitable sampling technique for this study and is discussed next.

4.5.3 Non-Probability Sampling

In this study, the researcher made use of non-probability sampling. Non-probability sampling allows the researcher to select the sample from the population because they are easy to access (Cohen *et al.*, 2018:214). The researcher's choice of non-

probability sampling is to demonstrate that a particular trait exists in the population intending to create generalisations concerning the identified population (Showkat & Parveen, 2017:3). The targeted group represents itself and all the findings that are established, only relate to the group studied and cannot be extended to the wider population. The method is viewed as less expensive, less complicated and easy to apply.

Both Cohen *et al.* (2018:214-222) and Showkat and Parveen (2017:2-9) discuss the four types of non-probability sampling as follows:

- Convenient sampling – researchers using this type of sampling prefer research participants they have easy access to. The participants may be chosen because of proximity to the researcher or the fact that they are readily accessible.
- Purposive sampling – is when the researcher uses their own discretion to choose the participants. The participants are chosen for a specific purpose, especially those who have required knowledge about the issue being investigated.
- Quota sampling – researchers using this sampling model, use it to assign proportionality in the representation of participants. The number of participants should represent the weighting of the population.
- Snowball sampling – this sampling is used to locate hard-to-locate participants where one respondent provides the location of more respondents who are then contacted by the researcher. Snowball sample is therefore applicable when the population of required participants is not known.

The sampling technique used in this study is discussed in the following section.

4.5.4 Purposive-Convenient Sampling

Purposive-convenient is a combination of two research sampling methods allowing the researcher to choose participants based on own discretion and accessibility. Nine

teachers from nine primary schools and teaching Mathematics in Grade 6 were an appropriate target population for this study. The researcher viewed them as a population that could assist in achieving the research objectives and give answers to research questions.

The researcher used purposive-convenient sampling to identify individuals that became part of the sample from which data were collected (Creswell, 2007:118). Purposive-convenient sampling allowed the researcher to identify participants who possessed common characteristics concerning assessment in Mathematics. Nine primary school teachers who were teaching Mathematics in Grade 6 at the time of research were sampled from Alexandra township within the Johannesburg East District. The participants were selected on the basis that they were conveniently located for easy access by the researcher, they were qualified teachers with a minimum Teacher's Diploma and teaching Mathematics at the Grade 6 level.

4.5.5 Data Collection Procedures

Collecting data is at the heart of research undertaking. The process of data collection assists the researcher in carefully gathering relevant information that can be used to provide answers to the research questions (Rimando *et al.*, 2015: 2026). Data collection is a systematic collection of data to understand a phenomenon as it occurs (Rimando *et al.*, 2015:2026). Creswell (2010:78) asserts that the researcher becomes the main focal point in data collection. Because the researcher chooses time and space, research cannot proceed without their being immensely connected with data collection instruments. The researcher employed a variety of instruments to collect data with the aim of results validation. This research study used semi-structured interviews, non-participatory observation and document analysis as instruments to collect data in schools over four weeks. Figure 4.2 presents the data collection instruments used in this study.

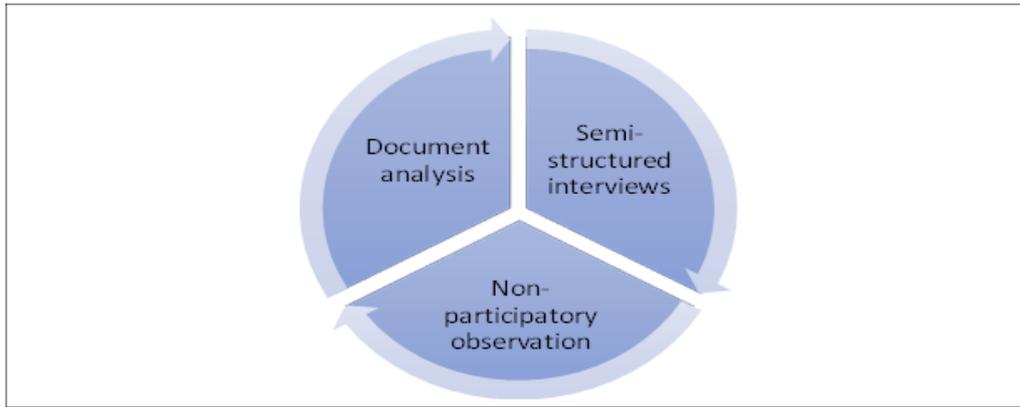


Figure 4.2: Data collection instruments as applied in this research (adapted from Okeke, 2018:209)

The section below discusses the data collection instruments, semi-structured interviews, non-participatory observation and document analysis, as they apply to this research study beginning with semi-structured interviews.

4.5.5.1 Semi-structured interviews

An interview is one of the data collection instruments used to collect information in the real-world situation through dialogue that takes place between the interviewer and several participants. To create an open and relaxed atmosphere in which open discussions between the researcher and the participant, the individual interview was used (Gaskell, 2011:14). Individual interviews also allow a two-way conversation wherein the researcher asks the questions and the participants provide answers relating to the ideas, beliefs, views and opinions of the participants (Creswell, 2010:87). According to Cohen *et al.* (2018:506), face-to-face interviews allow the participants and the researcher to engage in a close discussion about the participant's interpretation of the world and their experiences about the situation under study. Denscombe (2007:174) postulates that interviews allow the researcher to unearth the underlying factors of the subject under study in understanding the participants' views of the world of practice of the subject under study. Encapsulating the benefits of interviews, McMillan (2016:344-345) cites the following advantages:

- Interviews allow for greater depth, providing rich information as the interviewer has the opportunity to decipher information from a range of

communication strategies. Thoughts and feelings of the participants are captured.

- Interviews limit neutral responses from the participants.
- Interviews allow the researcher to ask probing questions seeking clarity with follow up questions on various issues not clearly articulated.
- An interview allows the researcher to gain a clearer understanding of the phenomenon under study from the perspective of the participants.

Though the benefits of using interviews were identified, the researcher was mindful of its challenges as well. Dialsingh (2011:2) warns that face-to-face interviews do not allow the participants to think through answers they provide and at times not convenient answers. Because of the presence of the interviewer, the participants may feel threatened to disclose sensitive information that they feel might jeopardise their school. Lastly, researchers using face-to-face interviews as mode of data collection should expect to take longer time to complete compared to focus group interviews. To mitigate the mentioned challenges, the researcher made introductory visits to the sites to develop working relationships and allay fears of presented information being made public domain and directly linked to a particular participant

Because of ethical issues, the interviews were carried out with the consent of the participants (Denscombe, 2010:181). The researcher used interviews to explore and deduce teachers' views and implied information as well as actions about the topic under study, that is, the use of assessment for learning in Mathematics. The researcher used open-ended questions (*cf.* Appendix G) and they were objective and allowed the researcher to be flexible in probing for deeper information. The questions allowed the researcher to deal with the dynamic and complex behaviour of the participants..

The interviews allowed the researcher to initiate the conversation and encouraged the participants to verbalise their thoughts without being intimidated. In the process, the researcher was able to elicit teachers' views and opinions regarding the application of assessment for learning in Mathematics (Creswell & Creswell, 2018:187). The interviewees were afforded enough time to articulate their views and encouraged to

elaborate on their experiences and challenges they encounter in classroom practices. All nine sampled teachers participated in the semi-structured interviews.

After securing permission from Gauteng Provincial DBE (cf. Appendix C) and UNISA Ethics Committee (cf Appendix A), the researcher secured consent from the schools. Before the commencement of each individual interview, the researcher explained the process and each participant was asked to sign the consent form. The researcher, with the permission of the participant, recorded the interviews sessions to avoid losing valuable information and field notes to supplement the recorded information (Efron & Ravid, 2013:104). The researcher interviewed nine participants from nine primary schools at their respective sites. The participants were interviewed at their workplaces during free periods and after school as per the agreement, to avoid disruptions of teaching and learning. The interview process lasted for about an hour, giving the researcher ample time to ask probing questions in an environment where the teacher was familiar and felt at ease. After each interview, the participants were asked to contribute information that they felt was pertinent to the issue under study.

4.5.5.2 Non-participatory observation

Observation as a data collection instrument offers a researcher the opportunity to gather first-hand information on the lived experiences of the participants (Cohen *et al.*, 2018:542; Moser & Korstjens, 2018:12). It allows the researcher to have a direct encounter with the participants (Creswell & Creswell, 2018:188), relying on his/her senses to collect data (O’Leary, 2004:170). Creswell (2010:83) identifies four types of observations used in research. First, as a complete observer known as a non-participant observer who keeps distance when observing from the observed situation. The second is referred to an observer as a participant, who get involved and yet does not influence the dynamics of the setting. Thirdly, is the observer as a participant, which is mostly used in action research and allows the researcher to become part of the research. The researcher works closely with the participant and intervenes in the process and even attempts to influence it. Lastly, is the complete participant. The researcher becomes part of the observed and they may not even notice that they are observed.

In this study, a non-participatory observation was used to gather data, allowing the researcher to document how teachers apply AfL in Mathematics. It allowed the researcher to gain awareness of participants' practices in context. The researcher thus gained access to observe what was going on in the Mathematics classrooms. The observation was done in Mathematics classrooms in the presence of the learners. The researcher used an observation document to observe Grade 6 teachers in their Mathematics classrooms, during which field notes were taken on how teachers apply assessment for in Mathematics (Creswell, 2010:83).

The researcher observed nine Mathematics teachers from nine different primary schools in Alexandra Township. An observation discussion was held with Mathematics teachers of the schools to discuss how the observation process would unfold. The researcher sat at the back of the class and documented observations by taking additional notes on how teachers applied assessment for learning in Mathematics in Grade 6 classes. The observation schedule was used to document how Mathematics teachers plan and administer AfL practices. The researcher used AfL, a self-developed analysis tool (*cf.* Appendix H) to check if the cognitive levels were accounted for as prescribed by Mathematics CAPS document.

4.5.5.3 Document analysis

Documents represent reports that record the realities and practices with a purpose to advance a practice (Flick, 2009:259). Flick advances a notion that documents should not be viewed as a source of information but rather, as a source that describes how events are unfolding within the context of the phenomenon under investigation.

In this study, different documents that advance the use of AfL were analysed using a self-designed tool (*cf.* Appendix I). These documents included the teacher lesson plans, school assessment plan, AfL planned activities and the availability of Mathematics CAPS documents. The mentioned documents were requested from Mathematics teachers because the researcher views them as important in the planning and application of AfL practices in Mathematics. The analysis and the application of Bloom's Revised Taxonomy, as well as the cognitive levels on AfL activities, were investigated, and their fairness and equality of these activities were

analysed. The documents revealed the good practices and challenges teachers experience regarding the planning and implementation of AfL in Mathematics in Grade 6 classrooms.

Once all data were collected, the data analysis processes and procedures could begin and these, as applied in the study are discussed in the subsequent section.

4.6 DATA ANALYSIS

Once data has been collected, careful considerations should be taken on how this data is analysed to make meaning and bring an understanding of the phenomenon under study. The process of analysing data involves careful steps in organising the collected data that is, carefully reading through the database and developing codes to create themes to assist in its interpretation (Creswell, 2013:179). Creswell (2014, 208) points out that the data analysis process involves bringing text data into segments by taking it apart and carefully putting it together again. De Vos, Strydom, Fouché and Delport (2012:252), posits that the data analysis process should aim at preparing the raw field-collected data for a detailed inspection and scrutiny. This process, as Baxter and Jack (2008:554) assert, should run concurrently with data collection stages whilst the researcher is still interacting with the participants.

Qualitative data present a pool of information obtained from diverse sources, in this case, semi-structured interviews, notes from observation and information from analysing documents. This information should be organised and interpreted to show key findings that speak to the research underway. Cohen *et al.* (2018:644) explain that analysing data involves the process of exploring and making meaning of the data and finding similarities and relationships between the data. For this study, the researcher took it upon himself to locate and link data to the research question through an intensive interpretation by constantly reading and re-reading data until the meaning was identified. Once understood, the researcher was able to use classified and grouped data to identify themes and categories.

4.6.1 Qualitative Data Analysis

Describing qualitative data analysis, Flick (2013:5) mentions that it is a process wherein data collected is interpreted and classified to make meaning through which practices and experiences are described. During the analysis of qualitative data, the researcher is making sense of views of participants concerning the phenomenon under study through the use of patterns, themes and categories (Cohen *et al.*, 2007:461). As Gibbs (2012:2) points out, data analysis involves the transformation of data into a clear and understandable material to generate ideas and find meanings to practices. Therefore, during qualitative data analysis findings are developed and presented (Patton, 2002:432).

According to Best and Khan (2006:270), the first step in qualitative data analysis entails the process of organising data. Having the organised collected data, the researcher describes relevant details of the study, including inter alia the locale, participants under study, the purpose of activities being investigated, the point of view of the participants and the consequences of their practices. The final stage of analysis is the interpretation of data, whereby the researcher provides the simplification of the findings, thus providing answers to questions (Patton, 2002:434).

4.6.2 Data Analysis Process

The analysis of data for this study was done as per the qualitative content analysis process that assimilated Creswell's (2013:190-191) suggested procedures. The procedure for analysis is presented in Table 4.2 below.

Table 4.2: Data analysis procedures (adapted from Creswell, 2013:190-191)

Data analysis and Representation	Case Study	This study's procedure
Organising data	Create and organise files for data	Data obtained from participant teachers were transcribed and organised into sets that could be easily understood.
Reading and profiling	Read through text, making margin notes from initial codes	The researcher took time to carefully read through the text before the coding.
Classifying data	Use categorical aggregation to establish themes	During the coding procedure, relationships in data were identified and used to establish themes and categories.
Interpreting the data	Using direct interpretations	The researcher used a direct interpretation of collected information in tables.
Representing and visualising data	Present an in-depth picture of the case using narrative, tables and figures	Information analysed was represented using words and tables.

The qualitative analysis process outlined above provided a framework to corroborate data from interviews, observation and analysis of documents that were systematised through a thematic organisation.

4.7 TRUSTWORTHINESS OF THE RESEARCH

Trustworthiness in qualitative research is achieved when credibility, confirmability, dependability, and confirmability are addressed in data collection (Babbie & Mouton, 2012:276; Cohen *et al.*, 2018:248). These four constructs of trustworthiness are discussed below and how they are nuanced in this study begins with credibility.

4.7.1 Credibility

In qualitative research, credibility suggests the degree to which the researcher can represent the authentic meanings from information derived from the participants (Moon, Brewer, Januchowski-Hartley, Adams & Blackman, 2016:2). Moon et al. (2016: 3) identify different strategies that can be applied to demonstrate research credibility, and these include data and research triangulation, prolonged engagement, continuing observation and member checks, each of which are discussed below.

Data triangulation involves the use of a variety of strategies to gather data from sampled participants to address research aims and objectives (Creswell & Creswell, 2018:201; Flick, 2009:445). Triangulation assists the researcher in reducing findings biasness and cross-examine the integrity of participants' responses.

To address triangulation, this study used three data collecting strategies, namely, semi-structured interviews, non-participatory observations and document analysis. The intent of using different data collection instruments was to elicit a different and in-depth outlook on how teachers apply assessment for learning in Mathematics. The instruments were validated by the supervisors to ascertain the appropriateness of the research tools to measure what they intended to measure (Leung, 2015:237; Taherdoost, 2016b:28).

Prolonged engagement is another strategy that bolsters the credibility of data in research. According to Anney (2018:276), prolonged engagement provides an opportunity for the researcher to understand the world of the participants. In so doing, the researcher can test misrepresented information and build trust. Babbie and Mouton (2012:277) point out the importance of remaining to do the fieldwork until the point of data saturation is reached. The authors cited above come to one conclusion that prolonged engagement allows the researcher to test the legitimacy of participants' contributions and verify their findings in context.

To gain familiarity with the participants and their environment, the researcher did introductory visits to the primary schools. During such visits, the researcher distributed letters requesting permission to use schools as sites of data collection (*cf.* Appendix

D). The second engagement involved going back to the schools to the participants to explain ethical issues related to the research procedures (*cf.* Appendix E).

The sampling process in this study also contributed to extended engagement where the participants were engaged during the data collection process. The data collection exercise began with a semi-structured interview, followed by non-participatory observation, and concluded with document analysis.

Continuing observation allows the researcher to document any differences in frame of reference to the data collected (Babbie & Mouton, 2012:277). It helps prove or disprove evidence gathered in the process of answering the questions raised by the study and identify special elements related to the study (Korstjens & Moser, 2018:121). To achieve continuing observation the researcher remained within the school every after each data collection strategy. During this time, the researcher reflected on the events of the day to make sense of the data that was collected.

Member checks involve feeding the information back to the participants for the researcher and the participants to look at the data differently (Korstjens & Moser, 2018:121). The member check process helps participants in correcting any errors in information gathered the researcher went back to the respondents. The researcher took it upon himself to revisit the participants who were requested to make alterations where necessary and provide supplementary information.

4.7.2 Transferability

According to Anney (2018:277), transferability is the extent to which research findings can be applied to similar contexts with different participants. This is achieved if a thick description of the site, participants and detailed steps are taken to collect data are explained by the researcher (Korstjens & Moser, 2018:121). As this study is qualitative, Babbie and Mouton (2012:227) therefore state that the generalisability of research findings is only limited to the investigated context and do not apply to other contexts. Even under such conditions, a researcher should articulate and apply research practices that provide a detailed account of the study (Cypress, 2017:214;

Hafeez-Baig, Gururajan & Subrata, 2016:3. On the other hand, Korstjens and Moser (2018:121) contend that the thick description of participants' experiences should be able to make sense to a person outside of the population under study. Cole and Gardner (1976) suggest the following six basic principles of transparency in research:

- the study should clearly state the number of institutions taking part and their location,
- there should be a clear-cut explained restrictions of participants to contribute data,
- clear clarification of the total number of participants involved in the study,
- there should be a clear description of data collection instruments,
- description of the duration and frequency of data collection on-site, and
- the time frames over which data is collected.

The researcher, therefore, did not claim the transferability of findings but left it to the reader to make sense of the knowledge that was constructed to make such modifications in transferring the findings.

4.7.3 Confirmability

Confirmability refers to the degree to which research findings can be confirmed by other researchers (Anney, 2018:279). Babbie and Mouton (2012:2778) suggest that research findings should be a product of the focus of the investigation and not the researcher's thoughts or biasness. Therefore, it borders on the neutrality of the researcher in which the researcher reflects the real experiences of the participants. Kortjens and Moser (2018:121) point out that the researcher must prove that their results are generated from the study participants' views and their lived experiences. Confirmability for this study included reporting on the methodological steps taken to conclude the study. The audit trail describing steps of collecting data was available and audited by the supervisors. This included the review and examination of the original transcripts, field notes and analysis of data documents.

4.7.4 Dependability

Dependability is described as the consistency and reliability of research findings (Moon *et al.*, 2016:2). According to Shenton (2004:71), the research design and methodology should be documented allowing the reader to assess the extent to which research practices have been followed. Just like confirmability, dependability involves the researcher providing an audit trail of the process as it unfolds; however, dependability takes it a step further and includes the aspect of consistency in the analysis procedures, which should be in line with certain standards (Korstjens & Moser, 2018:122).

The penultimate section of this chapter explains the aspect of ethical issues of the research that the researcher had to adhere to during the process of conducting the research involving human participants.

4.8 ETHICAL MEASURES

Working with people as participants in a study is accompanied by ethical issues concerning how they are being treated during their interaction with the researcher (Walliman, 2011:42). Govil (2013:17) points out one of the requirements of an ethical issue in research is respect, which talks to how a researcher treats the participants before, during and after the completion of the study. Research involving human participants should be guided by certain values and principles that assist the researcher in not compromising research integrity (Sotuku & Duku, 2018:115). Research ethical considerations for this study included clearance to conduct research and informed consent from the participants to participate in the study.

Before conducting the study, the researcher applied for ethical clearance from the University of South Africa ethics board for permission to carry out the study (*cf.* Appendix A). Approval was granted by the Gauteng Department of Education which allowed the researcher to gain access to the research sites study (*cf.* Appendix C). The researcher did not have any personal stake in the outcome of the study from all the sites and participants that were identified to collect data.

The sampled participants were contacted and were informed of the purpose of the study before the commencement of data collection (*cf.* Appendix E). After a discussion concerning the study, the participant voluntarily signed the consent forms which clearly stated that there were no financial incentives to be gained during and after the study is complete (*cf.* Appendix F). Throughout the engagement, participants were informed that they were not forced to remain involved during the data collection process, thus giving them a right to withdraw their participation whenever a need arose for them to do so. The research undertaking did not raise any cultural, religious, gender and other differences that could have hindered their participation in the study.

The researcher did everything possible not to disrupt the sites' teaching and learning ethos by respecting their rules and regulations during data collection. Having discussed the research schedules with the participants, the researcher kept to the time slots as agreed. The participants were not in any way compromised or deceived into believing that collected data will be used for anything other than the purpose already highlighted to them. The participants' interviews took place at the convenient schedule and the researcher explained why the interviews were recorded. The researcher respected participants' space during the observation process, he remained seated at the space provided for him at the back of the class without participating or contributing to participant classroom activities. After every data collection strategy, the researcher requested each participant to make any contribution that they felt was important to the study. The researcher promised the participants that pseudonyms would be used for the study and their names or the names of their schools would not be used for reporting purposes.

4.9 CHAPTER SUMMARY

This chapter gave a detailed description of the research design, paradigm and methodology used to collect data from participants. The qualitative research approach described in this chapter highlighted how the researcher was able to interact with the participants through semi-structured interviews, non-participatory observations and document analysis. These three data collection instruments assisted the researcher in eliciting and triangulating important information about how Grade 6 Mathematics teachers apply AfL in Mathematics. A qualitative approach was employed and the

research design, which was a bounded case study, was described as well as the sampling procedures and data analysis procedures. How the study participants were purposively and conveniently chosen to provide rich information on the application of AfL was also discussed. The data for this research study was obtained from ten primary schools in Alexandra Township part of Johannesburg District 9.

The final sections of the chapter presented the trustworthiness by elaborating on measures that were put in place to ensure the trustworthiness of the process. Finally, the chapter concluded with a discussion on how the issues of ethical considerations about human participants were addressed.

CHAPTER 5

ANALYSIS, FINDINGS AND DISCUSSION

5.1 INTRODUCTION

The previous chapter presented the research design and methods that the researcher utilised to conduct the empirical study to realise the aim of the study. This chapter presents the findings that were obtained from interviews conducted with the Mathematics teachers, findings from documents analysed as well as data from classroom observation. The findings are qualitatively presented, analysed and interpreted in line with the study objectives to answer the main research question: *How do Mathematics teachers apply assessment for learning in Grade 6?* The data collected was broken down into manageable pieces during the coding process to facilitate the development of themes. The theoretical framework (constructivism, social justice, TPACK, and Bloom's Revised Taxonomy, as discussed in Chapter 2) underpinning this study and the literature reviewed were used to guide the study discussion. The first aspect of the empirical findings highlights the profiles of the participants.

5.2 PROFILE OF PARTICIPANT TEACHERS

Inline and within the prescripts of the research ethics, Grade 6 Mathematics teachers gave informed consent to participate in the research study before the interviews started. All nine sampled participant teachers agreed to be interviewed, observed in their Mathematics classrooms and provide relevant documents to the researcher. The researcher was, therefore, able to collect data in the participant teachers' natural setting. The participant teachers in the study were referred to as MT#1-MT#9 and their names and identity are only known by the researcher. Consequently, nine teachers had agreed to participate in the study. However, due to political unrest in the community that started towards the end of data collection period, observation and document analysis could not be done with MT#8. Their profiles are presented in Table 5.1 below.

Table 5.1: Profile of participant Mathematics teachers in the research study captured from the semi-structured interviews

Pseudonym	Subjects taught	Teaching experience	Teacher workload (periods) per week
MT#1	Mathematics; Social Sciences	08 months	36
MT#2	Mathematics	01 year	48
MT#3	Mathematics	23 years	48
MT#4	Mathematics; Natural Sciences & Technology	09 years	33
MT#5	Mathematics; Home Language	6 years	36
MT#6	Mathematics	37 years	36
MT#7	Mathematics; English FAL	03 years	32
MT#8	Mathematics	16 years	36
MT#9	Mathematics	07 years	48

It can be deduced from this table that there are teachers with more and those with a lesser number of years of teaching experience. The participant teachers' experiences highlighted their variety of views in terms of the application of AfL practices in their classrooms. The table also shows CAPS subjects taught by each participant teacher as well as the number of periods each participant teaches per week (workload). In this study semi-structured interviews, non-participatory observation and document analysis were used as data collection instruments. Each instrument was reported separately to answer the sub-research questions (*cf.* 1.4). For the purpose of reflecting on the trustworthiness of the research instruments, the researcher synthesised the triangulation of data collected through the use of emergent themes and categories (*cf.* 5.10).

5.3 QUALITATIVE ANALYSIS OF INTERVIEW DATA

The analysis of data for this study involved three important steps which included the reduction of data, re-organisation and representation of data (Roulston, 2014:301). These three steps assisted the researcher in developing the themes that are important in the application of AfL in the Grade 6 Mathematics classrooms. The approach that was adopted by the researcher to analyse the data was informed by the work of Creswell (*cf.* 4.6.6). The analytical approach involves several steps beginning with the

organising of collected data into categories, making sense of the data through reading and re-reading it, coding data then sorting into themes, classifying data through finding relationships, directly interpreting data in tables as well as using words. Table 5.2 below presents the emergent themes and categories captured from the semi-structured interview data.

Table 5.2: Emergent themes and categories from participant teacher interviews

	Sub-research Questions	Themes	Categories
1	How do Grade 6 Mathematics teachers understand AfL?	1. Teacher understanding of assessment in Mathematics	1.1 Teachers' conceptualisation of assessment 1.2 Types of assessment 1.3 Methods of assessment 1.4 Assessment for learning 1.5 Importance of AfL constructive feedback
2	How do teachers integrate TPACK in AfL in Mathematics?	2. Integration of TPACK in Mathematics AfL	2.1 The use of technology in AfL 2.2 Teachers' lack of pedagogical content knowledge 2.3 Teachers' knowledge of approaches to AfL
3	What are the benefits and challenges faced by teachers in applying AfL in Mathematics in Grade 6?	3.1 Benefits of AfL	3.1.1 Benefits of constructive feedback to learners 3.1.2 Improve teaching 3.1.3 Self-regulatory learning
		3.2 Teachers' challenges	3.2.1 School infrastructure 3.2.2 Overcrowding 3.2.3 Teacher workload 3.2.4 LoLT 3.2.5 Lack of resources 3.2.6 Learner-centred application of assessment practices
4	Which assessment intervention can be adopted to improve the quality of Mathematics teaching and learning in Grade 6?	4. Intervention to empower Mathematics teachers	4.1 In-service training 4.2 Availability of resources 4.3 Parental involvement

The findings that emerged from the analysis of participant interview data is presented below. The discussions of the themes and categories present an explanation of the theme as it relates to AfL practices which are reinforced with extracts from participant teachers' interviews (*cf.* Appendix J).

5.4 PRESENTATION OF EMERGENT THEMES AND CATEGORIES FROM ANALYSIS OF INTERVIEW DATA

The broader themes that were identified were: *teacher understanding of assessment in Mathematics; integration of TPACK in Mathematics AfL; benefits of AfL; teachers' challenges and intervention to empower Mathematics teachers*. The first theme to be discussed below, which has five categories, is based on the teacher broader understanding of assessment as it relates to Mathematics and moving specifically to teacher understanding of AfL and feedback

5.4.1 Theme 1: Teacher's Understanding of Assessment in Mathematics

This theme reflects on the conceptualisation of assessment practices in Grade 6 Mathematics. It centres around participants' understanding of what assessment is and its attributes which are prerequisites for assessment planning and its effects on teaching and learning. From the interview data, the theme was flagged in the categories presented below.

Category 1.1: Teachers' conceptualisation of assessment

How Grade 6 Mathematics teachers conceptualise assessment and its importance in teaching and learning could influence how they plan their activities, that is, putting theory into practice (Dorovorolomo, Phan & Maebuta, 2010:447). To explore their conceptualisation of what assessment is, participant teachers were asked to define in their own words what assessment is. It emanated from the analysis of participant teachers' responses that they have an understanding of what assessment is and its importance in the teaching and learning of Mathematics. This is made evident by the following excerpts from participant teachers:

Assessment is a process teacher use to monitor the learning process and the progress of learners, how they are moving from one level to the next, in order, for a teacher to assist them. (MT#5)

Assessment is an ongoing process or a continuous process where the teacher tests or measures the learners' level of understanding, the skills acquired, what they know during teaching and what they don't know. So that she or he can give support or remedy to those who are experiencing barriers. (MT#3)

Sharing a similar understanding was another participant teacher who mentioned that:

Assessment is what the teacher uses to trace learners' understanding as well as themselves, whether the method that they are using benefits the learner, or whether the learners are mastering the concept taught or the teacher has to change and use different teaching methods. (MT#2)

The participant teachers' responses indicate that they have the correct conceptualisation of what assessment is and its importance. The explanations provided by participant teachers confirm William's (2013:15) assertion that teachers need to keep track of the learner to influence instruction. It should be seen from the participant teachers' quotes that they understand assessment as it assists both the teacher and the learner in identifying gaps in the learning of Mathematics (*cf.* 2.3.3 and *cf.* 3.2).

Furthermore, it could be derived from the analysis of participants' interviews data that Mathematics teachers also use assessment to measure if the skills stipulated in the Mathematics policy are met in teaching and learning. This is made clear by the following explanation:

Assessment is used to test the knowledge as well as learners' understanding of what has been taught. In Mathematics, we assess the skills that have been taught, and how far the learner

understands the mathematical concept as well as the application of learnt skills in solving mathematical problems. (MT#7)

The participant teachers' remarks about what assessment is, point to the different but unified reasons for assessing the learning process with the ultimate purpose of influencing classroom practice. The DBE (2012:3) emphasises the need for teachers to use assessment to collect and analyse information about a learner to make an informed decision on the next step in teaching and learning. In the application of assessment practices, that is, testing of skills, Mathematics teachers are expected to apply cognitive levels which test learners' utilisation of skills in problem solving (*cf.* 2.6.2). It, therefore, appeared that the participant teachers had a positive conceptualisation of assessment.

Category 1.2: Types of assessment

This category reflects on participant teachers' understanding of the different types of assessment that should be used to develop feedback in Mathematics (*cf.* 3.3). The understanding could, therefore, assist the Mathematics teacher in employing the relevant type for the purpose it was designed for. How each assessment type is employed in Mathematics has a bearing on how teaching and learning will unfold as well. The literature has identified baseline, diagnostic, AfL (formative) and AoL (summative) as four types of assessments used in Mathematics (*cf.* Figure 3.1). This means that Mathematics teachers should have a deeper understanding of each of the different types of assessments to influence all classroom practices.

Participant teachers were asked to indicate and describe each type of assessment as highlighted in the Mathematics CAPS document. The data showed that Mathematics teachers had an understanding of the different types of assessments used in Mathematics to drive teaching and learning. The knowledge of different types of assessment is expressed in the comments by participant teachers:

There is the baseline assessment which is used to check the prior knowledge of learners, to see whether the learners have the basic knowledge of the content of the topic that you are going to

deliver. There is also formative assessment, those are the daily activities that we do in class to check whether learners are on par with the concepts that the teacher is teaching. Then the other one it is summative, which is done after the topic, and include all formal activities given to learners. The results are recorded and check the progress of the learners to see where they are in terms of learning. (MT#5)

We have baseline assessment, formative assessment and summative assessment. A baseline assessment is when you when the students are from a previous stream and then they start in a new grade, you assess them on how far they have learnt. It provides a benchmark of where to start teaching. Formative is all informal activities learners complete in class or at home and summative include the formal activities used for promotion purposes. (MT#7)

The participant teachers gave the correct types of assessment as stipulated in the CAPS document (DBE, 2011a:296). Their utterances provide different important terminologies associated with types of assessment such as checking prior knowledge, moving the teaching process forward, checking learner progress and understanding, benchmarking and others (DBE, 2011a:296). In emphasising the central role of different types of assessment, Jabbarifar (2009:3) advocates for assessment to be used to improve instruction thus enhancing the learning process. Therefore, teachers' use of assessment to research in their Mathematics classrooms assists them in receiving feedback to plan to meet learning intentions.

Category 1.3: Methods of assessment

Participant teachers divulged the preferred assessment method they apply in judging of learners' work to identify learning gaps as well as improve learning. The method chosen is based on the participant teacher's views on the effectiveness of the method and classroom contextual realities. This line of thinking is revealed in the excerpts below:

I prefer self-assessment; learners are given space to rate their thinking by looking at themselves and what they need to do to improve. (MT#1)

I use group-assessment because learners master the concept faster learning and participating in a group. So, if learners are to be judged by other groups they work harder, and their contribution improves. (MT#2)

Additionally, the participant teacher publicised the impact of overcrowded classrooms in the usage of different methods. The teacher lamented the effects of the number of learners in a class by saying:

I use a combination of peer and teacher assessments because of the number of learners in my class. Unfortunately, learners cheat, therefore, peer-assessment does not give me the overall performance of a learner and therefore, teacher-assessment assists me to identify learners with challenges. (MT#7)

The participant teachers' responses point to the importance of using different methods based on the classroom realities that impact assessment. Generally, the participants seem to agree that the different methods are important and useful in the identification of learners that require assistance. The participant teachers mentioned that methods of assessment are consistent with methods identified in the literature (*cf.* 3.3).

Category 1.4: Assessment for learning (AfL)

It emanated from the literature that AfL played an important role in providing feedback that assists both the teacher and the learner in planning and learning (*cf.* 3.6). It also highlighted Mathematics teachers' use of assessment to reflect learners' cognitive development towards meeting the learning outcomes (*cf.* 2.3.1.1). Participant teachers were given space to articulate their understanding of AfL in Mathematics having been asked: *In your own understanding, how would you define AfL?* Concept development

is central to the learning of Mathematics, and teacher knowledge in using assessment to improve classroom instruction becomes crucial (*cf.* 2.3.1). Participant teachers saw AfL as an integral practice of teaching and learning providing them and their learners with information on learner development. Participant teacher understanding of what AfL is in terms of its role in the teaching and learning process was expressed through the following comments:

Assessment for learning is the assessment given to learners after teaching them a concept to check their understanding and skills associated with it. (MT#4)

During the progression of the lesson, the aim is to teach a particular skill or concept and then to test if the learners understand what has been taught. The assessment for the learning activity, therefore, assists the teacher in checking how learners are progressing in developing a mathematical concept. (MT#7)

Among teacher understanding of AfL was the idea that it prepares learners for the summative assessment. It provides teachers with an understanding of how learners will perform over time, as expressed in the excerpt below.

Assessment for learning is the assessment done on a day-to-day basis. It is a building block towards the formal assessment, there is a strong link between the informal assessment and formal assessment before there is a formal assessment, there should be an informal assessment. (MT#6)

The statements above can be viewed as both positive and negative as well. Teachers' use of AfL practices towards building Mathematics concepts to meet the learning intentions and thus improving learner performance in the AoL activities should be commended. On the other hand, the teachers' use of AfL is not about building learner confidence in handling mathematical concepts in assessment, but to help the learner memorise this concept for final assessment should be viewed as catastrophic. The use

of AfL should assist the teacher with knowledge of their learners and not deprive learners with opportunities to learn (*cf.* 2.5.1 and *cf.* 2.5.2).

Category 1.5: Importance of AfL constructive feedback

The participant teacher interviews data brought to light their understanding of the importance of feedback derived from assessment for learning activities. Teachers pointed to how it is used to improve their teaching strategies (*cf.* 3.6). The excerpts from the teachers below reveal their views.

Feedback is very important to learners as well as a teacher. It allows them to identify gaps both in the teaching of a concept and assist the learner in identifying areas that need their attention.
(MT#5)

Feedback assists the teacher in reflecting whether the instruction was effective and whether a different teaching method and approach is needed concerning the concept being taught.
(MT#1)

Feedback helps the learner to attend to misconceptions they might have developed during the teaching process. (MT# 2)

It also transpired from participant teacher interview data that although feedback is a vital component of enhancing teaching and learning, there are challenges experienced. The excerpt of MT#7 below, reveals the challenge of why teachers cannot provide individualised feedback to learners in the classroom. This becomes apparent from the expression: *Because of the number of learners in the classroom, it is difficult to plan for individualised feedback for learners. Feedback is given to the whole class as corrections written on the board.* (MT#7)

The *difficult to plan for individualised feedback* expresses the participant teacher's frustration based on the classroom environment that inhibits progress. It is also proof

that in its current form, feedback does not serve its purpose of helping the individual learner develop Mathematics skills at their pace or reflect on their learning (*cf.* 2.3.2).

5.4.2 Theme 2: Integration of TPACK in Mathematics

This theme focused on the use of technology in assessment and teacher pedagogical content knowledge in applying AfL. Participant teachers were asked if technology has a role to play in assessment, whether they are currently using technology and how they develop AfL activities. It emerged from the literature that knowledge of AfL principles play a crucial role in assisting Mathematics teachers in developing assessment activities that will help learners reach their performance potential (*cf.* 2.3.2). This theme discusses interview data that revealed and explored teacher understanding of AfL application.

Category 2.1: The use of technology in AfL activities

According to Higgins, Huscroft-D'Angelo and Crawford (2017:284), the use of technology in assessment is essential as it influences and enhances the learning process. The study revealed that there is varied Mathematics software available that could be used by Mathematics teachers in their classrooms (*cf.* 2.6.1 and *cf.* 2.6.5). Participant teachers believed that the use of technology can benefit both the teacher and learner as well in terms of skills development in using technology and in minimising teacher chalkboard usage. Participant teachers did not mention non-digital technologies and how they influence teaching (*cf.* 2.6.1). This is revealed through the following excerpts:

Yes, the use of technology in Mathematics is very important. The teacher needs to use the technology because it will minimise writing everything on the chalkboard. We can come prepared with activities and feedback, and project these for learners to complete.

(MT#3)

The response of MT#7 suggests that learners' reading skills improve when they are using technology and therefore, it has a major influence on how teaching and learning unfold in class. This assumption is drawn out in the excerpt of the interview data below.

Nowadays, we are using technology for everything. Learners know how to use android and tablets, interestingly, learners can read a message from a phone, but they cannot do it from the chalkboard and struggle to read Mathematics activities we give them. We can, therefore, use technology to improve their reading skills. (MT#7)

The general perspective of MT#2 is that learners should see the importance of using technology and its impact on their future. The participant teacher asserts that if teachers used technology in their Mathematics classrooms, learners can gain skills that they later use for their development. This is how the participant teacher responded:

Nowadays, technology is so important, and when learners use it, they also develop a skill of using it to their benefit. The skill learners acquire from using technology at school can assist them outside of school. (MT#2)

Through the review of literature, it was revealed that the availability of resources poses a challenge to AfL applications in Mathematics classrooms (*cf.* 3.7.6). Although it transpired from interview data that teachers were willing to use technology, the reality in classrooms is that technological equipment is non-existent. Interview data indicate that teachers do not use any technology in the assessment and the teaching of Mathematics.

Though the use of technology is vital in improving how we teach and assess, I do not have it except on my phone, which I use in class to Google something or if there is an argument in class about a mathematical concept. I also encourage my learners to use Google at home when they encounter challenges in the process of completing their activities. (MT#5)

On the contrary, MT#3 indicated that she uses her own laptop. Though the participant has a personal laptop, it is not enough to influence how she assesses Mathematics concepts as she does not have certain other technologies that could assist her. She commented by saying:

I use my laptop and only to type activities that I give to learners. I cannot use it in the assessment of Mathematics because the school does not have data projectors nor connectivity. (MT#3)

Though teachers view the use of technology as beneficial, some of the technology in Grade 6 is restricted by the DBE. There is a suggestion by MT#8 that the use of calculators is prohibited in Mathematics classrooms as learners need to develop estimation skills as it applies in the real world as well as the availability of resources.

The Department of Basic Education does not allow technology such as calculators to be used in Mathematics classrooms in Grade 6. Teachers have to find strategies for improving learner's calculation skills. (MT#8)

In Mathematics I don't have any technological resources that I can use to teach and assess mathematical concepts. I only rely on the textbooks to assist me in teaching and assessing mathematical concepts. (MT#4)

The excerpt below is the teacher's views on the use of technology in assisting the learners to complete the activity given. The teacher opposes the use of technology as it slows down the development of logical thinking which is an important skill that teachers have to develop in learners. In response to the question of the use of technology in assessment, the following perspective was given:

No, I don't think that the use of technology is important. I think it makes our learners lazy. Technology does things for people they

could do with a bit of applying their minds. So, I think technology is not good for my learners. (MT#6)

Generally, some of the participant teachers seem to agree on the use of technology in AfL practices. Though they did not specifically indicate the different technological software used in Mathematics (*cf.* 2.6.1), they did indicate they need to be equipped with more technology in their schools if it is to have an impact their assessment. The response of participant MT#6 shows a limited understanding of the various technologies available and only refers to the use of calculators. The view that was expressed, “make our learners lazy” clearly depicts their attitude towards the use of technology in influencing teaching and learning.

Category 2.2: Teachers’ lack of pedagogical content knowledge with AfL

The participant teachers’ interview data revealed that teachers lack pedagogical content knowledge related to the development of AfL activities. How they plan (*cf.* Table 5.3) and administer AfL practices in classrooms lacks cohesion towards meeting learner needs and the management of classrooms (*cf.* 2.6.3). When asked: *How do you develop and administer assessment for learning activities?* teachers could not give practical explanations that link practice to the policy, as shown by the responses below.

I do not develop an assessment for learning activities, I am usually using the activities that are there in the textbooks that I use for teaching Mathematics. (MT#8)

To choose activities, I make use of different textbooks that are CAPS compliant. (MT#2)

I use CAPS aligned textbooks as well as the Annual Teaching Plan. Should the activities in the books be difficult for learners, I then develop my activities that will be relevant to the concept being taught. (MT#6)

I use CAPS aligned textbooks ... The CAPS document tells us what to teach and what schemes to assess, then I get class activities from the textbook. (MT#7)

The responses of teachers above indicate reliance on the use of textbooks for learner AfL activities. The challenge with this practice is that such activities may not be learner-centred in terms of context and learners cannot connect their classroom practices with the real-world (Dreyer, 2014:13).

Significant to this study, as reflected by MT#2 and MT#9, is the need to plan AfL activities beginning with what learners know and building on it to abstraction. This transpired from the teacher's comments:

I use different questions starting from the basic which is a lower level to more challenging. This assists me in catering to all the levels of learner understanding. (MT#2)

Activity questions are designed in a way that simple to complex questions is presented to the learners. (MT#9)

Both excerpts above imply that teachers know the importance of developing AfL activities from what is generally known about the concept of simple to complex or concrete to abstract application in Mathematics. But classroom observation and analysis of documents indicated no application of such (*cf.* Tables 5.3 and 5.4) during the development of AfL activities.

Category 2.3: Teachers' knowledge of AfL approaches

The development of AfL activities should be based on a sound knowledge of the different approaches as well as varied methods that should be applied (*cf.* 2.3.3, 2.6.2, 2.6.6 and 2.7). Teachers were asked which policies they used when developing AfL activities. They were asked to articulate their understanding of planned and unplanned assessment in Mathematics. Their responses lacked the knowledge of using the CAPS document, as shown by the following extracts:

I use different books that I have in my possession when I plan assessment activities. (MT#2)

I use a combination of materials in developing learner activities. These include textbooks, departmental manuals as well as the lessons plans from the department. The department provides us with lessons and these lessons have got some informal tasks, its purpose is to assess learners informally and then you are not relying on one textbook. (MT#9)

Sometimes I use the manual from the university where I am currently studying, for example, they are teaching us the fundamental Maths. Fundamental Maths talks about everything; therefore, this policy helps me in developing assessment activities. (MT#4)

The data from interviews further indicated that teachers understand the approaches to AfL practices related to planned and unplanned assessments. Their responses were framed as:

Planned assessment is prepared before a teacher goes to class, and unplanned assessment is the remedy that the teacher uses to reinforce the concept when the concept taught is not well understood and when the instruction is not effective. (MT#1)

Planned activities are indicated in the lesson plan. It is activities the teacher gives to check the learner understanding of the topic. Unplanned is not the lesson plan, it happens during teaching and learning. (MT#7)

Of interest is that teachers consider choosing activities from textbooks as planning (cf. 5.5.1) rather than developing them for their learners. The non-participant observation identified the challenge of language in Mathematics as teachers had to explain the

activity questions through reading them to learners (*cf.* 5.7.4). Not planning AfL activities based on the classroom contextual factors, disadvantages the learners in improving learning as well as assisting the teacher in future planning.

5.4.3 Theme 3.1: Benefits of Applying AfL in Mathematics

This theme emerged when the participant teachers were asked to identify the benefits of applying AfL in Mathematics and the challenges they experience in their Mathematics classrooms during the application of AfL activities. The views of the teachers on this aspect are equally crucial in highlighting their experiences and recurring challenges that frame teacher attitude towards the use of AfL as it is explained in the literature. Categories that were discussed under this theme included benefits of constructive feedback, improving teaching and learning through AfL practices and self-regulatory learning assessment for learning.

Category 3.1.1: Benefits of constructive feedback

Constructive feedback assists the teacher and the learner in closing the gap on how the specific learner is currently performing and highlighting the desired performance (Al-Hattami, 2019:886). It emanated from the study that the role of AfL is to provide constructive feedback to learners about their learning (*cf.* 2.3.1). Participant teachers emphasised the importance of AfL constructive feedback and acknowledged the benefits it has on their classroom practice. They see AfL practices as an agent for providing feedback that learners can use in improving the quality of learning. The participant teacher responses that expressed the benefits of feedback in Mathematics are illustrated in the following extracts:

Constructive feedback assists the learner in identifying learning gaps and can plan for intervention strategies accordingly. (MT#8)

This kind of feedback helps stimulate the thinking process of learners helping them in understanding themselves and what they need to do to improve their performance in the future. (MT#1)

From the above comments, it can be interpreted that the constructive feedback in Mathematics assists the learner in making necessary adjustments to help enhance how they learn Mathematics. Therefore, these assertions are consistent with the constructivist view of a learner being given space to display what they can do for the teacher and the learner to take necessary steps in assisting the learner (*cf.* 2.3.3).

Category 3.1.2: The improvement of teaching and learning

AfL practices were found valuable with regards to assisting the improvement in teaching and learning. The participant teachers felt that AfL provides the basis on which the outcome and evidence of learning could be established. The participant teachers' sentiments were expressed as follows:

Without AfL there will be no learning and teaching. It assists the teacher in reflecting on their teaching strategies and help the learner predict how formal assessment will be structured and therefore, prepare thoroughly for it. (MT#5)

Teachers will find it difficult to set assessment of learning activities if they do not understand the academic capabilities of their learners. The learners will not know what they are capable of doing and they will find it hard to complete formal assessments. Therefore, AfL benefits the teacher and the learner as well. (MT#7)

Category 3.1.3: The encouragement of self-regulatory learning

Self-regulatory learning is the learner's ability in using feedback and working towards achieving the learning intentions presented (Matric, 2018:79). It can be deduced from the participant teachers' interview data that AfL assists the learners in choosing and monitoring their actions towards achieving desired goals. The interview data revealed how learners can use feedback as a springboard through which motivation for the attainment of specific educational goals is increased (Cazan, 2012:743). Participant teachers felt that AfL practices help learners to learn through experience and can link

the present with future academic needs. These views were expressed in the following comments:

We use similar activities between AfL and AoL so that learners can link between informal and formal assessments. That way they can set their learning goals and make necessary adjustments towards meeting them. (MT#2)

It is through AfL and its feedback that learners build their self-esteem and look at teaching and learning as a continuous practice and not as just task-orientated. Therefore, learners have control over their learning. (MT#1)

5.4.4 Theme 3.2: Teacher Challenges in Applying AfL

The interview data indicated several challenges in the application of AfL in Mathematics classrooms. Participant teachers were asked to identify their challenges that impede the application of AfL practices. The emergent categories were overcrowding, teacher workload, the language of teaching and learning, lack of resources and learner-centred application of assessment practices and are discussed below.

Category 3.2.1: Overcrowding in classrooms

It transpired from the interview data that the size of the class possesses a threat in the application of AfL practices in Mathematics classrooms (*cf.* 3.7.2). Disruptive behaviour of learners in overcrowded classrooms was observed (*cf.* 5.7.4) by the researcher, and it created unproductive working environments. The participant teachers were asked to identify challenges that inhibit the application of AfL in Mathematics. The effects of overcrowded classrooms are borne out in the extracts below:

My biggest challenge is the number of learners that I have in my Mathematics classrooms. I find it hard to plan for individualised

teaching because of overcrowding. And because of the work that needs to be covered in a term, it is difficult to go back and teach concepts that I know learners did not understand. I have tried extra classes intending to assist my learners, but it does not help.
(MT#4)

I think my problem and a major challenge is overcrowding in my classrooms. Because of the number of learners in my class, I am unable to reach those learners that need my close supervision. They are always left behind because I am unable to reach out to them. (MT#6)

Category 3.2.2: Teacher workload

Participant teachers' interview data disclosed how teacher workload becomes a constraint towards meeting curricular needs. The participants' utterances reflected on the amount of work in terms of the weight of subjects as well as what they have to cover which constitutes their workload (*cf.* 3.7.4). This is evident from the extract below:

I am currently teaching Home Language, it has lots of work, as much as Mathematics, so both are heavy on me. It is a burden on me, as much as I try, and I miss learners along the way trying to meet subject demands. (MT#5)

The responses of MT#1 and MT#8 below suggest that the policy, the school managers and subject advisors put pressure on teachers to complete the work prescribed for Grade 6 in a particular term. This exerts unnecessary pressure on both the learner and the teacher as both have to move faster in completing the Annual Teaching Plan (ATP) rather than building the Mathematics concept with the learners. The quotes below illustrate the dilemma.

The Mathematics policy is task-orientated, and not learner-orientated. The policy through the Annual Teaching Plan states all

the formal tasks learners should complete with no consideration of classroom realities. The pressure is always on the teacher to plan according to the departmental plan and at times neglecting learners' mathematical needs. (MT#1)

School visits done by our district are based only on the amount of work done by the learners in their books, no comments regarding the quality of activities completed by learners. Their main concern is about the completion of the Annual Teaching Plan and not learners' academic skills as required by the policy. As long as the teacher can prove that they have covered the topic in the learners' books and corrections done, there is not much help from them. (MT#8)

Furthermore, it could be derived from the analysis of participant teacher interview data that the policy progression requirements implemented in the Intermediate Phase create a problem in Grade 6 (cf. 1.2). This was made transparent by the following extract:

Coupled with overcrowded classrooms, the number of progressed learners is giving us a headache. The policy overlooked the amount of work these learners have to cover in a year. And because Mathematics concepts have not been fully developed in the previous grades, it forces us to slow the pace of teaching and assessment. (MT#7)

The statement above suggests that the progression of learners impacts the learner performance. The participant teacher felt overburdened having to meet policy needs in terms of concepts to be covered in Grade 6 and having learners in the classroom who lack basic Mathematics skills. The utterances are congruent with researcher classroom observations in which most participant teachers read through AfL activity questions.

Category 3.2.3: Language of learning and teaching (LoLT)

It transpired from the participant teachers' statements that the language used in the assessment of learners poses a barrier towards learner independence (cf. 3.7.5). The non-participant observation revealed that teachers took the central role in the assessment as they read the activity question to learners (cf. 5.7.1; Sharma, 2015:275). On this aspect the participants responded:

The biggest barrier in assessment is the language of learning and teaching. English is a language that learners find difficult to understand. Without help from the teacher in explaining assessment questions, learners experience difficulties in completing assessment activities. (MT#9)

Sometimes, in most cases, learners do not understand the questions that they have been asked in the assessment because they lack knowledge of the language of learning and teaching, the language used is poorly developed. (MT#1)

Most of the time I spend a lot of time explaining the requirements of the activities. The language of teaching and learning used in the textbook is difficult for my learners. (MT#7)

This finding confirms the suggestion of Brock-Utne (2012:774) that learners learn better when they understand their teacher. The Mathematics is assessed in a language neither teachers nor learners have mastered well enough for effective teaching and learning (Mudaly & Singh, 2018:57).

Category 3.2.4: Lack of resources to enhance AfL

Resources play an important role in the assessment and teaching of the content by encouraging learners to decode, organise their learning and improve their logical reasoning, communication and interaction with others (Bušljeta, 2013:56). In light of this, participant teachers were asked to share their views on the relevant resources

used to assess concept development in learners. The following extracts reflect the views and concerns in response to the question of resources:

I rely on different textbooks as my resources, we have nothing else. Learners depend on us to clearly explain the concept. Though in my view technology is important in teaching, we do not have any for assessment and teaching. (MT#2)

These sentiments were reiterated by MT#8 who pointed out that the only materials available for her to use as resources are textbooks: *I do not have enough resources to help learners participate in the lesson. I rely on different textbooks as my resources for teaching.*

The acknowledgement by participant teachers that resources play an influential role in teaching, learning and assessment provides a positive stance towards their usage.

Category 3.2.5: Learner-centred assessment for learning practices

Though the participant teachers acknowledged the impact of AfL practices, creating such an environment in overcrowded classrooms was a stumbling block. The researcher observed that the environment that enables a learner-centred approach to assessment was found to be lacking. Overcrowding in Mathematics classrooms did not allow for a productive learner discussion towards completing Mathematics activities. Participant teacher sentiments are demonstrated in the extracts below:

Because of the large number of learners in a class, we cannot keep up with the pace of attending to different groups at the same time. When we are attending to one group, the other groups are not doing the work given to them to complete. (MT#4)

Another factor relates to learner Mathematics abilities, in which, learners that are knowledgeable to the concept being taught, take over the discussion. Regarding this MT#7 highlighted:

Intelligent learners sometimes take over and provide all the answers to the activity without allowing discussions in their groups.

(MT#7)

The participant teachers' views indicated that the language of teaching and learning does not promote effective learning that allows learners to express their contribution and engage other learners towards completion of activities. MT#8 said:

Learners experience difficulties in reading and engaging each other in English. Even if they read instructions in activities they often do not understand, and most often, they wait for the teacher to explain.

These excerpts indicate difficulties in creating a learner-centred approach to assessment practices. The classroom environment could not, therefore, promote active participation through which learners can create individual knowledge based on their experiences (*cf.* 2.3.1). Meeting learner needs in such circumstances require Mathematics teachers to alter their attitude towards assessing large classrooms.

5.4.5 Theme 4: AfL strategies to empower Mathematics teachers

Participant teachers were asked if they had strategies that could best assist in the effective application of AfL practices in their classrooms. Three categories comprising in-service training, availability of resources and parental involvement emerged regarding their needs and successful application of AfL in classrooms and are discussed next.

Category 4.1: In-service training in designing AfL activities

The participants' teachers expressed the need for developmental in-service workshops that could assist with skills in developing AfL Activities. This was revealed in the following excerpts:

Mathematics teachers need support from the departmental officials in the district office. The officials need to come to schools and provide us with skills on how to plan for assessment for learning activities in Mathematics. (MT#3)

We need workshops on how to develop AfL activities in Mathematics because there is a link between assessment for learning and teaching Mathematics concepts. (MT#7)

Participant teachers acknowledged having received introductory training related to assessment and voiced that the training was insufficient to meet the curricular demands of AfL practices. This was evident in this remark:

The only developmental workshop I received concerning assessment was when CAPS was introduced around 2012. Ever since there is no support. (MT#3)

I have not received any workshop except for the information that I am getting from my studies I am currently doing. (MT#4)

In line with the above responses, another teacher participant cited the need for quality in all AfL activities in Mathematics and stated:

I need a developmental workshop that will identify quality rather than quantity as a prerequisite for assessment for learning activities, planning and application in Mathematics. (MT#8)

The teacher participant views are that in-service workshops are to be tailored so that Mathematics teachers are adequately skilled to meet classroom demands associated with assessment for learning application. The excerpt, to a certain extent, reflects a practice that lacks efficacy and influence on teaching and learning practices.

School management, especially departmental heads, was viewed as an integral part of teacher development. To shed more light on the need for workshops, when asked

what internal arrangements can be made to upskill teachers' confidence in assessment, a participant teacher expressed how departmental heads could use their proximity to teachers in terms of teacher development. Their participation could influence the assessment for learning planning practices and the participant teacher commented as follows:

The departmental head should be fully involved in assessment practices. They should know what I am teaching and how I assess by verifying the activities I am giving to my learners in Mathematics. (MT#6)

Generally, the participant teachers seem to agree that the application of AfL in Mathematics should be coupled with teacher development. This shows that the teachers had noticed the need for a concerted effort to address assessment practices in Mathematics. Central to their development is school-based management and district officials who need to come on board with programmes of intervention. Lack of training translates into low teacher proficiency in the application, which is evident with teachers that are poorly performing in terms of AfL practices (Online article by Martinelli, 2018). Inadvertently, the inadequately trained teachers are showing signs of the poor performance of applying AfL practices such as planning (*cf.* 5.6.1.1) and application of assessment strategies (*cf.* 5.7.1).

Category 4.2: Availability of resources to enhance concept development through AfL

The matter of available resources to enhance concept development surfaced in the participant's teacher interview data. Thus, the participant teacher recommended that resources should be made available to both teachers and learners, as expressed by the following sentiments:

Schools should start using their allocated funds to buy teaching and learning resources. (MT#6)

The participant teacher excerpt emanates from the National Norms and Standards for School Funding Policy of 1998a which provides a statutory basis for funding of schools based on socio-economic affordability (Carter, Barberton & Biden, 2017:36). The South African Schools Act (SASA Act 84 of 1996) states that funds allocated to schools should be used among other things, to purchase educational materials and equipment for effective teaching and learning in schools.

Though the participant teachers did not mention any specific Mathematics resources (*cf.* 2.6.1), it does point to a need for resources to assist teachers in the assessment of Mathematics. Consistent with non-participant observation (*cf.* 5.7.2) teachers relied on the chalkboard and textbooks during the assessment. Participant teacher MT#3 identifies basic technology that could be of use to Mathematics, especially to assist in the planning process. The teacher suggested that:

The Department of Basic Education should provide Mathematics teachers with technology such as data projectors and laptops for teachers as well as tablets for learners. (MT#3)

The teacher also reiterated the issue of connectivity to maximise the utilisation of resources. These findings concur with the assumption of the researcher that resources play a significant role in facilitating mathematical concept development. Likewise, Andambi and Kariuki (2013:158) suggest that the use of resources in assessment assists the learner in understating and retaining mathematical concepts longer.

Category 4.3: Parental involvement in AfL

In terms of stakeholders that could play a significant role in the assessment of Mathematics, parents were identified. Participant teachers emphasised the importance of parents being involved in the assessment of learners. Effeney *et al.* (2013:59) present the same opinion on the role that should be played by parents in education. Because of their proximity to the development of their children, they have an influential role to play on academic development as well. Teachers indicated that some of AfL activities are to be completed at home, and they expect parents to assist their children

in the completion of such activities. The participant teachers explained how parents could be involved in the following way:

At times we give learners AfL activities to complete at home and most learners do not do their work. It wastes a lot of time having to give extra time in the classroom to allow learners to complete something they should have done at home. (MT#4)

A parent should learn to create an environment that assists in the learning of Mathematics at home. (MT#1)

Participant teacher comments regarding parents being involved in the assessment practices contradict the outcome of document analysis (*cf.* Table 5.3). Participant teachers did not have their school assessment policy in their files, nor was it distributed to parents. This is an indication that there is no communication between the teacher and the parents regarding the assessment of learners.

5.5 QUALITATIVE ANALYSIS OF NON-PARTICIPANT OBSERVATION

Non-participant observation data were collected and analysed to obtain first-hand information on what happens in Mathematics classrooms concerning AfL application. Such observations form part of important tools in qualitative research as it allows the researcher to see all classroom teaching and assessment practices being physically present in a natural setting. Therefore, the observation focused on why things happen as they do, how Mathematics teachers taught and applied AfL, influenced learners to participate towards completion of activities, used available resources in concept development, and together with learners developed feedback from activities completed. The observation took place in eight different classrooms and each observation lasted for an hour which was time allocated for the Mathematics lessons on the day of observation. The analysis focused on the observation sheet that was used during data collection (*cf.* Appendix H) and the notes the researcher took.

What emerged on the non-participant observation is described in the following section which presents the themes and categories from the non-participant observation data.

The majority of the themes from participant interview data were seen to be consistent with non-participant observation data. However, there were new categories that emerged from observation and some of the themes from the interview data were not observed and were not discussed in the analysis. Table 5.3 presented themes and categories that emerged from non-participant observation data.

Table 5.3: Emergent themes and categories from non-participant observation

	Sub-research Questions	Themes	Categories
1	How do Grade 6 Mathematics teachers understand AfL?	1. Teacher understanding of assessment in Mathematics	1.1 Using learning intentions to influence AfL practices 1.2 Teaching approaches in Mathematics classrooms 1.3 Methods of assessment
2	How do teachers integrate TPACK in AfL in Mathematics?	2. Integration of TPACK in Mathematics AfL	2.1 The use of technology in AfL 2.2 Teachers' lack of pedagogical content knowledge
3	What are the benefits and challenges faced by teachers in applying AfL in Mathematics in Grade 6?	3.1 Benefits of AfL	3.1.1 Teacher- learner use of feedback 3.1.2 The use of AfL to improve teaching 3.1.3 Self-regulatory learning
		3.2 Teachers' challenges	3.2.1 School infrastructure 3.2.2 Overcrowding 3.2.3 Language of Learning and Teaching 3.2.4 Lack of resources 3.2.5 Learner-centred application of assessment practices

5.6 PRESENTATION OF EMERGENT THEMES AND CATEGORIES FROM NON-PARTICIPANT OBSERVATION

The broader themes that were identified were: *teacher understanding of assessment in Mathematics; integration of TPACK in Mathematics AfL; benefits of AfL; and teachers' challenges* Three themes emerged from the analysis of non-participant

observations and align with the first three themes of participant interviews and are presented and discussed in the subsequent sections.

5.6.1 Theme 1: Teacher understanding of assessment in Mathematics

According to Sequeira (2012:3), teaching involves a series of events that a teacher uses to influence learning as well as supporting the learner to internalise information. During teaching, Mathematics teachers help a learner in building the understanding of a concept. This theme entailed analysing how Mathematics teachers influenced the understanding of mathematical concepts being taught in their classrooms. The emergent sub-themes involved the descriptions of the learning intentions and teaching approaches employed by participant teachers. The two categories (1.1 and 1.2) discussed next emerged from participant teacher observation data and did not feature in the participant interview data.

Category 1.1: Using learning intentions to influence AfL practices

The descriptions of the learning intentions in a Mathematics classroom set the tone for the conditions of success that learners have to achieve (*cf.* 3.5). Therefore, learning intentions assist the learner in linking the concept being taught and assessed. The researcher observed that none of the participant teachers explained or tried to articulate the learning intentions to their learners. The observation data revealed that during teaching, participant teachers gave a definition of the concept under study, a few examples on the board and then gave learners activities to complete.

The researcher observed that none of the participant teachers explained or tried to articulate the learning intentions to their learners.. Observation revealed that learners did not make attempts towards the completion of the assessment. The researcher is of the view that learners were left to make their own connections between concepts explained and assessment activities provided by the teacher. This is a participant teacher shortcoming that needs intervention as studies show the importance of sharing learning intentions with learners in learning (Crichton & McDaid; 2016:194; Mahajan & Singh, 2017:66).

Category 1.2: Teaching approaches in Mathematics classrooms

Teaching approaches assist the teachers in teaching the concepts to help learners understand their dynamics (Gill & Kusum, 2016:6692). Classroom observation revealed that a high degree of teacher-centred strategies was used during teaching and learning. It was noticed that during the development of the concept, teachers provided all the information and learners passively received information (Emaliana, 2017:60). The learner engagement during teaching was poor leading to other learners doing other things than paying attention to the teacher. The participant teachers' practices were contrary to the aspirations of DBE (2012:4), that of developing active and critically thinking learners. A conclusion can be drawn that Mathematics teachers need to develop learner-centred teaching strategies.

Category 1.3: The use of different methods in the assessment of Mathematics

Teacher-, self-, peer- and group-assessments are the various methods that could be utilised in Mathematics classrooms (*cf.* 3.8). These methods assist the learners and the teacher in developing feedback that is used to move teaching and learning forward (*cf.* 3.4; Wiliam, 2013:16). Mathematics teachers' knowledge of the impact and benefits of the application of these methods becomes important. Therefore, a classroom environment is created to assist learners in achieving the desired education goals of learning Mathematics in Grade 6 (*cf.* 2.6.2).

Participant MT#1 wrote the solutions to the activity on the board and learners wrote the corrections in their books. Learners contributed to the solutions by answering the teacher, and the teacher sought clarity-seeking concerns from learners which opened a class contribution towards finding the answer. What was observed was that only learners who participated in the concept development process were able to give solutions and gave explanations about how they got to their answer. The majority of the learners ended up copying the answers from the board. MT#2, on the other hand, allowed the groups to report on their findings to the class. Each group was able to self-assess their solution through the contribution of the class. The participant facilitated the class discussion allowing the presenting group to validate their solutions. MT#9 encouraged class discussion and the learners who provided solutions to the activity

were engaged by the teacher and peers and even when a wrong solution was given, the learner was assisted by peers with the participant teacher stepping in to assist. MT#3 gave an activity in which learners had to provide solutions to the problems as they went along. The participant teacher gave prompt feedback as she allowed learners to complete one sum and then discuss the solution, although the time given was insufficient to attend to learners' needs to self-reflect.

None of the participants observed was able to give individual learner feedback as the activities were too long and teachers had a lot of reading and explaining to do as the learners were completing the activity (*cf.* 5.5.3, Section 3.1). Most participant teachers struggled to control learner behaviour as the noise levels were high and the overcrowded classrooms made it difficult for the participant teachers to closely monitor individual learners.

5.6.2 Theme 2: Integration of TPACK in Mathematics Assessment for Learning

This theme presents the findings emerging from non-participant observation giving an insight into how participant teachers integrate TPACK in AfL. The observation assisted the researcher in unpacking the impact of technology in AfL as well as participant teacher pedagogical content knowledge in applying assessment for learning in a Mathematics classroom.

Category 2.1: The use of technology in AfL

The data revealed that the participant teachers did not have digital-technological resources to use during assessment except for non-digital technologies such as textbooks and chalkboard. Learners responded to assessment for learning activities using either activities in their textbooks or photocopied material and examples written on the chalkboard. The majority of teachers were engaged with the *Data handling-presentation and analysis of graphs* topic during the scheduled observation and it was felt that they could have used various software in the assessment.

Category 2.2: Teachers' lack of pedagogical content knowledge with AfL

Observation revealed that participant teachers did not develop their AfL activities but relied on textbooks. This is an indication that participant teachers lack the knowledge of the importance of developing activities that will incorporate learners' context and classroom realities (*cf.* 2.3.4). The activities given to learners did not relate to their environment and experiences (*cf.* 2.3.5) and coupled with a language(English) with which learners were not as yet proficient, participant teachers spent time reading through the questions to simplify meaning.

5.6.3 Theme 3.1: Benefits of Applying AfL

This theme entailed a broader outlook of what transpired in the Mathematics classroom and how teachers use what they perceive as benefits of AfL. The emergent category involved how teachers and learners use feedback derived from AfL, to drive classroom instruction.

Category 3.1.1: Teacher-learner use of feedback

The observations revealed how Mathematics teachers used feedback derived from AfL activities. The importance of feedback is that it provides teachers and learners with information about what needs to be done moving forward (*cf.* 3.11). The teacher and the learner create a platform through which a discussion is held concerning Mathematics learning or understanding. As much as the participants tried to derive feedback with learners through the corrections, most learners did not benefit from it. Most learners in the classes observed did not participate fully in the activities because teachers communicated with only learners who were willing to participate. Though the teachers tried to have open class discussions through corrections (Dreyer, 2014:67), the engagement did not benefit the majority of learners. Classrooms lacked a collaborative relationship between the Mathematics teachers and their learners and amongst the learners as per constructivist theory views (*cf.* 2.3.3). In all the discussions that ensued after the completion of activities, dominant learners took over the learning process neglecting the individuality of learners in classrooms (*cf.* 2.3.5) and those learners in need of social interaction to learn or the use of ZPD (*cf.* 2.3.2).

The observation showed that little congruity exists between participant teachers' knowledge about feedback (*cf.* 5.5.3, Sub-theme 3.1) and classroom practices. As observed, feedback ended up being corrections written by the teacher and copied by learners into their exercise book. Participant teachers did not check learners' books to identify errors or misconceptions during the completion of the activities. Therefore, the feedback provided on the board did not attend to individual learner's needs or focus on common errors (Hadzic, 2016:12).

Category 3.1.2: The use of AfL to improve teaching

Generally, in all Mathematics classrooms observed, the researcher did not observe much teacher intention of using feedback derived from AfL to improve their teaching strategies. As it has been identified from the planning perspectives, that is the development of AfL activities (*cf.* Theme 2, category 2.2 and *cf.* 5.71, category 2.2), teachers rely mostly on readily available lesson plans and do not develop their own. Nevertheless, this does not imply that the participant teachers cannot use the same lesson plans to improve their teaching, it could be that they can support the teacher in completing the ATP. This is a shortcoming at the research sites that need intervention. The researcher also observed that participant teachers did not effectively use unplanned assessment practices to engage learners in concept development.

Category 3.1.3: AfL for self-regulatory learning

The constructivist view on assessment is that it should be learner-centred promoting active participation (*cf.* 2.3.1.1) through social interaction (*cf.* 2.3.1.2). During data collection, the researcher observed that classroom environments did not acknowledge that learners are different and need to self-direct (Cetin, 2015:95). Due to the classroom realities that persisted during the collection of data, learners were not allowed to self-reflect on the assessment activities. It is the view of the researcher that learning was externally regulated through participant teachers taking over the assessment process, thus giving less autonomy to learners.

5.6.4 Theme 3.2: Teacher Challenges Encountered during the Application of AfL

The information derived from non-participant observation indicated that there are various challenges experienced by a Mathematics teacher. It should be noted that observation did not reveal any successes that are worth discussing. The participant teachers' challenges identified included: *school infrastructure; classroom overcrowding; the language of Learning and Teaching; lack of resources; and learner-centred application of assessment for learning*, which were categories identified.

Category 3.2.1: School infrastructure

Coupled with overcrowded classrooms, most classrooms lacked storage area that is designated for resources such as textbooks and learners' books. In some of the classrooms, textbooks and exercise books were packed on the floor and windowsills because of the lack of storage capacity. This limited participant teacher movement within the classrooms, and they could not attend to learners who were sitting at the back of the class.

Category 3.2.2: Classroom overcrowding

The DBE suggested a ratio of 40:1 as the prerequisite teacher to learner ratio in class for public primary schools. This has resulted in the skewed distribution of learners in classrooms. As observed, all the classes observed had between fifty and seventy-nine learners (*cf.* 5.5.3, category 3.1). Because of overcrowded classrooms, the participant teachers battled with disruptive learner behaviour which adversely affected the completion of the activities (*cf.* 3.7.2). Teachers could not provide for a personalised individual learner or group interaction as the constructivist view on teaching suggests (*cf.* 2.3.2). Though the participant teachers tried to use group work strategies, most groups were soon taken over by dominant learners (*cf.* 2.3.5), most learners in the classrooms relegated into copying corrections written on the chalkboard. Therefore, the classroom atmosphere did not encourage increased social interaction through which learners are treated with fairness and equity (*cf.* 2.5.1 and 2.5.2). The

overcrowding in classrooms, therefore, did not expand learner access that allows support to meet the educational needs of learners (*cf.* 2.5.3).

Category 3.2.3: Language used in AfL

The language of learning and teaching is the most vital tool through which the teacher and the learner communicate, and through which knowledge is transferred. Donald, Lazarus and Lolwana (2006:96) note that in its form, spoken or read in Mathematics, language is an essential instrument to drive the assessment process. The use of language, therefore, becomes crucial for learner participation and towards the completion of assessment activities (DoE, 1997:23). The LoLT used in Mathematics classrooms was English, which posed as a barrier in terms of understanding and completion of the tasks (Setati, 2008:105).

As observed, because learners lacked proficiency in the language of teaching and learning Mathematics, it impeded their classroom engagement (Donald *et al.*, 2006:197). This is exemplified by participants MT#1, MT#2; MT#5; MT#6 and MT#9 who opted in reading each question of the activity, explain its requirement and let the learners complete the activity (*cf.* 5.5.3, Category 3.1). The lack of understanding due to the language barrier inadvertently affected how learners engaged among themselves and with the teacher as well. The switch between LoLT and HL as learners engaged in the completion of the activity led to a noisy environment in most classes. The environment became unproductive and the participant teachers spent time trying to bring the classes under control. An example of an assessment activity that was completed by learners in one of the Mathematics classrooms is presented below in Figure 5.

School: A
Teacher: MT#1
Subject: Mathematics
Activity: Informal Assessment
Date: 13 September 2019
Topic: Data Handling- Interpreting Bar graphs

Use the information in the textbook to answer the following questions:

- a. In which month does Durban have the most rain?
- b. In which month does Cape Town have the most rain?
- c. In which month does Durban have the least rain?
- d. In which month does Cape Town experience the least rain?
- e. Is Durban in a summer or winter rainfall region?
- f. Is Cape Town in a summer or winter rainfall region?
- g. Which city has the highest annual rainfall?
- h. What is the difference in the rainfall in March for the two cities?
- i. What is the difference in the rainfall in December for the two cities?
- j. Predict which city would have the most rain in May the following year. Give a reason for your answer.
- k. What is the total annual rainfall for?
 - Cape Town?
 - Durban?

Figure 5.1: Sample of an AfL activity completed by learners (adapted from MT#1 classroom AfL exercise)

The activity above was given by participant MT#1 and in this activity, learners had to analyse data from a double bar graph to answer these questions. The teacher had to read through and explain the mathematical meaning of the words such as: 'least, highest, rainfall region, difference and predict' as they relate to Mathematics'. According to Riccomini *et al.* (2015:236) developing LoLT and its Mathematics vocabulary is a prerequisite to assisting learners to access concepts and instructions. Learner proficiency in Mathematics not only depends on their ability to compute but also communicate using mathematic-specific terms (Gürefe, 2018:662). The time that could have been used in completing the activity and developing the concept being learnt was used in giving a detailed explanation of the terms used in the activity. Though the participant teacher had explained these terms in the examples, learners could not transfer their usage to the Mathematics activities. This finding relates to the planning process as alluded to with special reference to management intervention in

motoring the planning and implementation of AfL in schools (*cf.* 5.6.1.2). The participant teacher knowledge of learners, as well as the objective monitoring by the departmental head, could assist in supporting learner experiences towards the completion of activities.

Poor comprehension of task requirements by learners challenged their contribution towards its completion. This was evident when most participants took the initiative of reading and explaining the questions to learners before they could complete the activities.

Category 3.2.4: Choices of resources used in AfL activities

The availability of Mathematics resources in Mathematics cannot be overemphasised (*cf.* 3.7.6). But of equal importance is how Mathematics teachers utilise the available resource in AfL activities in their Mathematics classrooms. The use of resources can assist the teacher in assessing Mathematics concept in dynamic ways (*cf.* 2.6.5). The observation revealed that the majority of teachers use the chalkboard, textbooks and learners' books during teaching and assessment. Teachers developed the concept under discussion through writing examples on the board, giving examples on how to answer a question related to the concept and at times erasing the examples already on the board. One participant teacher, MT#5 who was dealing with measurement, provided learners with different measuring tools to measure the height, width and the breadth of different objects in the classroom. This exercise increased the participation of learners in group activities even though some learners were dominant in their groups because group roles were not clearly explained.

Nevertheless, this observation supports the participant teachers' sentiments regarding the available resources during interviews (*cf.* Theme 3.2, category 3.2.4).

Category 3.2.5: Learner participation in the completion of classroom assessment activities

This theme provided a broader outlook regarding teacher practices in the process of implementing AfL practices. It highlighted how Mathematics teachers worked towards

engaging and involving learners in the learning process by using AfL practices. The constructivist view of learning is that classroom practices, that is, teaching, learning and assessment should be learner-centred (*cf.* 2.3.3). Therefore, assessment for learning activities should be developed in such a way that they reflect learners' social environment and realities (Aljohani, 2017:99). Learners should relate to the concept being taught through contextualised Mathematics activities. Such activities are said to be just and allow Mathematics activities to be fair to learners providing equal access to learning (*cf.* 2.5). Learner participation in classroom activities increases if that activity addresses their educational needs and they find value in the concept being taught (Bhowmik, 2015:12). Because of unrest in the area during the data collection, the researcher was only able to observe seven participants.

The classroom observation revealed that teachers are struggling to create an environment that allows for a learner-centred approach to assessment (*cf.* 5.5.4, Sub-theme 4.1). The findings indicate that Mathematics teachers dominate the teaching and assessment practices in their classrooms based on the challenges they encounter (*cf.* 5.5.3, Sub-theme 3.1). Below is the analysis of how the participants approached AfL activities in their classrooms.

MT#1, MT#2; MT#5; MT#6 and MT#9 all tried to use a teacher-centred approach to assist the learners in completing Mathematics activities. Having described the concept, the participants did a few examples on the board and then gave an activity for learners to complete in their books. The participants read the questions for the learners and gave a brief analysis of what is expected from the learners when answering the question (*cf.* 3.7.5). Therefore, the participants guided learners towards completing the activity and did not allow any discussion amongst learners, learners talked directly to the participant teacher when they needed assistance. As observed, only a few learners in these classrooms participated or engaged the teacher in seeking clarity regarding the activity.

Participant MT#3, having discussed the concept and having given examples on the board, gave an activity to learners to complete. The class was divided into groups and learners were instructed to find solutions working as a group. First, the teacher and the learners read the activity as a class and as they read, she referred them to the

concept being developed and clarified. The learners had to choose one learner who had to report back on the solutions by the group. Though the noise levels were high in the groups, some groups worked collaboratively with minimal interference from the teacher, except when the group required her to explain or give direction (*cf.* 2.3.1.2 and *cf.* 2.3.2). Even though the teacher gave learners space to work as a group, some learners decided to work as individuals to complete the task. Participant MT#7 allowed the learners to work as a class to complete the activity but invited one learner at a time to go to the board, ask the classmates what the question required and having reached a class consensus, they would write it on the board. The disagreements within the classroom led to a lot of noise and mostly unproductive noise which the participant teacher was able to control and monitor. The environment allowed learners to refer to related concepts of the work covered in the previous term to come to the conclusion (*cf.* 2.3.3).

5.7 DOCUMENT ANALYSIS

When the researcher asked for permission to collect data in schools, he also asked to analyse documents that are essential in the application of AfL in Mathematics. Taking into consideration the main aim of this study, the researcher analysed documents that were used in the classrooms to implement AfL practices in Mathematics classrooms. Documents analysis focused on how teachers plan for AfL, such as school assessment plan, Mathematics lesson plans, internal moderation and the nature of the AfL activities. It is expected that each school has an assessment policy and that each teacher should have a copy in his file. The analysis is guided and based on the Mathematics teachers' use of planning documents (see Appendix H).

Understanding the implication of AfL practices enables the Mathematics teacher to plan his/her lesson and assessment to meet learner needs. The teacher takes into account the contextual factors that drive learning as well as the assessment of learners in their classroom. From the analysis of documents requested for this study, none of the Mathematics teachers had the school assessment policy in their files. The school assessment policy dictates when, how and why to assess learners, thus providing the frequency of each type of assessment in Mathematics classrooms. How informal

assessment (AfL, AaL, baseline and diagnostic) is undertaken in Mathematics classrooms is therefore left to the discretion of the individual teacher to decide (*cf.* 3.3).

Without the school assessment policy, other external stakeholders like parents are, therefore, left out of their role that could influence the assessment and teaching of Mathematics because AfL importance is never explained to them. Proper planning for effective implementation enables the Mathematics teacher to practise the skills of influencing classroom practices. Here two points are important: Which documents should Mathematics teachers include in their files? How should Mathematics teachers use these documents? Having these questions in mind, Table 5.5 below presents the contents of the documents analysed, that which participant teachers were using in applying assessment practices in their Mathematics classrooms. The outcome of the documents is discussed using themes that emerged from the participant teacher interviews.

Table 5.4: Summary of the contents of school assessment policy, lesson plans, planned activities and analysis tool related to AfL planning and application

Teacher	School assessment Policy	Lesson Plans	Assessment for Learning Activities	AfL Analysis Tool: Single lesson Observed
MT#1	The teacher does not have an assessment policy but instead have the summative assessment programme. CAPS document not available.	The teacher develops lesson plans that stipulate lesson outcomes and skills learners are expected to display during the assessment.	The teacher uses activities from different CAPS-aligned textbooks as well as DBE workbooks.	The activity only catered for knowledge dimension domain requiring learners to use only knowledge process dimension of the cognitive dimension.
MT#2	The teacher does not have an assessment policy but instead had the summative assessment programme. CAPS document not available.	The teacher does not develop lesson plans but instead uses the lesson plans purchased from a third party.	The participant teacher uses activities from CAPS aligned with the textbook.	The activity catered for factual, conceptual and procedural in the knowledge dimension and knowledge and conceptual understanding in cognitive process dimension.
MT#3	The teacher does not have the school assessment policy but instead had the summative assessment programme. CAPS document not available.	The teacher does not develop lesson plans but instead uses the lesson plans purchased from a third party.	The participant teacher uses activities from CAPS-aligned textbook as well as DBE books.	The activity catered for factual, conceptual and procedural in the knowledge dimension and knowledge and conceptual understanding in cognitive process dimension.
MT#4	The teacher does not have the school assessment policy but instead had the summative assessment programme. CAPS document not available.	The teacher does not develop lesson plans but instead uses the lesson plans purchased from a third party	The participant teacher uses activities from CAPS-aligned textbook.	The activity only catered for factual and conceptual knowledge of the knowledge domain and only routine procedures of the cognitive process dimension domain.
MT#5	The teacher does not have the school assessment policy but instead had the summative assessment programme.	The teacher does not develop lesson plans but instead uses the lesson plans purchased from a third party	The participant teacher uses activities from CAPS-aligned textbook.	The activity only catered for the factual and conceptual knowledge of the knowledge domain and only routine procedures of the cognitive process dimension domain.

Teacher	School assessment Policy	Lesson Plans	Assessment for Learning Activities	AfL Analysis Tool: Single lesson Observed
	CAPS document not available.			
MT#6	The teacher does not have the school assessment policy but instead had the summative assessment programme indication the different types of assessments. CAPS document not available.	The teacher does not develop lesson plans but instead uses the lesson plans purchased from a third party.	The participant teacher uses activities from CAPS-aligned textbook.	The activity catered for factual, conceptual and meta-cognitive knowledge dimension as well as knowledge, routine procedures of the cognitive process dimension.
MT#7	The teacher does not have the school assessment policy but instead had the summative assessment programme indication the different types of assessments. CAPS document not available.	The teacher does not develop a lesson plan but instead uses the discontinued GPLMS lesson plans	The teacher does not develop the activities but instead uses activities that are in the textbook	The activity catered for factual and meta-cognitive knowledge dimension as well as the knowledge and routine procedures of the cognitive process dimension.
MT#9	The teacher does not have the school assessment policy but instead had the summative assessment programme indication the different types of assessments. CAPS document not available.	The teacher does not develop lesson plans but instead uses the lesson plans purchased from a third party.	The teacher develops assessment activities to be completed by learners.	The activity covered the factual knowledge of the knowledge dimension as well as the knowledge of the cognitive process dimension.

5.8 PRESENTATION OF EMERGENT THEMES AND CATEGORIES FROM THE ANALYSIS OF DOCUMENTS

Themes that emerged from the analysis of school assessment policy, lesson plans, planned activities and analysis tool are *an application of AfL in Mathematics* and *integration of TPACK in Mathematics assessment for learning*. Themes emerging from participant data differ from semi-structured interviews and non-participant observation, as the researcher aimed at understanding how Mathematics teachers plan to apply AfL in their classrooms. A detailed outcome of the analysis is presented in the section below. New themes that emerged are highlighted in *Italics*.

Table 5.5: Emergent themes and categories from document analysis

	Sub-research Questions	Themes	Categories
1	How do Grade 6 Mathematics teachers understand AfL?	1. Teacher understanding of assessment in Mathematics	1.1 Teacher conceptualisation of assessment 1.2 Planning for concept development
2	How do teachers integrate TPACK in AfL in Mathematics?	2. Integration of TPACK in Mathematics AfL	2.1 Teachers' lack of pedagogical content knowledge with AfL 2.2 <i>Management intervention in the planning and implementation of AfL</i>
3	What are the benefits and challenges faced by teachers in applying AfL in Mathematics in Grade 6?	3.1 Benefits of applying AfL	3.1.1 Constructive feedback 3.1.2 The improvement of teaching 3.1.3 Assessment for learning for self-regulatory learning
		3.2 Teachers' challenges	3.2.1 <i>Availability of Mathematics CAPS document</i>

The broader themes that were identified were: *teacher understanding of assessment in Mathematics; integration of TPACK in Mathematics AfL; benefits of AfL; teachers' challenges* are presented and discussed through categories next. The theme that is discussed next, which has five categories, is based on the teacher broader

understanding of assessment as it relates to Mathematics and moving specifically to teacher understanding of AfL and feedback.

5.8.1 Theme 1: Teacher Understanding of Assessment in Mathematics

Unlike in the interview data where the focus was on identifying participant teachers' understanding of AfL, in the analysis of documents the concept was broadened to take into account how teachers plan to apply AfL in Mathematics classrooms. Categories teacher conceptualisation of assessment and planning for concept development are described below.

Category 1.1: Teacher conceptualisation of assessment

In line with the findings of interview and observation data, the analysis of policy documents made it evident how Mathematics teachers apply AfL practices in their classrooms. The implementation of AfL in Mathematics should be preceded by the planning process (Kanellopoulou & Darra, 2018:67). Schools, through planning, should allow Mathematics teachers to document how they will transform Mathematics curriculum ideals into classroom events, that is, teaching and assessment (Sullivan, Clarke, Clarke, Farrell & Gerrard, 2012:461). Therefore, planning allows teachers to use their knowledge of learners to document how and when to assess learners in Mathematics. Learners and parents are informed about the assessment processes and practices that are to be followed for a particular academic year. School assessment policy should document what is to be expected in the assessment of learners.

Documents analysed for the study indicate that schools only plan for assessment of learning (*cf.* 1.3). This is consistent with the literature findings that most teachers plan for AoL (*cf.* 1.3) and Mathematics teachers lack effective strategies for planning and implement AfL in Mathematics (*cf.* 3.8.3).

Category 1.2: Planning for concept development in Mathematics

Though it was not the intention of this study to analyse Mathematics lesson plans, the researcher believes it was necessary to investigate how participant teachers plan to implement AfL in their classrooms through teaching strategies used as well (*cf.* 3.10). Creative teachers plan to use contextual instruction, and real-life experiences to drive concept development (Manurung, 2012:2). It was noted that the majority of the participant teachers (MT#2, MT#3, MT#4, MT#5, MT#6, MT#8 & MT#9), used lesson plans purchased by the school from a third party. It was evident that there was no indication that the teacher had interacted with a lesson plan nor did the lesson plan indicate the teaching method to be used. However, participant teacher MT#1 produced lesson plans that he had developed for teaching Mathematics. The lesson plans stipulated the learning intention, as well as identified skills learners, should to display in the learning and assessment of the concept taught but lacks the identity of the teaching strategy to be used.

Participant teacher MT#7 is still using the discontinued GPLMS lesson plans (*cf.* 1.2). This is of concern because this strategy and its lesson plans were rejected by Mathematics teachers. After all, it did not yield any positive outcome. Literature indicated that the GPLMS project was fast-paced and there was a lack of quality coaches for implementation (de Clercq, 2014:313; Msimango & Luneta, 2015:195). The fact that only one participant teacher produced a self-designed lesson plan is an indication of an unjust practice that fails to acknowledge learners' mathematical need by recognising learner diversity in classrooms (*cf.* 2.4.2).

5.8.2 Theme 2: Integration of TPACK in Mathematics AfL

The Department of Basic Education with its national goal of achieving knowledge-based citizens, states that its classroom should encourage an active and critical approach to learning, rather than rote learning of given truths (DBE, 2011a:4). In line with this obligation, the introduction of AfL practices to improve teaching and learning is commendable for the transformation of learner knowledge-building making learning an interactive process for learners. Two categories: teachers' *lack of pedagogical content knowledge with AfL* and *management intervention in the planning and*

implementation of AfL emerged as a result of the documented information as shown in the next discussions.

Category 2.1: Teachers' lack of pedagogical content knowledge with AfL

The findings from the planning perspective are that teachers do have assessment activities in place to assess the concept under study. The fact that Mathematics teachers do not plan their own activities is contrary to the constructivist approach to assessment. Constructivism proposes for a practice in which teachers develop activities that reflect and relate to learners' experiences and realities (*cf.* 2.3.3). This indicates the lack of fairness and equality in the assessment practices which are attributes of social justice in the assessment of learners (*cf.* 2.5). Incidentally, when teachers chose activities from textbooks and spent time reading questions in the activities for learners could be an indication that learners could not relate to the context of the activity (*cf.* 2.5.3). The importance of developing activities allows Mathematics teachers the opportunity to relate activities to learners' immediate environments and experiences (Leite, Fernandes & Figueiredo, 2018:4).

Category 2.2: Management intervention in the planning and implementation of AfL

Planning allows the Mathematics teacher to plan how to teach the Mathematics content (*cf.* 2.6.2), choose appropriate assessment method (*cf.* 2.6.3) and identify resources that will aid concept development (*cf.* 2.6.4). The state of affairs relating to the legislative role of departmental heads in the planning and application of classrooms programmes does not concur with policy directives. None of the participant teachers had CAPS policy documents in their possession. Because of the lack of policy direction in the participants' schools, departmental heads are not involved in the planning as well as the application of AfL practices. According to the Personnel Administrative Measures (DBE, 2016:36) departmental heads have the responsibility of providing policy direction in their departments. The importance of this exercise is that departmental heads should coordinate the development of internal policies that direct how assessment should unfold in their departments. The departmental subject policy

should take into account learners' contextual experiences and how to develop assessments that meet learners' needs (*cf.* 3.2 & 3.5).

The departmental head is, therefore, able to assist the teacher through developmental interventions in guiding the planning practices (DBE, 2016:36) and together with teachers find strategies to mitigate classroom challenges associated with the implementation of AfL in Mathematics (*cf.* 3.7). Findings suggest that without proper departmental policy direction on informal assessment, the participants' assessment planning did not address learners' academic needs. Lack of proper intervention can also be attributed to minimal intervention from district officials whose main concern is the completion of the ATPs rather than assisting in teacher development (*cf.* 5.5.4, category 4.1).

5.8.3 Theme 3.1: Benefits of Applying AfL

The findings of the empirical data revealed participant teacher understanding of benefits of applying AfL practices in Mathematics (*cf.* 5.5, category 3.1). Only one category emerged from this broader theme, *constructive feedback*, and it is discussed below.

Category 3.1.1: Constructive feedback

How Mathematics teachers develop AfL activities has a major bearing on the feedback they receive, which in turn, should influence how learners learn and teachers teach. The DBE (2012:3) stipulates that AfL practices in Mathematics are aimed at increasing classroom interaction between the teacher and the learner. To analyse the Mathematics AfL activities completed by learners, the researcher made use of a self-created assessment tool (*cf.* 2.6.2). The table assisted the researcher to categorise Mathematics activities as given by the teacher to the learners into the various knowledge dimensions. Table 5.4 presents the summary of distribution between the knowledge as well as the cognitive process dimensions in the Mathematics activities completed by learners.

Table 5.6: Mathematics activities indicating knowledge and cognitive process dimensions

The Knowledge Dimension	The Cognitive Process Dimension			
	Knowledge	Routine Procedures	Complex Procedures	Problem-solving
Factual Knowledge	MT#1; MT#2; MT#5; MT#6; MT#7; MT#9	MT#1; MT#3; MT#4; MT#5; MT#6; MT#7	MT#1	MT#1; MT#3
Conceptual Knowledge	MT#1; MT#2; MT#3; MT#6	MT#4		
Procedural Knowledge	MT#1; MT#2; MT#3			
Meta-Cognitive Knowledge	MT#1; MT#4; MT#6; MT#7			

The table above shows that the spatial distribution of teacher AfL activities concentrates mainly on the knowledge of the cognitive process dimension. Though the categories of the knowledge dimension are covered, it should be noted that the actual activities are of the low order reasoning. Therefore, the classroom activities given to learners dealt with basic Mathematics reasoning (*cf.* 2.6.2). Mathematics teachers are not meeting the skills to be demonstrated by learners according to CAPS requirement (Taole, 2013:40). The researcher's view is that participant teachers are battling to transfer Mathematics skills from paper to the learner.

The poor planning due to lack of proper management and monitoring (Table 5.3) has resulted in the application of AfL in Mathematics activities that is not effective. Though participant teachers articulated the importance of AfL in the teaching and learning of Mathematics (*cf.* 5.5.1), their planning practice as analysed in activities indicates a discrepancy between theory and application.

5.8.4 Theme 3.2: Teacher Challenges

This theme emerged after analysis of the documents participants teachers used to apply AfL in Mathematics. Such documents would assist the teacher in aligning their practice with a legislative framework (policy). The category discussed under this theme is the *availability of Mathematics CAPS document*.

Category 3.2.1: Availability of Mathematics CAPS document

The analysis of documents revealed that participant teachers do not have the Intermediate Phase CAPS document for Mathematics in their possession. The importance of the CAPS document is that it shows teachers the progression of Mathematics concept that should be followed from Grades 4 to 6 (DBE, 2011a:13) and clarification of such content in terms of the depth regarding teaching and assessment (DBE, 2011a: 213). The interview data revealed that the participant teachers rely on CAPS-aligned textbooks (*cf.* 5.5.1, category 2.2), but there was no mention of the policy. Without the knowledge of concept progression between grades, as stipulated in the policy, the participant teachers may fail to attend to learners' needs of progression and work towards attending to the learning gaps through assessment.

5.10 REFLECTION ON THE FINDINGS OF SEMI-STRUCTURED INTERVIEWS, NON-PARTICIPATORY OBSERVATION AND DOCUMENT ANALYSIS

This section presents the reflection of data collected from semi-structured interviews, non-participatory observation and document analysis. For the purpose of reflecting on the trustworthiness of data collected, emergent themes and categories were synthesised in the outlined below Table 5.7.

Table 5.7: Themes and categories emerging from all data

Themes	Categories: Semi-structured Interviews	Categories: Non-participant observation	Categories: Document analysis
1. Teacher understanding of assessment in Mathematics	1.1 Teachers' conceptualisation of assessment 1.2 Types of assessment 1.3 Methods of assessment 1.4 Assessment for learning 1.5 Importance of feedback	1.1 <i>Using learning intentions to influence assessment for learning practices</i> 1.2 <i>Teaching approaches in Mathematics classrooms</i> 1.3 Methods of assessment 1.4 Assessment for learning 1.5 Importance of feedback	1.1 Teacher conceptualisation of assessment 1.2 <i>Planning for concept development</i>
2. Integration of TPACK in Mathematics AfL	2.1 The use of technology in AfL 2.2 Teachers' lack of pedagogical content knowledge with AfL 2.3 Content knowledge of AfL approaches	2.1 The use of technology in AfL 2.2 Teachers' lack of pedagogical content knowledge with AfL	2.1 Teachers' lack of pedagogical content knowledge with AfL 2.2 <i>Management intervention in the planning and application of AfL</i>
3.1 Benefits of AfL	3.1.1 Constructive feedback 3.1.2 Improve teaching 3.1.3 Self-regulatory learning	3.1.1 Constructive feedback 3.1.2 Improve teaching 3.1.3 Self-regulatory learning	3.1.1 Constructive feedback 3.1.2 The improvement of teaching 3.1.3 Assessment for learning for self-regulatory learning

Themes	Categories: Semi-structured Interviews	Categories: Non-participant observation	Categories: Document analysis
3.2 Teachers' challenges	3.2.1 School infrastructure 3.2.2 Overcrowding 3.2.3 Teacher workload 3.2.4 Language of Learning and Teaching 3.2.5 Lack of resources 3.2.6 Learner-centred application of assessment practices	3.2.1 School infrastructure 3.2.2 Overcrowding 3.2.3 Language of Learning and Teaching 3.2.4 Lack of resources 3.2.5 Learner-centred application of assessment practices	3.2.1 <i>Availability of Mathematics CAPS Policy</i>
4. Intervention to empower Mathematics teachers	4.1 In-service training 4.2 Availability of resources 4.3 Parental involvement		

The difference in findings between the data instruments is shown in the categories (Table 5.7) that emerged from the same themes. The theme *teacher understanding of assessment in Mathematics* (cf. 5.5.1) emerged from semi-structured interviews, non-participant interviews and document analysis. Teacher understanding of what assessment provides an important view on AfL application. The category of using learning intentions to set conditions for success (cf. 5.6, Category 1.1) which emanated from non-participant observation relates to the theme *importance of feedback* (cf. 5.5.1, category 1.5) denoting that learners have to link feedback received to the discussed intentions to be achieved. The category of *teaching approaches in the Mathematics classroom* (cf. 5.6, category 1.2) which emanated from non-participant observation relates to the category of *methods of assessment* (cf. 5.5.1, category 1.3) and *planning for concept development* (cf. 5.7.1, category 1.2). These centred around the notion that planning teaching and assessment are interrelated and have implications on teaching and method of assessment in assessing the concept taught.

The categories related to *the use of technology, lack of pedagogical content knowledge* emanated from data collection strategies (cf. 5.7, interviews: Theme 2, categories 2.1-2.3; observation: Theme 2, categories 2.1-2.2; document analysis: Theme 2, category 2.1). The theme integration of TPACK in data sets was characterised by the idea of using technological resources to assess the content. The category related to *interventions carried by school management* (cf. 5.7, category 2.2) emanated from analysis of documents, where the departmental head should have a leading role in monitoring the application of AfL practices in Mathematics. The finding indicated that the participant teachers are not monitored on how they apply AfL which limits its effectiveness in classroom practices.

Teachers' challenges (cf. 5.5.1, Theme 3.2), featured as a theme from semi-structured interviews and non-participant observation clearly articulated challenges and frustrations participant teachers face. Participant teachers revealed contextual factors that inhibit the application of AfL in their Mathematics classrooms. School *infrastructure* (cf. 5.5.1, category 3.2.1), *overcrowding* (category 3.2.2), *Language of Learning and Teaching* (category 3.2.3), *lack of resources* (category 3.2.4) and *learner-centred application of assessment practices* (category 3.2.6) are categories that emanated as teachers' challenges. Document analysis, on the other hand, revealed that the participant teachers did not have *Mathematics CAPS policy* (cf. 5.7, Theme teachers' challenges, category 3.2.1). This is a concern that the very policy that highlights the depth of the content to be taught and assessed in class is not available.

Categories *in-service training* (category 4.1), *availability of resources* (category 4.2) and *parental involvement* (category 4.2) surfaced only from interviews under the theme strategies to empower Mathematics teachers (cf. 5.5.1, theme 4). The theme emanated from participant teachers' identified gaps in the application of AfL practices in their classrooms.

5.11 CHAPTER SUMMARY

In this chapter, the researcher presented the findings of the empirical study. The data collected through three different data collection tools were analysed and interpreted with the view to answering research questions using themes that emerged from interviews, non-participant observations and document analysis. The data analysed was broken down into manageable pieces through coding and facilitated the development of themes as well as categories. Thereafter, a narrative account of what emerged was presented taking into account the research questions and objectives and using verbatim quotes from the participants and invoking the literature to support the findings.

The next chapter, Chapter 6, presents a summary of the review of the literature and a synthesis of findings. Finally, limitations, conclusions and recommendations based on the outcomes of the current study are given.

CHAPTER 6

SUMMARY, CONCLUSION, AND RECOMMENDATIONS

6.1 INTRODUCTION

The previous chapter presented the analysis of data that was obtained through semi-structured interviews, observations, and analysis of documents, according to the emerging themes and categories. This chapter presents the findings, it summarises the review of the literature and the empirical study, concerning the research questions and the objectives of the research undertaking.

The study limitations are also discussed, through which the potential problems that emerged from the research are highlighted. Drawing from the study results, recommendations are made to the Department of Basic Education, schools under the Department of Basic Education and Mathematics teachers as well. The researcher presents a proposed framework that could assist Mathematics teachers at the research sites to apply AfL. Lastly, recommendations for future research are provided. The subsequent section presents a summary of the research findings. This chapter begins by presenting a summary of the literature review and then finding from the empirical study.

6.2 SUMMARY OF LITERATURE REVIEW

The literature review for this study was divided into two chapters: Chapter 2 which presented the theoretical framework, and Chapter 3 that discussed the conceptual framework on which this study was founded.

Chapter 2 commenced by presenting the theory that underpinned this study: Constructivism (*cf.* 2.3.1). This learning theory was divided into cognitive constructivism and social constructivism based on the work of Jean Piaget (*cf.* 2.3.1.1) and Lev Vygotsky (*cf.* 2.3.1.2). This theory was identified because the DBE has recognised it as the bedrock for the assessment of learners in Mathematics classrooms (DBE, 2011a:4). Constructivism theory was singled out as an

underpinning theory because it postulates the need to recognise the role played by learner's cognitive development as well as social parameters that influence learning (*cf.* 2.3.2). As Van den Berg (2017:81) articulates, constructivism is more concerned with how learners construct knowledge for lifelong learning rather than the transmission of knowledge and rote learning.

Assimilation and accommodation are the distinctive tenets of cognitive development of a learner based on readiness appropriation (Piaget, 1958). Cognitive constructivism as applied to Mathematics requires active learners where problem-solving should be a discovery process (Ojose, 2008:29). Therefore, the knowledge of different stages in cognitive development assists the Mathematics teacher in developing Mathematics activities that are appropriate to keep learners engaged and involved. Understanding the cognitive development of a learner, Mathematics teachers provide learners with rich experiences towards concept development (Simatwa, 2010:370). In this way, the learner is provided with mental space that enables modification of existing knowledge to incorporate new learning experiences within an existing structure.

Another key ideology of constructivism is the role of social interaction towards meeting the learning needs in Mathematics classrooms. Vygotsky's social constructivism acknowledges the role that is played by the collaboration of individuals in knowledge development (Amineh & Asl, 2015:13). That is, learning occurs through interaction with others who are knowledgeable about the concept under study, such as peers and teachers, towards learner attainment using ZPD (*cf.* 2.3.2).

Apart from the constructivist theory, Chapter 2 presented Social Justice, TPACK, Connectivism and Bloom's Revised Taxonomy as theories that could assist in answering the research questions. Social Justice was discussed based on the constitutional requirements regarding learning (*cf.* 2.5). Using the inclusivity principle, the Education Ministry expects Mathematics teachers to practise fairness and treat all learners with equality in classrooms (DBE, 2011a:5). Through inclusivity, teachers should diversify their assessment practices which would assist them in identifying barriers and learning gaps. The connectivism discussion highlighted the impact of the use of technology and socialisation to influence learning (*cf.* 2.4). It demonstrated that knowledge lies within the diversity of individual learners and that with inter-

connectedness coupled with the use of relevant technology and other resources, learning can be enhanced. TPACK (*cf.* 2.6) posits that the use of relevant technological resources, teacher's pedagogical content knowledge of assessment practices as well as the understanding of the content to be delivered, provides a recipe for improved learner performance (Koehler *et al.*, 2013:14). Bloom's Revised Taxonomy (*cf.* 2.7) deals with teacher application of AfL through the development of activities based on classroom realities and other related contextual factors such as the learner environment. Grade 6 Mathematics teachers are expected to be well-versed with Bloom's Revised Taxonomy presented as cognitive levels in the CAPS policy document (DBE, 2011a:296). The application of the cognitive levels in the AfL activities provides teachers and learners with feedback on Mathematics skills achieved or those that need attention.

Chapter 3 presented the concept of learner assessment. The chapter began with a discussion that brings to light different types of assessments applied in Mathematics (*cf.* 3.3). Then, the discussion shifted to the role of AfL in Mathematics classrooms beginning with important elements for effective application of AfL practices (*cf.* 3.3.4.1.1) leading to deliberations on methods of assessment (*cf.* 3.4) and value of learning intentions in Mathematics assessment (*cf.* Figure 3.5). Section 3.7 presented various challenges that inhibit the application of AfL in Mathematics classrooms followed by a summary of the global view on the application of AfL (*cf.* 3.8). The literature review concluded with the discussion of the transformation of assessment in the South African context (*cf.* 3.8.4).

6.3 SUMMARY OF THE EMPIRICAL STUDY

The empirical study aimed at providing understanding into the application of AfL by Grade 6 Mathematics teachers. To obtain insight into the phenomenon under study, this research used a qualitative approach (*cf.* 4.4.3) embedded within a case study design (*cf.* 4.5.1). The research methods entailed the sampling strategy (*cf.* 4.6.2), data collection methods comprising of semi-structured interviews (*cf.* 4.6.5.1), non-participatory observation (*cf.* 4.6.5.2) and document analysis (*cf.* 4.6.5.3). The data collection was followed by data analysis (*cf.* 4.6.6) which went concurrently with the collection of data from research sites. Issues of trustworthiness (*cf.* 4.9) and ethical

measures (cf. 4.10) that were adhered to in the proceedings of data collection and the analysis was discussed.

Several key themes emerged from participant teacher interviews, observation and document analysis. Emergent themes included: *teacher understanding of assessment in education, integration of TPACK in Mathematics, benefits of assessment for learning (AfL), teachers' challenges and interventions to empower Mathematics teachers* (cf. Tables 5.2, 5.3 and 5.6).

The participant teachers acknowledged the importance of assessment and added that its influence is proportional to understanding learner development in meeting learning goals (cf. 5.4, category 1.1). An in-depth analysis of the participant teacher's beliefs of AfL and its role in enhancing teaching and learning, revealed their conceptualisation of its practices (cf. 5.4, category 1.4). Participant teachers indicated that the use of AfL practices in Mathematics assessment provides them with feedback used by both the teacher and the learner in identifying learning gaps to be attended to. The participant teachers referred to different methods of assessment employed in their Mathematics classrooms (cf. 5.4, category 1.3) with the aim that the teacher and the learners can self-reflect on classroom instruction (cf. 3.4, Figure 3.4).

However, the participant teachers' pedagogical application of AfL (cf. 5.4.2, category 2.2) revealed that there is inadequate understanding of the constructivist approach to assessment. An area of concern is that participant teachers do not develop AfL activities for use in their classrooms but instead, relied on textbooks aligned to DBE policy for their phase. A question may arise related to this practice: Do Mathematics teachers understand AfL practices or contextualisation of assessment thereof? Teachers saw AfL application in their classrooms in a limited way (Kippers, Wolerinck, Schildkamp, Poortma & Visscher, 2018:209). It is the view of the researcher that assessment activities did not count much towards improving how they teach and how learning occurs (cf. 3.8.2). This is consistent with findings of Alotaibi (2019:74) who posits that teacher confidence and knowledge of AfL implications does not imply confidence in its application. From this, it was concluded that teachers did not understand the implication of applying constructivism and social justice theories in the assessment of Mathematics.

The interview data also identified several factors that contribute to the inappropriate application of AfL practices. Training on application of AfL in classrooms (*cf.* 5.4.5, category 4.1), overcrowding, teacher workload, the language of teaching and learning, and lack of teaching resources (*cf.* 5.4.4, theme 3.2) were identified as common contextual constraints that were reported by participant teachers. The teachers are aware of these classrooms' contextual factors (*cf.* 5.5.1, Theme 3.2), hence their appeal for interventions to become competent in the application of AfL (*cf.* 5.4, category 4.1). Participant teachers emphasised the need for the availability of teaching and learning resources to enhance the learning process (*cf.* 5.4.5, category 4.2).

The observation data exposed the effect of overcrowded classrooms in the application of AfL practices. Participant teachers were aware of the situation and had to spend time dealing with learner behaviour that hindered the successful completion of assessment activities. Having given group exercises to their learners, participant teacher movements were limited. In some classrooms, it was observed that learners did not show interest in the activities being done and participant teachers did not notice such unproductive behaviour. These findings concur with those of Olaleye, Ajayi, Oyebola and Ajayi (2017:131) who suggested that overcrowding in classrooms negatively affects the academic performance of learners leading to poor attainment of learning goals.

The language of learning and teaching was observed to be a hindrance to learner autonomy. In all the classes observed, participant teachers resorted to reading the activities and sometimes gave illustrations to clarify concepts in the activity question. Henry, Nistor & Baltes (2014:13) posits that teachers find it challenging to administer an assessment to learners whose language proficiency is weak. To model how to read fluently, teachers read the questions aloud and learners repeated after them. Though some reading aloud is a strategy to enforce comprehension and engage learners (Minskoff, 2005:3), observation revealed that it took a lot of time and it hindered the completion of classroom activities. To compensate for learner deficiency, participant teachers tried to use the home language of learners. The switching between languages in the midst of completing the activities added a further layer of a challenge having to switch between two languages to complete the activity (Daly & Sharma, 2018:18). Code-switching to compensate for lack of LoLT in Grade 6, though it has

benefits (Azlan & Narasuman, 2016:459), impacts on learners' attitude towards Mathematics proficiency (Truxaw & Rojas, 2013:1080). Because of the language barrier, learners hurried to complete the activities giving them less time in engaging with each other towards finding solutions.

The findings drawn from interviews and non-participant observation revealed that participant teachers value giving feedback to learners (*cf.* 5.4.1, category 1.5; *cf.* 5.6.3, category 3.1.1). Giving back constructive feedback derived from assessment activities is an important feature in AfL practices (Owen, 2016:169). Feedback provides information on what needs to be done next to help the learner improve their performance (*cf.* 3.4, Figure 3.4). Therefore, learners and teachers can identify the learning gaps and plan on how to meet the learning intentions and goals, taking responsibility for teaching and learning. In each of the Mathematics classrooms observed, one hour was allocated for Mathematics teaching, learning and assessment. Participant teachers are expected to go through a variety of activities in each period such as ten minutes for mental Mathematics, marking of homework if available, the introduction and teaching of the concept for the day before AfL. activities are given to learners. Because classroom contextual factors, as discussed above (*cf.* 6.2.3.2-6.2.3.4), participant teachers could not give feedback based on learners' needs. Time constraints or lack thereof meant that teachers could only give blanket feedback which was provided as corrections written on the chalkboard. No proper engagement with the learners was encouraged, that is, learners could not seek clarity for questions based on the corrections given.

Although one or two participant teachers tried to have learners provide answers to activities, this process was soon derailed by noise resulting from disagreements. Teachers often had to step in to quell the unproductive noise levels. Though the interview data revealed that teachers understand the implications of developing feedback, classroom observations disclosed inappropriate practices.

The viewing of the school assessment plans revealed that teachers have formal assessment (AoL) plans in their files. This is an indication that the assessment of learners is still dominated by assessment of learning (summative assessment). Participant teachers do not plan for AfL activities but rather use lesson plans

purchased from a third party and use activities in the CAPS aligned textbooks. The researcher believes there is nothing wrong with such practices provided activities take into account learners' context, which is a requirement of the constructivist approach to assessment. Secondly, assessment activities should be fair in that it connects the learner with their experiences and their environment. Because participant teachers do not plan their lessons and assessment activities, they miss an opportunity of enabling future planning and learning. The finding reveals that teacher proficiency in the planning of AfL is inadequate in improving learner experiences in concept development.

During the activities given to learners to complete, it was found that they did not meet the criteria of the cognitive levels, as stipulated in Section Four of the CAPS document. The activities were predominantly focused on knowledge and routine levels of the Cognitive Process Dimension which meant that the complex, as well as problem solving, were missing. It seems that the Mathematics teachers observed are not meeting assessment policy stipulations, which has serious implications in that learners in Grade 6 are passing Mathematics without having mastered the important skills required in the latter grades. Though there has been a slight improvement in SAMEQ results (DBE, 2016b) much is still to be done to improve learner competency from the township and rural schools (TIMMS, 2016). The process should start with attending to a range of factors, and how teachers develop assessment for learning activities should be given a priority, as policy requires, AfL practise is learner-centred (*cf.* 2.3.3) and provides teachers and learners with feedback to move classroom instruction forward (*cf.* 3.3.4.1).

6.4 SYNTHESIS OF RESEARCH FINDINGS

The synthesis of research findings is drawn from the themes outlined in Chapter 5, the theoretical framework (*cf.* Chapter 2) and the review of the literature (*cf.* Chapter 3). The findings are grouped into three categories: *teacher understanding of AfL*, *integration of TPACK in Mathematics* and *challenges impeding the effective use of AfL in Mathematics*.

6.4.1 Teacher Understanding of AfL

Regarding Mathematics teacher understanding of AfL (*cf.* 5.4.1), data revealed how Mathematics teachers understand basic elements of AfL application and policy influence on its usage. This finding concurs with the literature on the worldwide adoption of AfL practices in classroom instruction (*cf.* 1.4 and 3.8). The participant teachers' understanding of the influence of AfL in teaching and learning concurs with the findings of Umar (2018:24), who found its positive impact on performance. However, the researcher observed the limited scope on theory understanding during the application of AfL. As per mandatory precepts, AfL practices should be influenced by constructivist approaches (DBE, 2011a:4) in which learner context is taken into account during assessment. This aligns with the theory of social justice in which fairness and equality (*cf.* 2.5) are requisite of a just assessment. Data from interviews and document analysis revealed that participant teachers did not develop AfL activities, instead used prescribed activities found in the Mathematics textbooks currently in use in their classroom (*cf.* 5.4.2, category 2.2 and 5.9.4, category 2.1).

It was revealed by participant teachers' interview data on how AfL application assists both the teacher and the learner in developing feedback that influences teaching and learning (*cf.* 5.4.3, category 3.1.1). The teacher and the learner, with the help of other learners, work towards closing the learning gaps (*cf.* 3.4, Figure 3.4). This practice draws from the ZPD (*cf.* 2.3.3), which is a social constructivist understanding that learning can improve through support. The findings revealed how teacher-, self- and peer-assessment can be used to provide feedback to influence learning (*cf.* 3.4 and 5.4.1, category 1.3).

6.4.2 Integration of TPACK In Mathematics

The TPACK provides a concerted effort in assisting the learner's development of the Mathematics concept (*cf.* 2.6). The constructivist view on assessment is a learner-centeredness approach which allows for deeper learning (Landis, 2008:10). The data from the empirical study on the integration of TPACK did not reveal substantial successes. Emanating from semi-structured interviews and non-participant observation is the lack of digital-technological tools enhance the assessment process

(*cf.* 5.4.2, category 2.1; 5.6.2, category 2.1). Although participant teachers have an understanding what AfL implementation entails, their pedagogical practices lacked theory underpinnings of fairness (*cf.* 2.5.2), policy principles (*cf.* 3.8.4.1) and the use of the learning intentions to influence learner participation (*cf.* 5.6.1, category 1.1).

The lack of teacher planning manifested in the findings of the analysis of documents used in Mathematics classrooms (*cf.* 5.9.1, category 1.2). Using the third party purchased lesson plans limits contextualising assessment according to learners' cognitive development (*cf.* 2.3.1) and actuation of learning through elevated participation (*cf.* 2.4.3). The constructivist view is that the context should be used as a resource that influences the development of a concept through assessment (*cf.* 2.3.5). Mathematics teachers should, therefore, plan within learners' context to create increased participation opportunities (Garrison & Akyol, 2013:10).

The need for skills in applying AfL in Mathematics points to a necessity for intensive training opportunities. In-service training emerged as a challenge from participant teacher interviews, the non-participant observation (*cf.* 5.6.4, Theme 3.2) and document analysis (*cf.* Table 5.5) revealed the seriousness of the matter. What is commendable though is that Mathematics teachers who participated in this study had a desire to apply AfL practices and requested training.

Challenges that influenced the application of AfL in Mathematics classrooms are discussed presented next.

6.4.3 Challenges impeding the Effective Use of AfL in Mathematics

The findings revealed challenges that need attention if the educational goals of AfL were to be realised. The participant teacher data revealed challenges of lack of theoretical background to influence practice, lack of an assessment model and challenges related to the availability of teaching, learning and assessment resources.

The implementation of the South African curriculum is based on the constructivist view on learning through which learning should be characterised by active participation, problem solving abilities and cooperation (Mogashoa, 2014:52). Although the data

revealed that participant teachers had assessment activities for each of their classes, the quality of activities did not take into consideration the various cognitive levels and the knowledge dimensions as required by the Mathematics policy (*cf.* 5.9.3, category 3.1.1; Table 2.4). The activities failed to assess learners on high order reasoning, that is, complex procedures and problem solving on both the cognitive process and knowledge dimensions (*cf.* Table 2.3, *cf.* Table 5.6). The participant teachers did not seem to value the creation of fair activities (*cf.* 2.5.2) and take into account learner context through social connections (*cf.* 2.4.1). This practice confirms Kwenda, Adendorff and Mosito (2017:153) assertion that teachers overlook theories during classroom practices as they develop coping mechanisms based on a context.

The literature review reveals how the use of an AfL model assists the Mathematics teachers to foster reasoning process in Singapore (Eric, Dawn, Wanty & Seto, 2012:147; *cf.* Figure 3.7). In this study, even though the participant teachers were positive about the use of AfL in Mathematics, the actual application is sub-standard (*cf.* Table 5.5). A study carried out in Zimbabwe revealed that teachers lacked effective strategies in applying AfL practices because of the lack of teacher development (Kurebwa & Nyaruwata, 2012:343; *cf.* 3.8.3). Having experienced AfL application challenges, Australia is using an AfL project, which is a programme to reskill Mathematics teachers in their application of AfL practices (Birenbaum *et al.*, 2015:119; *cf.* 3.8.2). It can be concluded that the application of AfL practices without a model is an arbitrary process.

The aspect of resources to improve assessment pedagogy, which emerged from interview data showed that the participant teachers were using simple traditional resources (*cf.* 5.6.4, category 3.2.4). These resources included the chalkboard, textbooks as well as learners' books. Research (Igiri & Effiong, 2015:32; Kasilia, Mulwa & Kamwaria, 2018:8066; Yara & Otieno, 2010:131) shows that the use of varied and innovative resources encourages learner participation and promotes knowledge retention.

The synthesis of findings allows for the presentation of the research conclusion and is the implication for educational practice.

6.5 RESEARCH CONCLUSION

The problem statement that was outlined in Section 1.4 helped the researcher to develop the main research question and sub-research questions. The conclusions presented here will be expressed in terms of answers to the research questions set out in Section 1.4 as:

How do Mathematics teachers apply assessment for learning in Grade 6?

- How do Grade 6 Mathematics teachers understand AfL?
- How do teachers integrate TPACK in AfL in Mathematics?
- What are the benefits and challenges faced by teachers in applying AfL in Mathematics in Grade 6?
- Which assessment intervention can be adopted to improve the quality of Mathematics teaching and learning in Grade 6?

The sub-research questions will be presented first which will be followed by the discussion of the main research question.

How do Grade 6 Mathematics teachers understand AfL?

6.5.1 How do Grade 6 Mathematics teachers understand AfL?

Assessment for learning relates to classroom activities created to develop feedback to move learning and teaching forward (*cf.* 3.3.4.1). In the context of this research question, Mathematics teachers should have a deep understanding of the AfL and its implication in learning and teaching (*cf.* 3.3.4.1). The literature review highlighted the importance of pitching the assessment of learners at the correct level using learning intentions (*cf.* Figure 3.5). Learning intentions outline learners' conditions for success during teaching and assessment (Crichton & Mcdaid, 2016:193). Learners can link what is expected of them, their current knowledge and then with the teacher, plan the next step (*cf.* Figure 3.4).

Findings from the interviews (*cf.* 5.4.1) conducted with the Grade 6 Mathematics teachers resonate with the literature review regarding the importance of monitoring the learning process. Contrary to expectations, findings from non-participant observation revealed that participant teachers mainly used teacher assessment methods (*cf.* 3.4.1) due to contextual factors and challenges persistent in the classroom (*cf.* 5.4.4).

6.5.2 How do Teachers integrate TPACK in AfL in Mathematics?

The findings of the study showed any that teachers do not have advanced technological resources that could be used to drive the assessment of mathematical concepts. The non-participant observation data revealed that the majority of participant teachers still rely on standard technologies such as CAPS-aligned textbooks and the chalkboard. Because of the lack of technology use, the researcher could not identify participant teachers' abilities in applying technology to transform their methods of assessment. The empirical research revealed that the participant teachers do not have sound AfL pedagogical content knowledge starting with planning for assessment (*cf.* Table 5.5) to its application in Mathematics classrooms (*cf.* 5.4.2, category 2.2).

6.5.3 What are the Benefits and Challenges faced by Teachers in Applying AfL in Mathematics in Grade 6?

It emerged from the empirical study that participant teachers understand the importance of AfL practices towards learning and teaching. They point out how it provides feedback that is used to identify learning gaps, pointing out where the learner is in terms of understanding.

The theoretical understanding of AfL however, did not translate into classroom practice due to contextual factors encountered. Participant teachers struggled with creating a learner-centred environment conducive to learning due to challenges such as large classrooms, the language of teaching and learning (LoLT), and lack of resources. Teachers could not adequately manage their classrooms as they tried to deal with learner behaviour that was detrimental towards developing feedback through assessment. The empirical study disclosed that participant teachers could not promote

inclusive learner participation in assessment activities which compromises learners who need assistance and support but could not be identified.

6.5.4 Which assessment intervention can be adopted to improve the quality of Mathematics teaching and learning in Grade 6?

This research had its sights on identifying and presenting interventions that could be adopted to improve Mathematics teachers' practices. Although improvements in the assessment policy have been made by the Department of Basic Education, this study discovered obstacles that hinder the application of AfL practices in Mathematics classrooms. The empirical study revealed that Mathematics teachers are aware of the challenges that inhibit the application of AfL practices in the classes. Findings from interviews highlighted a need for the DBE to effectively revive in-service training (*cf.* 5.4.5 Category 4.1) for teachers. The in-service training should be extended to areas of teacher knowledge in teaching and assessing over-crowded classrooms (*cf.* 5.4.4, Category 3.2.1) to making resources available to teachers (*cf.* 3.2.4). This strategy would empower Mathematics teachers to plan and effectively use AfL practices in large classrooms. Schools should make resources available for assessment to be as practical as possible to enhance concept development (Alshatri, Wakil, Jamal & Bakhtyar, 2019:449). Document analysis revealed that there is a lack of teacher planning and an absence of CAPS policy documents to direct their practice (*cf.* Table 5.5). Policy knowledge (CAPS demands) impacts on the planning processes, thus, affecting participant teacher's ability in implementing AfL practices in their classrooms (Deneen, Fulmer, Brown, Tan, Leong, & Tay, 2019:40). Teachers need to have CAPS documents at their disposal, and the DBE should take stock and make available CAPS document to individual teachers.

6.5.5 How do Mathematics Teachers apply Assessment for Learning in Grade 6?

The practice of AfL significantly improves teaching and learning leading to better performance of learners and, if properly utilised, will likely elevate motivation to learn, improve deep learning and improve learners' performance. However, the findings of this study revealed that the application of AfL was not encouraging. It emerged from

the study that Mathematics teachers lack proper pedagogical content knowledge on how to apply AfL in their classrooms. For instance, their practices with regards to planning for assessment indicate a lack of understanding of the principles that guide the implementation of AfL. The lack of proper planning, contextualising assessment activities, providing and discussing learning intentions and giving feedback were the major limitations the researcher identified inhibiting the application of AfL. The findings of the empirical study led to the researcher proposing an AfL model for the application in Mathematics in Grade 6. The researcher regards the model as a unique contribution to the body of knowledge. The presentation of the model is provided in Figure 6.1 below, followed by a description of what the model entails.

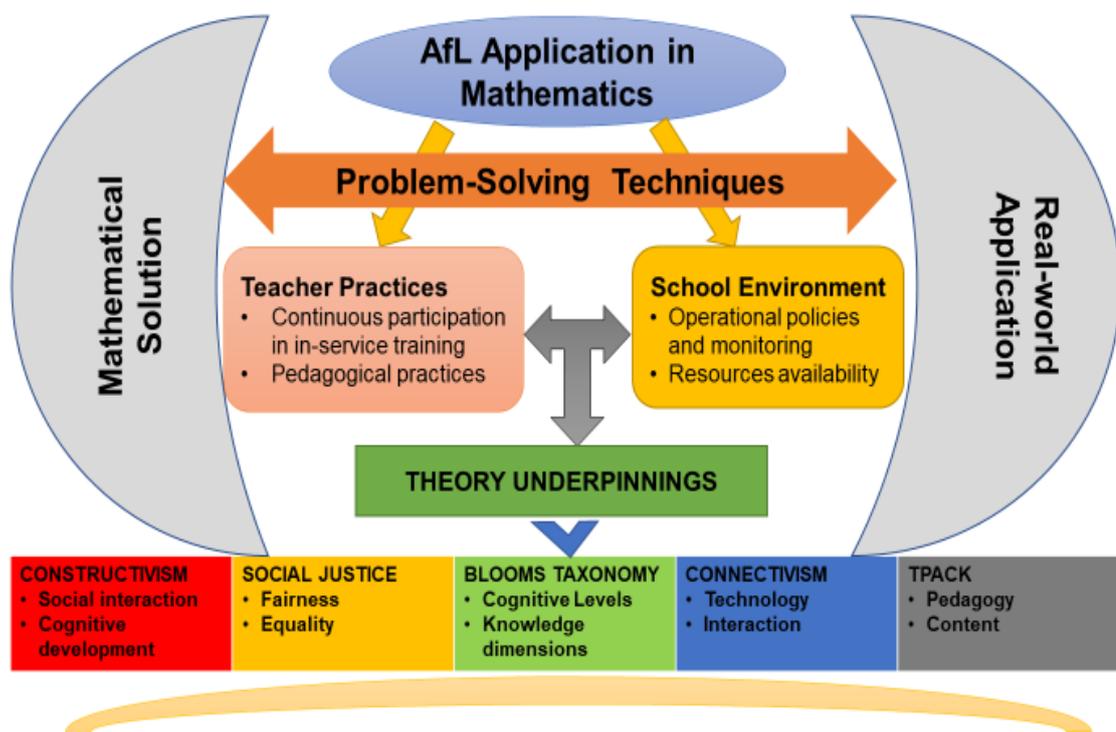


Figure 6.1: The model of AfL application in Mathematics in Grade 6

6.5.5.1 Overview of the model

This model is of a result of the driving force behind this study, which explored how Mathematics teachers apply AfL in their classrooms. The model is based on the established theories (*cf.* Chapter 2) and the themes that emerged from empirical research (*cf.* Chapter 5).

The model is based on Mathematics teachers' sound knowledge of the theories that underpin the use of AfL in Mathematics. The theories, therefore, form the foundation on which to build the use of AfL (*cf.* Figure 6.1). The researcher is of the view that this sound knowledge of theory will improve Mathematics teaching practices and create a school environment that promotes its application.

6.5.5.2 Understanding of theory

The dimensions of theory understanding include the knowledge of how to incorporate a constructivist approach to learning (*cf.* 2.2.1), the use of social justice in planning (*cf.* 2.4), application of cognitive levels in activities (*cf.* 2.6), the choice of technology to assess concept development (*cf.* 2.3) and pedagogical content knowledge of AfL practices as well as an assessment of content presented in Mathematics (*cf.* 2.5).

The constructivist theory explains that learning takes place through cognitive and social interaction of learners with the content delivered and with one another in the presence of a teacher. As the findings of this study have shown, learners did not show interest in interaction with others towards finding solutions but rather concentrated on the final answer based on individual work. Cognitive engagement through discussions could further encourage learners to improve their thought process towards development.

Instead of Mathematics teachers giving an activity that requires learners to answer many questions that they could not finish, learners could be given a maximum of three questions based on the content. This will afford them time and space to discuss and present their solutions to the class. Giving learners activities they struggle to complete does not help the teacher and the learner in developing feedback that could be used for instructional purposes.

Activities given to learners should be fair to learners in terms of language and the context used. The empirical study revealed that teachers spend quite an amount of time reading through the activity before learners could complete. Essentially, fairness implies that learners should not be disadvantaged in any form to learn. Mathematics teachers should be aware of the needs of his/her learners and therefore develop

activities that are beneficial and treat learners equally. Mathematics teachers should administer AfL practices to the benefit of all learners in their classrooms.

The Intermediate Phase Mathematics CAPS document provides cognitive levels that should be assessed in Mathematics. The findings of the analysis of the documents indicate that Mathematics teachers gave activities that were pitched at low-level cognitive levels. Mathematics teachers should have sound knowledge of the different levels and use them to develop activities and/or choose activities that will address the variety of levels and skills. Each activity should incorporate more than one cognitive level, and in that way, learners will be able to receive 'proper' feedback needed for the teacher to plan for the next step.

The teachers should be familiar with appropriate technology and resources that could be used to enhance concept development in the assessment. The technology identified, whether textbook, computers, mathematical software and others, should acknowledge that information lies in diversified sources. The interconnectedness of these sources is of paramount importance if AfL application has to make an impact on learning and teaching.

6.5.5.3 Teacher practices

Participant teachers need to understand that their practice impacts on learner academic performance. They need to develop a clear direction on what needs to be done for AfL practices to have an impact on how teaching and learning and teaching should unfold in their classrooms. It will be to their benefit and those of learners if they attended developmental in-service training organised by the Department of Basic Education through the district office and internal school discussions. The pedagogical content knowledge of AfL application would assist them in developing effective activities to develop productive feedback (*cf.* 2.2.3). In this case, feedback that will help alter how they teach Mathematics to learners. Pedagogical strategies should be grounded in AfL theories as discussed above (*cf.* 6.4.1) and should be the teachers' point of departure for AfL planning and application.

6.5.5.4 School environment

The school should provide teachers with direction on how AfL practices should be applied. Operational policies, in this case, imply the availability of assessment policy that articulates how both informal and formal assessments should be practised. The policy should stipulate the duties, role and responsibility of the Mathematics teacher concerning planning and administering of assessment. This policy implementation should be coupled with departmental head monitoring of the application of AfL as well as the availability of resources and the use thereof. The dimension of applying fairness and equality in the assessment as prescriptions of the theory of social justice (*cf.* 2.4.3) could create an environment that promotes inclusion thus expanding access to learning (*cf.* 3.8.4.2).

6.5.5.5 Problem-solving techniques

The concept of problem solving is central to the teaching and learning of Mathematics, and AfL application. The activities should be designed so that mathematical solutions are directly linked with real-world application. The participant teachers should be aware that learners come from a context that should be linked to mathematical concepts learnt at school. In this way, learners will be able to locate classroom activities within their experiences out of the classroom. The problem-solving techniques should be used as a scaffolding mechanism that provides academic support.

6.6 Brief explanation of the stages of implementing the suggested Mathematics AfL Model in Grade 6

The researcher suggests that the model should be implemented in stages allowing the DBE to prepare. The first stage of execution, therefore, relates to the state drafting the policy framework and role of different stakeholders such as provincial departments, district officials and teachers in its implementation. The drafting of the policy should take into account the important theoretical underpinnings as they are identified on the model (*cf.* Figure 6.1). These theories should be clearly defined, explained and understood based on the South African education classroom realities. Secondly,

stakeholders responsible for implementation should be empowered in terms of skills, information and dynamic associated needs towards the training of Mathematics teachers.

In the South African primary school context, work-based in-service training can be ideal to enhance teachers' assessment for learning pedagogy. The proposed model reflects that apart from theory underpinnings, Mathematics teachers should be engaged in improved continuous in-service training and pedagogical practices and onsite development of operational policies that are closely monitored by the school management, and provision of teaching and learning resources. The in-service training should be ongoing as the new pool of Mathematics teachers join the practice. Figure 6.2 below provides a suggested implementation cycle of the AfL model from its inception to its implementation and ongoing.

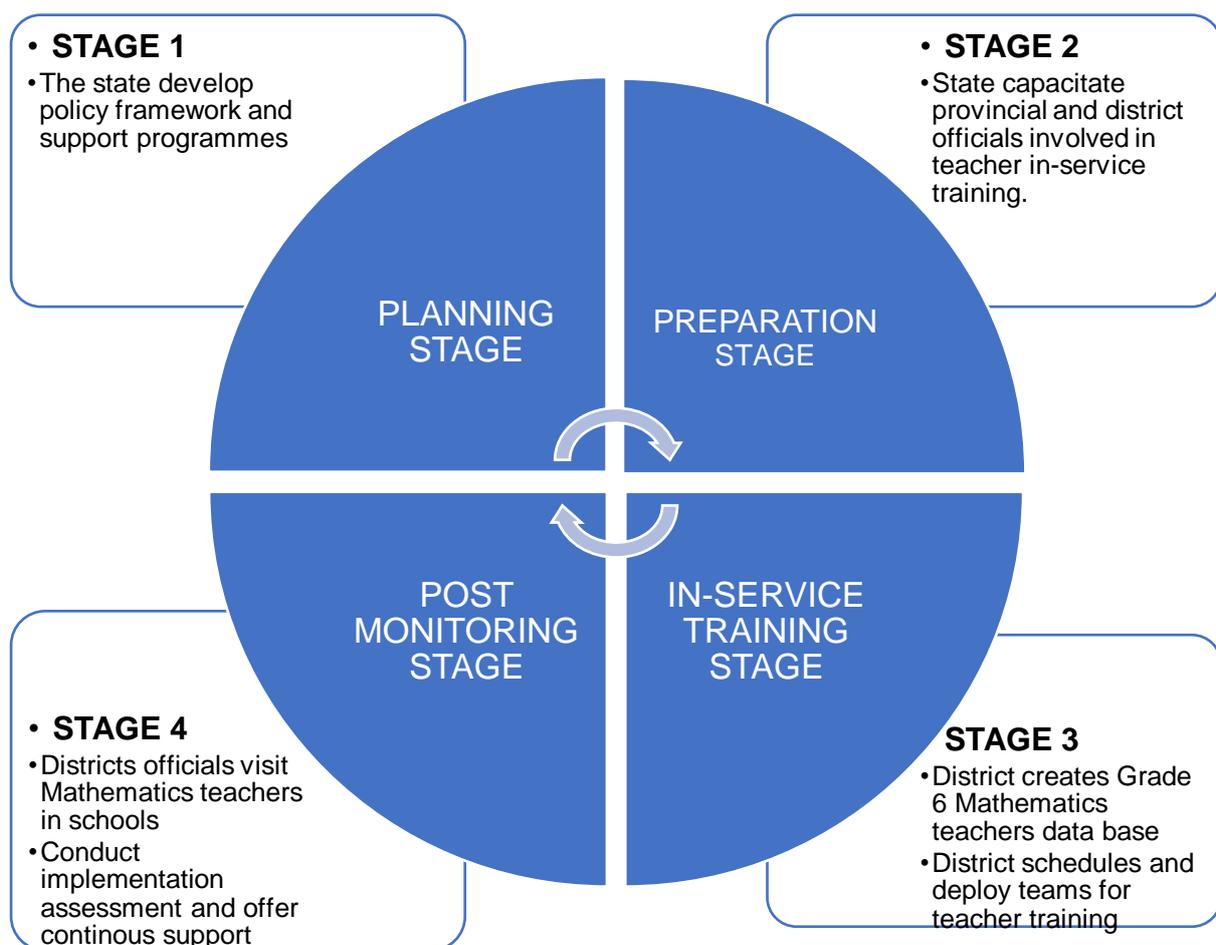


Figure 6.2: The suggested AfL implementation cycle: Planning, preparation, training and monitoring stages

6.7 ROLES AND RESPONSIBILITIES OF STAKEHOLDERS IN THE EXECUTION OF THE AfL MODEL

Figure 6.2 above presented an implementation cycle that requires a lot of planning, preparation, training and monitoring needed from different stakeholders for the model to be implemented successfully. Table 6.1 below presents the roles and responsibilities of the key players in the model implementation.

Table 6.1: Roles and responsibilities of the stakeholders in the implementation of the Mathematics AfL model in Grade 6.

STAKEHOLDERS	ROLE	RESPONSIBILITY
Department of Basic Education	To spearhead the implementation of the model	<ul style="list-style-type: none"> • Develop and introduce the policy that supports AfL implementation • Advocate for in-service campaigns about the value of AfL practices in Mathematics • Increase sufficient funding for the programme
Provincial Department and District	To work together to fast-track the implementation process	<ul style="list-style-type: none"> • Recalibrate the in-service training based on the policy stipulations • Conduct onsite research on schools' challenges for planning purposes • Provide notional time for teachers to attend training • Plan and monitor adherence to attendance to training
Mathematics teachers	To optimise individual adherence to in-service training policy	<ul style="list-style-type: none"> • Allocate time to attend training as scheduled • Participate in discussions and training as scheduled by the district
Other stakeholders: Universities, NGO's	To bring in new skills related to assessment of mathematics	<ul style="list-style-type: none"> • Use community Engagements to research and support teachers • Develop assessment manuals that can be used by teachers

6.8 LIMITATIONS

Smith and Noble (2014:100) posit that criticism of qualitative research is based on the researcher's philosophical assumptions. The researcher has an upper hand in the selection of different approaches and methods used to answer the research questions.

Since this study used a qualitative approach, its potential to be generalised as restricted. The results cannot be generalised to other educational contexts outside of the case of study. Despite this restriction, the researcher is of the opinion that this study contributes to classroom practice in terms of the application of AfL in Mathematics.

The research population, comprising of nine primary school Mathematics teachers, is relatively small taking into account the problem under study; however, the researcher believes it is common to a majority of Mathematics teachers. But the depth of the qualitative data gathered from semi-structured interviews, non-participant observation and document analysis enabled the research questions to be answered. Data collected represented participant teachers' experiences of AfL practices in their Mathematics classrooms.

The researcher could not conduct follow-up interviews to do member checks. In some instances, interviews had to be rescheduled because the participant teachers had other commitments and also, the area experienced political uprising. One teacher had to cancel classroom observation and document analysis and the other cancelled the visit due to uncertainties in the area.

Despite the aforementioned limitations, the researcher believes this study is valuable and will help highlight important practices in terms of applying AfL in Mathematics classrooms. The researcher assumes that if this study is conducted at a larger scale, it may yield more results regarding teacher practices associated with AfL in Mathematics in Grade 6.

6.9 RECOMMENDATIONS

It emerged from this study that Mathematics teachers had several challenges regarding the application of assessment for learning in their classrooms. Based on these findings the recommendations presented below are made to study sites as well as other stakeholders in the South African Department of Basic Education.

6.9.1 Recommendations to the Department of Basic Education

Policy clarity is imperative in the regulation of how Mathematics teachers should apply AfL in their classrooms. School assessment policy should take into consideration socioeconomic disparities at public schools and should be revised so that teachers have a model they should use in the development of AfL activities.

Based on the empirical findings, Mathematics teachers lacked pedagogical content knowledge of AfL practices. The findings revealed that they are incompetent when it comes to the development of activities to meet learners' classrooms needs. It is, therefore, imperative for the DBE to conduct intensive assessment workshops, ensuring that teachers' skills and competence are developed for the application of AfL practices in their Mathematics classrooms. It is suggested that in-service training should equip teachers with a variety of teaching and assessment strategies, especially those that are learner-centred such as interactive, constructivist, integrated, collaborative, direct and cooperative. Finally, training on how to develop activities rather than using textbooks would be beneficial to the teaching and learning process.

It is suggested that training should be ongoing, undertaken in association with topics and concepts being taught at a particular time. The policy should stipulate that several hours be allocated for Mathematics teachers to attend in-service training each term.

6.9.2 Recommendation to Schools

Schools should apply the current policy on AfL and use it towards enhancing the quality of teaching and learning. Each Mathematics teacher should be provided with the Intermediate Phase Mathematics CAPS, NPA, WP6 policy documents. The application of AfL should be preceded by internal planning in which the School

Management Team (SMT) takes a leading role. The assessment plan should include the frequency of AfL activities in Mathematics classrooms. School Departments led by the Departmental Head (HoD) should have regular meetings in which AfL practices are discussed, modelled and applied in accordance with learner experience and environment. HoDs should closely monitor how teachers give feedback to learners and they use feedback to plan for teaching and such discussed in length in meetings.

Schools are encouraged to provide relevant resources to help learners grasp the concepts under study. Technological resources are important in this regard, as the teacher could them to access a range of examples with differing levels of difficulty aimed at covering the knowledge dimensions. It is important for schools to have connectivity and strong access to the Internet and that classrooms are equipped with the necessary technological equipment to facilitate the teaching, learning and assessment processes. This connectivity could impact both teacher and learner belief in participating in communities of learning to assist one another by sharing knowledge.

6.9.3 Recommendation for Mathematics Teachers

The study revealed how the majority of Mathematics teachers lacked pedagogical knowledge of AfL practices in their classrooms. This present study also points out to inadequate teacher knowledge in assessing learners in overcrowded classrooms using constructivist assessment approaches, lack of assessment resources and the impact of poor LoLT proficiency on learner performance in Mathematics.

It is therefore recommended that teachers improve their AfL planning practices taking into cognisance the four areas mentioned above. Instead of relying on textbooks, activities should be planned based on the learners' context. Teachers should develop activities (using the CAPS document) that will provide enough feedback to influence teaching and learning, that is, activities should be marked during the period and teachers and learners adequately discuss feedback. Planning of assessment activities should take into account language barriers so that simplified concepts are used in the assessment. Teachers should further motivate learners to work interactively with others towards the completion of activities.

6.10 SUGGESTIONS FOR FURTHER STUDY

It is recommended that further research should examine the relationship between Mathematics teachers' assessment development and the use of feedback to influence classroom instruction. Future research could also investigate Mathematics teachers' attitude towards the use of AfL and feedback to influence learner performance. Moreover, action research that focuses on innovative techniques on assessing learners in overcrowded classrooms that can have a major contribution to improving teaching and learning, is recommended. The duplication of this research should make a comparison on the area of practice between 'successful' and 'struggling' primary schools in terms of the application of AfL in Mathematics.

6.11 A FINAL WORD

Looking back, it can be said this research study has tried to explore how Mathematics teachers applied AfL to enhance classroom teaching and learning in primary schools, in South Africa thus far. The introduction pointed to a plethora of challenges regarding policy change and its implementation to improve the educational experiences of learners. The critical review of literature that was undertaken was assisted by a theoretical framework that looked at educational theories which influence classroom practice. The methodology was clearly outlined, and it used a qualitative method to collect and interpret data to establish findings. The findings and recommendations have been presented through a model which guides the integration of theoretical underpinnings with pedagogical and content knowledge towards a sound classroom practice. Due to the fluidity of AfL practice in the Mathematics classroom, the researcher acknowledges that the application process will continue to evolve to accommodate the changes in the system. At present, Mathematics teachers are tasked with developing feedback that will influence classroom practice towards improving learner mathematical skills. However, the study revealed that Mathematics teachers struggle with the application of AfL practices in Alexandra Township and this contributes to the poor performance of learners. Various factors contribute to this impasse, primarily inadequate AfL pedagogical content knowledge. To improve the practice several recommendations have been made based on the findings of the study.

The impediments identified need to be addressed at departmental and institutional levels for AfL application to be effective. The literature revealed the importance of AfL practices and their influence on improving quality in teaching and learning in the Mathematics classroom, particularly as its integration and use can offer a greater contribution to learner performance in Mathematics.

The roots of education are bitter, but the fruit is sweet.

(Aristotle)

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APPENDICES

Appendix A: Research Ethics Certificate



UNISA COLLEGE OF EDUCATION ETHICS REVIEW COMMITTEE

Date: 2019/08/14

Ref: **2019/08/14/61954705/20/MC**

Name: Mr SS Mahlambi

Student No.: 61954/05

Dear Mr Mahlambi:

Decision: Ethics Approval from
2019/08/14 to 2024/08/14

Researcher(s): Name: Mr SB Mahlambi
E-mail address: 51954705@mylife.unisa.ac.za
Telephone: +27 84 299 4515

Supervisor(s): Name: Prof G van den Berg
E-mail address: vdberg@unisa.ac.za
Telephone: +27 12 429 4895

Title of research:

Assessment for learning: An approach towards enhancing quality in mathematics teaching and learning in selected primary schools

Qualification: D. Ed In Curriculum Studies and Instruction

Thank you for the application for research ethics clearance by the UNISA College of Education Ethics Review Committee for the above mentioned research. Ethics approval is granted for the period 2019/08/14 to 2024/08/14.

The low risk application was reviewed by the Ethics Review Committee on 2019/08/14 in compliance with the UNISA Policy on Research Ethics and the Standard Operating Procedure on Research Ethics Risk Assessment.

The proposed research may now commence with the provisions that:

1. The researcher(s) will ensure that the research project adheres to the values and principles expressed in the UNISA Policy on Research Ethics.
2. Any adverse circumstance arising in the undertaking of the research project that is relevant to the ethicality of the study should be communicated in writing to the UNISA College of Education Ethics Review Committee.



University of South Africa
Pretoria Street, Mucklenech Ridge, Gweru, Rhodesia
PO Box 290, Unisa, 0003 South Africa
Telephone: +27 12 429 3113 Fax: +27 12 429 3114
www.unisa.ac.za

3. The researcher(s) will conduct the study according to the methods and procedures set out in the approved application.
4. Any changes that can affect the study-related risks for the research participants, particularly in terms of assurances made with regards to the protection of participants' privacy and the confidentiality of the data, should be reported to the Committee in writing.
5. The researcher will ensure that the research project adheres to any applicable national legislation, professional codes of conduct, institutional guidelines and scientific standards relevant to the specific field of study. Adherence to the following South African legislation is important, if applicable: Protection of Personal Information Act, no 4 of 2013; Children's act no 38 of 2005 and the National Health Act, no 61 of 2003.
6. Only de-identified research data may be used for secondary research purposes in future on condition that the research objectives are similar to those of the original research. Secondary use of identifiable human research data requires additional ethics clearance.
7. No field work activities may continue after the expiry date **2024/08/14**. Submission of a completed research ethics progress report will constitute an application for renewal of Ethics Research Committee approval.

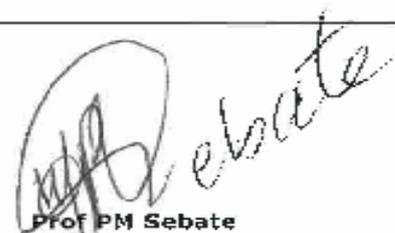
Note:

The reference number **2019/08/14/61954705/20/MC** should be clearly indicated on all forms of communication with the intended research participants, as well as with the Committee.

Kind regards,



Prof AT Motlhabane
CHAIRPERSON: CEDU RERC
 motlhat@unisa.ac.za



Prof PM Sebate
ACTING EXECUTIVE DEAN
 Sebatpm@unisa.ac.za

Approved decision template – updated 16 Feb 2017

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Appendix B: Request Permission Letter- Department of Basic Education



**Request for permission to conduct research at Alexandra Primary schools entitled:
*Assessment for learning: An approach towards enhancing quality in Mathematics teaching and learning in Grade 6.***

22nd July 2019

Gauteng Province: Department of Basic Education

Office of the Director: Education Research and Knowledge Management

7th Floor, 17 Simmons Street

Johannesburg

2001

Dear Sir/Madam

My name is Mahlambi Sizwe Blessing, and I am doing research under the supervision of **Prof. G. Van den Berg and Dr Ailwei Solomon Mawela**, lecturers in the Department of Curriculum and Instructional Studies towards a Doctor of Philosophy in Education Degree at the University of South Africa. We have no funding to sponsor this study. We are inviting you to participate in a study entitled ***Assessment for learning: An approach towards enhancing quality in Mathematics teaching and learning in Grade 6.***

The purpose of this study is to collect information regarding teachers' views of assessment for learning Mathematics in primary schools in Alexandra Township. Ten (n=10) primary schools with a total number of ten (n=10) teachers will be purposefully sampled to participate in this study. Participants are expected to respond to the face-to-face semi-structured interview questions, which will be followed by non-participatory observation, and end with documents analysis. To gather information, a tape recorder will be used to record the researcher and participant conversation, which will later be transcribed.

Participating in this study is voluntary and participants are under no obligation to consent to participation. Participants will be given the consent form to read and sign before participating.

They are at liberty to can withdraw at any time and without giving a reason. There are no attached promises or benefits for the participants and participation in the study is voluntary. The researcher does not anticipate any harm or negative consequences for you as a participant in this study. However, if any unforeseen harm or negative consequences may take place, such, will be reported to the relevant stakeholders such as UNISA Ethics Committee and the circuits through a written report.

Participants' names and school names will not be recorded anywhere, and no one will be able to connect participants to the answers you give. Answers will be given a code number, or a pseudonym and participants will be referred to in this way in the data, any publications, or other research reporting methods such as conference proceedings. A report of the study may also be submitted for publication, but individual participants will not be identifiable in such a report.

Hard copies of participants' answers will be stored by the researcher for five years in a locked cupboard/filing cabinet at the supervisor office for future research or academic purposes; electronic information will be stored on a password-protected computer. Future use of the stored data will be subject to further Research Ethics Review and approval if applicable. If necessary, hard copies will be shredded and/or electronic copies will be permanently deleted from the hard drive of the computer through the use of a relevant software programme.

This study has received written approval from the Research Ethics Review Committee of the CEDU research ethics, Unisa. A copy of the approval letter can be obtained from the researcher if you so wish. If you would like to be informed of the final research findings, please contact Mahlambi Sizwe Blessing at 084 299 4515 or email emahlasb@unisa.ac.za. The findings are accessible for three years. Should you have concerns about how the research has been conducted, you may contact Prof. G. Van den Berg at 0124294895 or vdberg@unisa.ac.za and Dr AS Mawela at 0124294381 or email:mawelas@unisa.ac.za

Hoping that you find this in order.

Yours faithfully

Mahlambi S.B.

Appendix C: Approval from the Gauteng Department of Education



GAUTENG PROVINCE

Department: Education
REPUBLIC OF SOUTH AFRICA

8/4/4/1/2

GDE RESEARCH APPROVAL LETTER

Date:	15 October 2018
Validity of Research Approval:	11 February 2019 – 30 September 2019 2018/327
Name of Researcher:	Mahlambi S.B.
Address of Researcher:	P.O Box 3714 Kempton Park 1620
Telephone Number:	012 429 2629 084 299 4515
Email address:	emahlasb@unisa.ac.za
Research Topic:	Assessment for learning: An approach towards enhancing quality in mathematics teaching and learning
Type of qualification	Doctor of Philosophy in education
Number and type of schools:	Twelve Primary Schools.
District/s/HO	Johannesburg East

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 above study subject to the conditions listed below being met. Approval may be withdrawn should any of the conditions listed below be flouted:

18/10/2018

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 0468

Email: Farh.1818@ed.gov.za

Website: www.education.gauteng.gov.za

The following conditions apply to GDE research. The researcher may proceed with the above study subject to the conditions listed below being met. Approval may be withdrawn should any of the conditions listed below be flouted:

1. *The District/Head Office Senior Managers concerned must be presented with a copy of this letter that would indicate that the said researcher/s has/have been granted permission from the Gauteng Department of Education to conduct the research study.*
2. *The District/Head Office Senior Managers must be approached separately, and in writing, for permission to involve District/Head Office Officials in the project.*
3. *A copy of this letter must be forwarded to the school principal and the chairperson of the School Governing Body (SGB) that would indicate that the researcher/s have been granted permission from the Gauteng Department of Education to conduct the research study.*
4. *A letter / document that outline the purpose of the research and the anticipated outcomes of such research must be made available to the principals, SGBs and District/Head Office Senior Managers of the schools and districts/offices concerned, respectively.*
5. *The Researcher will make every effort obtain the goodwill and co-operation of all the GDE officials, principals, and chairpersons of the SGBs, teachers and learners involved. Persons who offer their co-operation will not receive additional remuneration from the Department while those that opt not to participate will not be penalised in any way.*
6. *Research may only be conducted after school hours so that the normal school programme is not interrupted. The Principal (if at a school) and/or Director (if at a district/head office) must be consulted about an appropriate time when the researcher/s may carry out their research at the sites that they manage.*
7. *Research may only commence from the second week of February and must be concluded before the beginning of the last quarter of the academic year. If incomplete, an amended Research Approval letter may be requested to conduct research in the following year.*
8. *Items 6 and 7 will not apply to any research effort being undertaken on behalf of the GDE. Such research will have been commissioned and be paid for by the Gauteng Department of Education.*
9. *It is the researcher's responsibility to obtain written parental consent of all learners that are expected to participate in the study.*
10. *The researcher is responsible for supplying and utilising his/her own research resources, such as stationery, photocopies, transport, faxes and telephones and should not depend on the goodwill of the institutions and/or the offices visited for supplying such resources.*
11. *The names of the GDE officials, schools, principals, parents, teachers and learners that participate in the study may not appear in the research report without the written consent of each of these individuals and/or organisations.*
12. *On completion of the study the researcher/s must supply the Director: Knowledge Management & Research with one Hard Cover bound and an electronic copy of the research.*
13. *The researcher may be expected to provide short presentations on the purpose, findings and recommendations of his/her research to both GDE officials and the schools concerned.*
14. *Should the researcher have been involved with research at a school and/or a district/head office level, the Director concerned must also be supplied with a brief summary of the purpose, findings and recommendations of the research study.*

The Gauteng Department of Education wishes you well in this important undertaking and looks forward to examining the findings of your research study.

Kind regards



Mr Gumani Mukatuni
Acting CES: Education Research and Knowledge Management

DATE: 18/10/2017

2

Making education a societal priority

Office of the Director: Education Research and Knowledge Management

7th Floor, 17 Sirramonds Street, Johannesburg 2001

Tel: (011) 355 0488

Email: Earh.f@e.sba.e.s@gauteng.gov.za

Website: www.education.gov.za

Appendix D: Request Permission Letter- School Principal



Request for permission to conduct research at your school entitled *Assessment for learning: An approach towards enhancing quality in Mathematics teaching and learning in Grade 6*

22nd , July 2019

The school Principal

Dear Sir/Madam

I, Mahlambi Sizwe am doing research under the supervision of Prof. G. Van den Berg and Dr Ailwei Solomon Mawela, lecturers in the Department of Curriculum and Instructional Studies towards a Doctor of Philosophy in Education at the University of South Africa. We are inviting you to participate in a study entitled **“Assessment for learning: An approach towards enhancing quality in Mathematics teaching and learning in Grade 6”**.

This study aims to explore how Mathematics teachers implement assessment for learning in Grade 6 to improve teaching and learning practices.

Your school has been selected because **it is one of the primary schools in Alexandra Township which is the focus of this study**. The study will entail a **Mathematics teacher in Grade 6 to participate in the study. Face-to-face interviews, non-participatory observation and document analysis will be used to collect data from the Mathematics teacher**. The benefits of this study are that the findings may be used by primary schools working together with the Department of Basic Education to enhance Mathematics teachers' proficiency in implementing assessment for learning.

There are no foreseeable risks for participating in the study. There will be no reimbursement or any incentives for participation in the research. Key findings of the study will be shared with the Department of Basic Education, Mathematics teachers and academia through a summary report on the study after its successful completion.

Should you have concerns about how the research has been conducted, you may contact Prof. G. Van den Berg at 124294895 e-mail; vdberg@unisa.ac.za and Dr AS Mawela at 0124294381 or email: mawelas@unisa.ac.za

Yours sincerely

S. Mahlambi

Researcher

Appendix E: Request for Mathematics Teacher to Participate in the Study



Request for a Mathematics teacher in Grade 6 to participate in the study entitled *Assessment for learning: An approach towards enhancing quality in Mathematics teaching and learning in Grade 6*

22nd July 2019

DEAR PROSPECTIVE PARTICIPANT

My name is Mahlambi Sizwe Blessing, and I am doing research under the supervision of Prof. G. Van den Berg and Dr Ailwei Solomon Mawela, lecturers in the Department of Curriculum and Instructional Studies towards a Doctor of Philosophy in Education at the University of South Africa. We have no funding to sponsor this study. We are inviting you to participate in a study entitled **“Assessment for learning: An approach towards enhancing quality in Mathematics teaching and learning in Grade 6”**.

WHAT IS THE PURPOSE OF THE STUDY?

This study is expected to collect important information that could explore how teachers apply assessment for learning as an approach towards enhancing quality in Mathematics teaching and learning

WHY AM I BEING INVITED TO PARTICIPATE?

You are invited because you are currently teaching Mathematics, have the vast knowledge in the assessment that requires the use of assessment for learning in the assessment of Mathematics in grade 6. I obtained your contact details from your school principal. The total number of participants in this study is 10.

WHAT IS THE NATURE OF MY PARTICIPATION IN THIS STUDY?

You are expected to respond to the face-to-face semi-structured interview questions. To document information, an audio recorder will be used to record our conversation, which will later be transcribed. During the interview, you will be expected to respond to questions that are in line with confirmation of signing the consent form; teacher’s demographic information;

methods and or approaches used in assessment for learning; challenges and benefits of assessment for learning in Mathematics; and strategies to enhance teachers proficiency towards developing effective assessment for learning activities in Mathematics in Grade 6. The researcher will further conduct a non-participatory observation in which field notes will be taken, ending with documents analysis about the implementation of assessment for learning in Mathematics.

CAN I WITHDRAW FROM THIS STUDY EVEN AFTER HAVING AGREED TO PARTICIPATE?

Participating in this study is voluntary and you are under no obligation to consent to participation. If you do decide to take part, you will be given this information sheet to keep and be asked to sign a written consent form. You are free to withdraw at any time and without giving a reason.

WHAT ARE THE POTENTIAL BENEFITS OF TAKING PART IN THIS STUDY?

There are no benefits for the participants and participation in the study is voluntary.

ARE THERE ANY NEGATIVE CONSEQUENCES FOR ME IF I PARTICIPATE IN THE RESEARCH PROJECT?

The researcher does not anticipate any harm or negative consequences for you as a participant in this study. However, if any unforeseen harm or negative consequences may take place, such, will be reported to the relevant stakeholders such as UNISA Ethics Committee through a written report.

WILL THE INFORMATION THAT I CONVEY TO THE RESEARCHER AND MY IDENTITY BE KEPT CONFIDENTIAL?

Your name and the name of the school will not be recorded anywhere, and no one will be able to connect you to the answers you give. Your answers will be given a code number or a pseudonym and you will be referred to in this way in the data, any publications, or other research reporting methods such as conference proceedings. A report of the study may also be submitted for publication, but individual participants will not be identifiable in such a report.

HOW WILL THE RESEARCHER(S) PROTECT THE SECURITY OF DATA?

Hard copies of your answers will be stored by the researcher for five years in a locked cupboard/filing cabinet at the supervisor office, and or researcher's home for future research or academic purposes; electronic information will be stored on a password-protected computer. Future use of the stored data will be subject to further Research Ethics Review and

approval if applicable. If necessary, hard copies will be shredded and/or electronic copies will be permanently deleted from the hard drive of the computer through the use of a relevant software programme.

WILL I RECEIVE PAYMENT OR ANY INCENTIVES FOR PARTICIPATING IN THIS STUDY?

You will not receive any payments for taking part in this research.

HAS THE STUDY RECEIVED ETHICS APPROVAL?

This study has received written approval from the Research Ethics Review Committee of the CEDU research ethics, Unisa. A copy of the approval letter can be obtained from the researcher if you so wish.

HOW WILL I BE INFORMED OF THE FINDINGS/RESULTS OF THE RESEARCH?

If you would like to be informed of the final research findings, please contact Mahlambi Sizwe Blessing at 084 299 4515 or email emahlasb@unisa.ac.za. The findings are accessible for three years.

Should you have concerns about how the research has been conducted, you may contact Prof. G. Van den Berg at 124294895 e-mail vdberg@unisa.ac.za and Dr AS Mawela at 0124294381 or email: mawelas@unisa.ac.za

Thank you for taking the time to read this information sheet and for participating in this study.
Thank you.

(insert signature)

(insert your name)

Appendix F: Participant Consent Form



Title: *Assessment for learning: An approach towards enhancing quality in Mathematics teaching and learning in Grade 6.*

I, _____ (participant name), confirm that the person asking my consent to take part in this research has told me about the nature, procedure, potential benefits and anticipated inconvenience of participation.

I have read (or had explained to me) and understood the study as explained in the information sheet. I have had sufficient opportunity to ask questions and am prepared to participate in the study.

I understand that my participation is voluntary and that I am free to withdraw at any time without penalty (if applicable).

I am aware that the findings of this study will be processed into a research report, journal publications and/or conference proceedings, but that my participation will be kept confidential unless otherwise specified.

I agree with the recording of the questionnaire/ interview.

I have received a signed copy of the informed consent agreement.

Participant Name and Surname (please print) : _____

Participant Signature

Date

Researcher's Name & Surname (please print): Sizwe Blessing Mahlambi

Researcher's signature

Date

Appendix G: Interview Schedule Instrument



Title: Assessment for learning: An approach towards enhancing quality in Mathematics teaching and learning in grade 6.

DEAR PROSPECTIVE PARTICIPANT:

I, Mahlambi Sizwe Blessing, am doing research under the supervision of Prof. G. Van den Berg and Dr A.S. Mawela, lecturers in the Department of Curriculum and Instructional Studies, towards a Doctor of Philosophy in Education (PhD) at the University of South Africa and would like to know if you have read and signed the consent form as a participant of this research study. Please indicate by saying yes or No before we can proceed with this interview. There are four main sections that you are requested to respond to.

Section A: Teachers demographic information.

1. Please indicate your names, gender and school name
2. For how long have you been teaching Mathematics in Grade 6?
3. Would you please indicate your highest qualification?
4. Apart from Mathematics, which other subjects and grade are you teaching?

Section B: Mathematics teacher's approaches used in the assessment of Mathematics.

5. Have you received any training concerning the assessment of Mathematics in Grade 6?
6. Would you consider the training effective in equipping you to assess the learners? Elaborate.
7. In your own words and relating to Mathematics, how would define the concept of assessment? Elaborate your answer.
8. Are you familiar with any of the four types of assessments as highlighted in Mathematics CAPS document? Can you name them?
9. In your own understanding, how would you define assessment for learning?
10. How do you develop an assessment for learning activities for your learners? Briefly explain how you do it.

11. Which assessment policies/ materials do you use when developing assessment for learning activities in Mathematics?
12. Assessment for learning is approached through planned and unplanned assessment practices. Would you briefly explain what each entails in the assessment of Mathematics?
13. When developing AfL activities do you consider the cognitive levels as presented in Section 4 of the CAPS document? If yes explain how.
14. Which principles of assessment do you normally use when developing AfL activities? Elaborate your answer.

Section C: The teacher's pedagogical, content knowledge and use of technology in classroom assessment of learners in Mathematics.

15. Which Mathematics content areas as per CAPS document do you remember?
16. Are you familiar with the Mathematics content in the topics and how each topic should be assessed? Give an example.
17. Which is your preferred method(s) (teacher, self, peer, group) of assessment in Mathematics? What are the benefits of using this method(s)?
18. What skills or knowledge do you think you have that assists you in developing assessment for learning activities?
19. Do you consider the use of technology in concept development and understanding through assessment for learning activities? Elaborate your answer.
20. Do you currently use any technology in the assessment of Mathematics? Elaborate your answer.
21. What challenges do you experience in the usage of technology in the assessment? Or What is stopping you from using technology in the assessment?

Section D: Challenges and benefits of AfL approach in the assessment of learners.

22. Are the policies clear enough to assist you in developing assessment for learning activities? Elaborate your answer.
23. What do you think is lacking in the Department of Basic Education assessment policy?
24. In your own understanding, are there any benefits for using assessment for learning approaches in assessing Mathematics?
25. What do you think is the importance of increased classroom interaction during the completion of assessment for learning activities? Elaborate your answer.

26. How do you encourage learner participation in all classroom assessment activities?
27. What challenges do learners experience during their participation towards completion assessment for learning activities? Elaborate your answer.
28. Do you feel adequately supported concerning assessment activities development? Elaborate your answer.
29. What challenges do you experience regarding your Mathematics classrooms and other work-related issues within the school?
30. Are there any challenges you experience concerning the implementation of assessment for learning in Mathematics? If yes, mention those challenges.
31. What do you think could be the implications of not using assessment for learning in Mathematics?
32. In your view, if Mathematics teachers use assessment for learning approach, what could be its benefits:
 - a) to the learners,
 - b) to the Mathematics teacher?
33. Is there any value of feedback derived from assessment for learning activities? Elaborate your answer.

Section E: Strategies to enhance teachers' proficiency towards effective development assessment for learning activities in assessing Mathematics.

34. In your view, apart from the CAPS document and Mathematics textbooks, what else do you need to be effective in developing assessment for learning activities in Mathematics? Elaborate your answer
35. Considering the benefits of AfL in teaching and learning, what would you propose to your head of the department, deputy principal and or principal, regarding:
 - a) lesson planning,
 - b) availability of resources, and
 - c) planning of AfL activities
36. Who are the other stakeholders that you think should be involved to enhance teachers' proficiency in AfL practices in Mathematics? And how they should be involved. Elaborate and support your answer.

Thank you for your time.

Appendix H: Observation Schedule Instrument



Title: *Assessment for learning: An approach towards enhancing quality in Mathematics teaching and learning in Grade 6.*

DEAR PROSPECTIVE PARTICIPANT:

I, Mahlambi Sizwe Blessing am doing research under the supervision of Prof. G. Van den Berg and Dr A.S. Mawela lectures in the Department of Curriculum and Instructional Studies towards a Doctor of Philosophy in Education (PhD) at the University of South Africa and would like to know if you have read and signed the consent form as a participant of this research study. Please indicate by saying yes or No before we can proceed with the observation. There are nine (n= 11) main items to observe, namely: the teaching approach used by the teacher, lesson plans in the file of the teacher, AfL activities planning, lesson plan moderated by the Head of Department, assessment plans and forms of assessment, how feedback is given to learners, challenge the teacher faces when doing AfL and room for improvement.

Name of school	
Name of Teacher	
Grade	

Criteria	Possible answers
Subject being taught	
Assessment approaches in Mathematics	<p>Teacher-centred: teacher dominated, subject mattered centred, individualistic, indirect/guided</p> <p>Learner-centred: interactive, constructivist, integrated, collaborative, direct, cooperative</p>

Criteria	Possible answers	
The approach used in classroom assessment of Mathematics		
Learning and Teaching materials used during the assessment of Mathematics.		
Availability of subject lesson plan	Yes	No
Evidence of AfL activities in the lesson plan.	Yes	No
Is the lesson plan moderated by the departmental head	Yes	No
Assessment Plans and forms of assessment given to learners and parents.		
Teacher's approach, intervention and influence towards the completion of AfL activities.		
Learner engagement during the completion of Mathematics activities.		
Teacher and learner discussion based on feedback derived from the assessment given to learners.		
Teacher challenges during the implementation of assessment for learning activities.		
Room for improvement in developing and implementing AfL activities.		

Appendix I: Documents Analysis Instrument



Title: *Assessment for learning: An approach towards enhancing quality in Mathematics teaching and learning in Grade 6.*

DEAR PROSPECTIVE PARTICIPANT:

I, Mahlambi Sizwe Blessing am doing research under the supervision of Prof. G. van Den Berg and Dr A.S. Mawela in the Department of Curriculum and Instructional Studies towards a Doctor of Philosophy in Education (PhD) at the University of South Africa and would like to know if you have read and signed the consent form as a participant of this research study. Please indicate by saying yes or No before we can proceed with the document analysis. There are four main documents that I request from you, namely: CAPS subjects document, subject lesson plans, school assessment plan and assessment for learning activities. For recording, a pseudonym will be given to names of schools and teachers.

Name of school				
Name of Teacher				
Grade				
Documents	Criteria	Possible answers		
1. CAPS subjects being taught	Subjects being taught	a)	b)	c)
	Total number of periods being taught			
2. Planning of AfL activities	Availability of Mathematics Grade 6 lesson plan	Yes		No
		Comments:		
		Yes		No

	Availability of AfL activities in the lesson plan.	Comments:	
	Cognitive levels in AfL activities	Comments:	
	Evidence of lesson plan moderation by the departmental head e.g. lesson plan signed by departmental head.	Yes	No
		Comments:	
3. School Assessment Policy	Availability of school assessment policy	Yes	No
		Comments:	
	Frequency of AfL activities in the school assessment policy.	Yes	No
		Comments:	

Assessment for learning activities analysis tool:

The Knowledge dimension	The Cognitive Process Dimension			
	Knowledge	Routine Procedures	Complex Procedures	Problem-solving
Factual Knowledge	Straight recall	Perform well-known procedures	Conceptual understanding	Unseen, non-routine problems (which are not difficult)
Conceptual Knowledge	Appropriate use of mathematical vocabulary	Simple applications and calculations, which might involve many steps	Problems involving complex calculations and/or high order reasoning	Higher-order understanding, and processes involved
Procedural Knowledge	Identification and direct use of correct formula	Identification and use of correct formula generally similar to those encountered in class	Problems not based on a real-world context – could involve making significant connections between different representations	Might require the ability to break the problem down into its constituent parts
Meta-Cognitive Knowledge	Use of mathematical facts	Derivation from given information involved	Investigations to describe rules and relations – there is often not an obvious route to the solution	

Appendix J: Example of A Transcribed Interview

Interviewer: Mr X thank you for the time that you have afforded me. Now it is time for us to engage in an interview. So, if you feel there is a question that you cannot answer at the present moment, you can just indicate to me that we should go to the next question. Section A deals with the teacher's demographic information. Who is the teacher, and it is simple and straight forward. So, the first question is, just indicate to me your name, your gender and the name of the school in which you are currently teaching?

Participant: My name is Mr X, the gender, I am a male teacher, at X primary school which is based in Alexandra.

Interviewer: How long have you been teaching Mathematics in Grade 6?

Participant: It is now eight months.

Interviewer: What is your highest qualification?

Participant: I hold a Bachelor of Science in Mathematical Science for the University of xxx. I also hold a post-graduate certificate in education senior phase which was conferred by the University of South Africa.

Interviewer: Apart from Mathematics which other subjects and grade are you currently teaching?

Participant: I am teaching Social Sciences in grade 6 as well.

Interviewer: Since you joined the Department of Basic Education have you received any training concerning the assessment of Mathematics in Grade 6?

Participant: Yes I have received some training.

Interviewer: Would you consider the training effective in equipping you with skills to assess the learners in Mathematics?

Participant: The training is not well effective. Since the workshop that we attend are much more looking into what we know, not how to approach the topic, it is like we are attending a lecture, we are going back to a classroom, the facilitator tries to establish what we know. That is why I am saying it is not effective because the main purpose it should be learner-based.

Interviewer: So you feel that you need to be equipped on how to develop assessment activities that are learner-based?

Participant: Yes I need more workshops that will focus on assessment for learning implementation in my classroom. What I am doing I do not think is sufficient in driving the learning process.

Interviewer: How would you, as a Mathematics teacher, how do you define the concept of assessment?

Participant: Assessment is part of classroom practises, we assess to judge and to promote a learner in Mathematics.

Interviewer: Okay. Let's talk about the CAPS document because that is the policy that we are using for teaching, learning and assessment. Are you aware of the different types of assessment in Mathematics?

Participant: Yes, I am aware.

Interviewer: Can you kindly mention them and give a brief explanation of what it entails in the assessment of Mathematics.

Participant: We have informal assessments which are on a day-to-day basis that is assessment for learning, and we have the summative assessment which is taken at the end of the cycle, like at the mid-year exams and the final examinations. We also have the baseline assessment, which is usually conducted before the teaching and learning and to establish what the learners know and also to stimulate the thinking of the learners to the topic, to think deeply about the topic which you are going to embark on.

Interviewer: Okay. Then maybe in your own understanding, how would you define assessment for learning?

Participant: Assessments for learning are informal assessments done on a day-to-day basis, they are the building blocks towards the formal assessment. There is, therefore, a strong link between the informal assessment and formal assessment before there is a formal assessment, there should be an informal assessment.

Interviewer: Okay, and then when you are developing assessment for learning activities, which material or which policies do you look at?

Participant: I am using the CAPS document, all the informal activities are aligned to that CAPS document, I get these activities from CAPS aligned textbooks.

Interviewer: Okay. Now assessment for learning, is approached through planned as well as unplanned assessment practices, what is your understanding of planned assessment and unplanned assessment for learning?

Participant: Planned is the one that you prepare before you go to class, unplanned is the remedy that you use may be to reinforce the topic when you see that the topic is not well understood, when the instruction is not effective, that is when you go to an unplanned informal activity.

Interviewer: When developing assessment activities, do you maybe consider the cognitive levels, we have cognitive levels in section 4 of CAPS document, how do you then go back to the cognitive levels when you are planning the assessment activity?

Participant: May you repeat that?

Interviewer: How well are the cognitive levels stipulated by CAPS document linked to the activities that you give to the learners?

Participant: The informal activities that I give cater for all learners of different academic needs. The activities cater for level 1 cognitive levels which are based on simple calculations and have the upper questions that need critical thinking on problem-solving abilities.

Interviewer: Okay, and then which assessment principles do you apply in the development of the assessment for learning and teaching?

Participant: Fairness is the principle that I apply because the assessment for learning should cater all learners with different learning needs, so the activities are fair to all the learners. The activities are fair in terms of the language used because learners struggle with Language of Learning and Teaching which is English. Where learners have challenges, I step in to assist the understanding of the question.

Interviewer: Okay, all right. Section C is about teachers pedagogical and the content knowledge and the use of technology in the classroom, assessment of learners. Now it is getting big. Mathematics has different content areas as presented by CAPS.

Participant: Yes.

Interviewer: How many topics are covered by CAPS in Mathematics and which one do you remember?

Participant: The current one that we are on, we have data handling, we have patterns, we have geometry.

Interviewer: If I take data handling as a topic, are you familiar with methods how it should be assessed?

Participant: In the tests?

Interviewer: Yes, it could be a test or in assessment for learning?

Participant: Yes I am familiar with how it should be assessed because the allocation of time, as per the annual teaching plan, teaches us the amount of time in which we should spend, the more the time spend on there, on the topic, the larger the portion it takes in the test.

Interviewer: Maybe a follow-up question. We have different forms of assessment, you have your test, you have your assignment, you have your investigation, now if you would take data handling as a topic, out of the forms of assessment, which one do you think best, it can be best applied into assessing learners?

Participant: Data handling, can be best applied in projects and assignment, where learners collect data and different forms of graphs to analyse the data.

Interviewer: Now and then again, we have different methods of assessment used in judging learner's work, which one do you prefer to use in assessment for learning?

Participant: Well, I prefer to use the self-assessment.

Interviewer: Okay, and why do you prefer self-assessment?

Participant: So that I can be able to see how well the instruction is understood, to diagnose where the learners need some assistance and it assists the learners to rate their own thinking

or if they are learning. When the learner is self-assessing they can look at themselves come up with a plan on how to improve their learning.

Interviewer: And then, which skills or knowledge do you think you have as a teacher, that assist you in developing assessment for learning activities?

Participant: I have numerical skills, and also have people's skills, I can read learner's behaviour, it assists when I develop the assessment because I know, I will be able to know this learner will be able to do this one.

Interviewer: Do you consider the use of technology in concept development and understanding of assessment activities, or do you have any technology that will assist you to help the learners understand the concept?

Participant: Yes, I have. The school is under-resourced, but the management is doing all in its power to make this school an e-learning environment. So we want to move to translate from traditional teaching to modern teaching because it can improve the performance of the learners and their understanding.

Interviewer: Okay, do you currently use any technology in concept building?

Participant: Myself?

Interviewer: Yes.

Participant: Individually, no I don't use technology.

Interviewer: You don't use technology?

Participant: Yes.

Interviewer: Why are you not using technology if you thought it can improve learner performance?

Participant: As I have already indicated, the school does not have such resources and the Department of Basic Education is not supplying any technological resources.

Interviewer: Does the policy that you are currently using to teach and assess Mathematics clear enough to assist you in developing assessment for learning?

Participant: No, they are not clear.

Interviewer: What do you think is missing from the policy?

Participant: The policies are task-orientated and are not learner orientated. The policy is about the completion of the topics prescribed. given whether the tasks are in the books, but they don't care, whether the learners understand the concept.

Interviewer: So you, what do you think is lacking in the department of Basic Education, assessment policy now?

Participant: What is lacking in the assessment of the department is the overview look of the assessment that we need to move from, learn from task orientated to learner orientated because we need to equip them with skills, at the end of the day, the learners go out to the work industry, empty-headed, but their books are full of activities and signatures.

Interviewer: Okay, what, in your own understanding, are there any benefits of using assessment for learning in Mathematics?

Participant: Yes.

Interviewer: What are the benefits?

Participant: The benefits are that they reinforce the topics, they establish whether the instructions were effective, and they also assist us in how to approach the planning part to meet learners' needs.

Interviewer: What do you think is the importance of increased learner participation during the completion of activities?

Participant: It is very important to have the participation of the learners because when they participate they also gain confidence in themselves and also there is, it creates some competition amongst them, and it builds their self-esteem and it makes them look teaching as a continuous, not as just a task orientated.

Interviewer: How do you encourage your learners to participate in assessment for learning activities?

Participant: I usually call them individually to write the feedback of activities on the board.

Interviewer: What other challenges do you think that learners experience when they participate in the informal assessment?

Participant: Challenges?

Interviewer: What do you think is a challenge to the learner, when they participate in the assessment activity, let's say you give them an activity and say complete this activity, what are the challenges normally do they experience?

Participant: Sometimes, in most cases, learners do not understand the questions that they have been asked, in the assessment because some they lack knowledge of the language of teaching and learning, they are poorly developed.

Interviewer: Do you feel adequate, whether by the department or by the school, do you feel adequately supported with regards to assessment? Are you supported? Or do you feel you need support from certain areas?

Participant: No, I don't feel supported, I still need training on how to develop assessment activities that will assist me in teaching Mathematics to learners.

Interviewer: What challenges do you experience regarding your Mathematics classroom and other work-related issues within the school?

Participant: Well, learner-discipline is a challenge. The lack of learning culture in the institution, and the lack, the unwillingness of learners to do their work. That is a big challenge for me.

Interviewer: Okay. And then concerning the application of assessment for learning in Mathematics, do you experience any challenges as a teacher?

Participant: Yes, lack of resources that myself and the learners we could use in teaching and assessment. The lack of resources makes it difficult to teach mathematical concepts because learners have to visualise what we are discussing in class.

Interviewer: In your own view, what are the benefits of using assessment for learning in the Mathematics classroom?

Participant: It benefits them a lot, it helps them to understand the topic, it stimulates their thinking.

Interviewer: And then for the teacher?

Participant: Well, the teacher gets to know whether these instructions were effective, whether different teaching method is needed regarding the topic.

Do you think there is a value of feedback derived from assessment for learning?

Participant: Ja, but not only feedback but timely feedback, not late feedback.

Interviewer: Okay.

Participant: We do feedback now and then, immediately after the class or when there are no teachers.

Interviewer: Okay.

Participant: Because it also helps to know where they are lacking, what do they understand?

Interviewer: Then the last section E, and this is talking about the strategies that can be used, now to enhance the proficiency of teachers and towards effective development of assessment for learning activities? In your view, apart from CAPS document, and Mathematics textbooks, what else do you need, that will assist you in developing assessment for learning activities?

Participant: We need mathematical resources and teaching aids, we need these things to assist and to make the teaching and learning interesting because other learners learn by visual if maybe we had technological apparatus, and devices, things would be different.

Interviewer: Okay, considering the benefits of assessment for learning, in teaching and learning, what would you propose to your departmental head and the deputy principal, regarding the planning process?

Participant: The assessment for learning and the lesson plan, they link directly. The lesson plan should tell you what to expect, what to expect from the lesson and the informal assessment.

Interviewer: Okay. And then what would you maybe propose to your department or department of Education or whoever, about the availability of resources?

Participant: I will propose to the head of the school, the HOD to try and outsource resources to make a partnership with those well-resourced schools so that we can learn from them.

Interviewer: Okay, and then the planning, what will you propose about the planning of assessment for learning activities?

Participant: I will propose that teachers should before presenting a lesson, they should prepare for it, they should plan for it, how to engage the learners, how the lesson will unfold because if you go to class unprepared, it also creates some unwanted atmosphere in the classroom.

Interviewer: Okay, the last question. According to your views, who are the stakeholders, important stakeholders that you think should be involved to enhance teachers' proficiency in assessment for learning practices in Mathematics?

Participant: Teaching, learning begins at home. I think the parents should be more involved in the teaching and learning of their children, they should also create that love for Mathematics because the parents can show the learners that Mathematics is a hobby. It is not that some describe it as if they can instil that, that attitude that Mathematics it is life, it is how we live, it is a hobby, it is not just a subject. The performance of the learners will improve.

Interviewer: Do you think of any stakeholder that needs to be involved?

Participant: I think also the businesses, need to be involved, they need to invest in this underprivileged schools, we have businesses that operate in my area, they need to contribute towards the development of our schools through donations.

Interviewer: This concludes our interview. Thank you for availing your yourself to be part of this undertaking Mr X. I appreciate that you took time from your busy schedule to be part of this research study. Thank you very much.

Appendix K: Proof of Editing

To whom it may concern

This letter serves to confirm that editing and proofreading were done for:

**Sizwe Blessing Mahlambi
Assessment for Learning: An Approach towards Enhancing Quality in
Mathematics Teaching and Learning in Grade 6**

**PhD (Education)
Doctor of Philosophy (Education)
Curriculum Studies
University of South Africa
Supervisor: Prof. G. van den Berg
Co-Supervisor: Dr A.S. Mawela**

April 2020



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