THE IMPLEMENTATION OF FORMAL ASSESSMENTS IN INTERMEDIATE PHASE MATHEMATICS AS A FOUNDATION OF TEACHING AND LEARNING ENHANCEMENT IN THE LEJWELEPUTSWA DISTRICT

by

SENZENI SIBANDA

Submitted in fulfilment of the requirements for the Degree

MASTER OF EDUCATION

in the
Faculty of Humanities
at the
Central University of Technology, Free State

Supervisor: Dr L Kalobo PhD (Mathematics)

Co-supervisor: Dr AM Rambuda PhD (Subject Didactics)

WELKOM
MARCH 2020

DECLARATION OF ORIGINALITY

DECLARATION WITH REGARD TO INDEPENDENT WORK

I, Senzeni Sibanda, student number , do hereby declare that this research project submitted to the Central University of Technology, Free State for the Degree: Master of Education, is my own independent work; and complies with the Code of Academic Integrity, as well as other relevant policies, procedures, rules and regulations of the Central University of Technology, Free State; and has not been submitted before to any institution by myself of any other person in fulfilment (or partial fulfilment) of the requirements for the attainment of any qualification.

______________________ ______________________

SIGNATURE OF STUDENT **DATE**

DEDICATION

I would like to dedicate this work to my late brothers, Phebion and Silent and to my late sister Irene for their contribution to my education.

ACKNOWLEDGEMENTS

My heartfelt thanks go to the following:

- God Almighty, who gave me all the strength and wisdom to complete my studies.
- To my supervisor Dr L Kalobo, for your guidance and support throughout this academic journey.
- My co-supervisor Dr AM Rambuda, for his resolute support. I appreciate his endeavours to bring out the best in me. Your professionalism and supervision have made me the person I am today.
- To Marielle Tappan for your gracious efforts with the language and technical editing.
- To my husband Jordan, I really appreciate all the support and encouragement you gave to me in obtaining my qualification.
- My children Nokutenda and Tinotenda, for the encouragement you gave to me to finish my studies.
- To my parents for unceasingly praying for me.
- My prayer group, Musambangwena for all the support, encouragement and prayers.
- To my sister-in-law, Tendai and nephew, Mgcini for believing in my success.

ABSTRACT

The purpose of this research was to delve into the manner in which intermediate phase mathematics teachers implement formal assessments in order to enhance teaching and learning. The research was elicited by several reports on the underperformance of South African learners in mathematics. The constructivist philosophy was embraced to underpin the study; specifically, Piaget's cognitive constructivism and Vygotsky's social constructivism. The research emulated a mixed-methods research design, namely the sequential explanatory research design; hence it combined both the positivists and interpretivist paradigms. The sample of the study involved 151 intermediate phase mathematics teachers in the Lejweleputswa district. The study employed simple random sampling for the quantitative strand and purposive sampling for the qualitative strand. Data was gathered through the questionnaire, document analysis, which utilised a checklist and semi-structured interviews. The analysis of quantitative data was done in two sections, thus descriptive statistics first, followed by inferential statistics. Interview data analysis was done through the themes that emerged from participants' responses.

Results of the research have uncovered that the majority of teachers do not align assessment in mathematics to theories of education, in this case, the constructivist theory which informed the study. Furthermore, document analysis has revealed that assessments are inadequately implemented; they do not meet the requirements as stipulated by the Curriculum Assessment Policy Statement (CAPS). Some teachers face challenges when it comes to formal assessment implementation because they are not trained to teach in the intermediate phase, instead, they are trained for other phases. Additionally, the Free State Department of Education does not adequately train teachers in formal assessments. Learners have difficulties in understanding word sums, hence making it difficult for them to solve complex procedures in mathematics.

Hypotheses tests were conducted to compare teachers' implementation of formal assessments according to gender, age, teaching experience, professional teaching qualification, class size and school quintile. Independent-sample t-tests show that there is no statistically significant difference between male and female teachers on formal assessment scores. However, there is a statistically significant difference between young and old teachers on formal assessment scores. Old teachers implement formal assessment better than young teachers. The results also reveal that there is a statistically significant difference among teachers with teaching experience of 1-5 years and 6-28 years on formal assessment scores. Teachers with 6-28 years of teaching experience implement formal assessment better than teachers with 1-5 years of teaching experience. The results show that there is a statistically significant difference among mathematics teachers with or without professional teaching qualifications in the intermediate phase on formal assessment scores. Teachers qualified to teach in this phase implement formal assessment better than those who are not qualified to teach in this phase. The results also show that there is a statistically significant difference among intermediate mathematics teachers who teach an average of 25-40 learners and an average of 41-55 learners on formal assessment scores. Teachers who teach 25-40 learners implement formal assessment better than those who teach 41-55 learners. One-way between-groups analysis of variance (ANOVA) has revealed that there is no statistically significant difference among mathematics teachers who teach different intermediate phase grades on formal assessment scores. ANOVA has also revealed that there is a statistically significant difference among intermediate mathematics teachers who teach at different school quintiles on formal assessment scores. Teachers at quintile 4 and 5 schools implement formal assessment better than those at quintile 1, 2 and 3 schools.

The study, therefore, recommends that teachers must be involved in curriculum design. Teachers must be placed according to the subjects and phases they are qualified for. Teacher training institutions should practically train mathematics student teachers to implement formal assessments effectively. Teachers should be continuously developed by their subject advisors and lastly, teachers need to continue developing themselves to keep abreast of current developments in mathematics.

KEYWORDS: Assessment, cognitive constructivism, constructivist theory; Curriculum and Assessment Policy Statement; formal assessment; intermediate phase; learning; mathematics; social constructivism; teaching.

LIST OF TABLES

LIST OF FIGURES

TABLE OF CONTENTS

CHAPTER 1: ORIENTATION TO THE STUDY

1.1 INTRODUCTION

Statements such as “assessment drives learning” and “students respect what is inspected” are typically centred in the studies complementing the influence that assessments have in accumulating learning by encouraging students to become involved in their learning process (Jacoby, Heugh, Bax & Branford-White, 2014: 72-83). Learner assessment assists teachers to obtain information that is significant for decision making in the classroom, consequently, improving the performance of learners (Gonzales & Aliponga, 2012). In harmony with the idea, South Africa has also adopted assessment as an essential factor for enhancing teaching and learning in schools (Kanjee & Sayed, 2013).

Formal assessments have a profound influence on getting feedback from learners’ achievements and monitoring whether objectives are attainable. These assessments comprise the School-Based Assessment (SBA) and the final test for a particular grade (DBE, 2011a). The assessment program has an alternative of following diverse modes; though the DBE (2011a) proposes the suitable format of tasks to be used in the subject. Wyk and Wolhuter (2016) mention that formal assessments are where constructive formative feedback is provided to develop learners’ knowledge and skills.

Donald, Lazarus and Moolla (2014) assert that formal assessments help learners to move forward in their learning, to ‘form’ or shape their development. They are opposed to summative assessments, which focus only on the product or outcome of learning. The subsequent paragraph discusses the background of this study.

1.2 BACKGROUND TO THE STUDY

This study is elicited by various reports on the underachievement of South African learners in mathematics. Regardless of many years of mathematical development programs, there is still inadequate progress in the development of learners in South Africa. This is revealed by poor results/performance as reported by the Trends in International Mathematics and Science Study (TIMSS), Southern African Consortium for Monitoring Education Quality (SACMEQ) and the Annual National Assessments (ANAs) (Carnoy, Chisholm, Addy, Arends, Baloyi, Irving, Raab, Reevs, Sapire & Sorto, 2011; Taylor & Taylor, 2012). Furthermore, McCarthy and Oliphant (2013) confirm that South Africa is enormously underperforming in education, particularly in mathematics teaching and learning. As an example, the pass rate for mathematics was lowered to 20% from 40% to keep the learners moving through to the next grade or phase (DBE, 2016). In response to the above, Kanjee (2017) has encouraged teachers to pull up their socks in developing effective assessment systems that improve learning in South Africa. This statement implies that there is high underperformance in mathematics. The frequent failure of learners in mathematics has been the concern of all stakeholders in education.

Dyer (2014) argues that teachers perceive formal assessments as the most tedious part of their job which involves the most administration. Additionally, some learners confirm that they dread assessment time. On the contrary, learner involvement in assessment activities can be valuable in their knowledge enrichment. This can be achieved if teachers can concentrate on actively engaging learners in presenting their prior knowledge of the subject. This, in turn, encourages learners to complete the tasks. If assessment tasks are meaningful and exciting, learners might put in more effort and if learners are given the freedom to be creative and use their own strengths the results may well be outstanding. This is very effective to the learner's achievement and at the same time makes teachers' tasks as evaluators easier (Dyer, 2014). Brookhart, Moss and Lang (2010) and Kuze and Shumba (2011) assert that issues like teacher beliefs on formal assessments, lack of knowledge of formal assessments, training and experience affect teachers' effective implementation of these assessments.

1.3 PROBLEM STATEMENT AND RESEARCH QUESTIONS

Whilst formal assessment is incorporated in government policy documents, there is inadequate evidence based on research to confirm whether teachers implement assessments properly and adequately. Furthermore, research still indicates that although several studies have been carried out on teacher assessment practices, there has been limited research on teachers' assessment literacy in South Africa

(Kuze & Shumba, 2011). Additionally, a greater number of teachers have inadequate proficiency in the implementation of formal assessments and lack proper guidance and support on this aspect. There is an inadequacy of assessment knowledge and practice amongst teachers. Furthermore, large gaps in the knowledge of assessment practices have been noted (Kanjee, 2015). Resultantly, further study on how frequently teachers need to carry out assessments for teaching and learning enhancement and consider the reliability and validity of SBA is essential (Sayed, Kanjee & Rao, 2014).

1.3.1 Main research question

What is the nature of formal assessment in intermediate phase mathematics in schools?

1.3.2 Research sub-questions

- How are formal assessments used as a foundation for teaching and learning enhancement?
- What challenges do teachers and learners experience in the implementation of formal assessments?
- How could challenges teachers and leaners experience in the implementation of formal assessments be alleviated?
- To what extent do differences in biographical variables (gender, age, teaching experience, professional teaching qualification, class size and school quintile) and intermediate phase mathematics teachers' responses relate to their implementation of formal assessments?

1.3.3 Main objective of this research

Investigate the nature of formal assessment in intermediate phase mathematics at schools.

1.3.3.1 Specific objectives of the study

- Establish how formal assessments are used as a foundation for teaching and learning enhancement.
- Examine the challenges experienced by teachers and learners in the implementation of formal assessments.
- Establish how could challenges teachers and learners experience in the implementation of formal assessments be alleviated.
- Determine to what extent do differences in biographical variables (gender, age, teaching experience, professional teaching qualification, class size and school quintile) and intermediate phase mathematics teachers' responses relate to their implementation of formal assessments.

The ensuing section presents the purpose of the study.

1.4 PURPOSE OF THE STUDY

The aim of the research was to investigate the implementation of formal assessment in intermediate phase mathematics as a foundation of teaching and learning enhancement in the Lejweleputswa district. Moreover, this research also explores the challenges encountered by intermediate phase mathematics teachers in implementing effective formal assessments.

Formal assessments are an essential and inescapable component of teaching and learning (Tomlinson, 2014). Assessment has been proclaimed as one of the positive pedagogical instructions for enhancing learning (DeLuca, Luu, Sun & Klinger, 2012). Consequently, the implementation strategies need to be analysed so as to try and enhance teaching and learning of mathematics in the intermediate phase. The subsequent paragraph presents the hypotheses which will be verified in this study.

1.5 RESEARCH HYPOTHESES

A research hypothesis is a statement that is confirmable to the researcher because it is an informed surmise or belief by a researcher (Bakkabulindi, 2015). Two hypotheses are formulated for each idea that the researcher wants to test; these are the null and alternative hypothesis (Pietersen & Maree, 2016). In this chapter, only the null hypotheses are listed. Alternative hypotheses are listed in Chapter Four. The following null hypotheses will be tested in this study:

- There is no statistically significant difference between male and female intermediate mathematics teachers on formal assessment scores.
- There is no statistically significant difference between young and old intermediate mathematics teachers on formal assessment scores.
- There is no statistically significant difference among intermediate mathematics teachers with teaching experiences of 1-5 years and 6-28 years on formal assessment scores.
- There is no statistically significant difference among mathematics teachers with or without professional teaching qualifications in the intermediate phase on formal assessment scores.
- There is no statistically significant difference among intermediate mathematics teachers who teach an average of 25-40 learners and an average of 41-55 learners on formal assessment scores.
- There is no statistically significant difference among mathematics teachers who teach different intermediate phase grades on formal assessment scores.
- There is no statistically significant difference among intermediate mathematics teachers who teach at different school quintiles on formal assessment scores

The subsequent paragraphs discuss the preliminary literature review and theoretical framework guiding this study.

1.6 THEORETICAL FRAMEWORK

Imenda (2014) defines a theoretical framework as one which explicates the theory that the researcher has selected to guide the research; thus it is the execution of the underlying theory of the research, drawing out concepts from the theory in an attempt to provide an explanation for a phenomenon or research problem. Similarly, a theoretical framework indicates a coherent link between research questions and methodology, since it is used to support the selection of subjects, variables and design (McMillan & Schumacher, 2014). This implies that a theoretical framework will need to yield a suitable interpretation for the phenomenon.

1.6.1 Theories underpinning the research

This study falls under the constructivism theory because several contemporary views of efficient teaching and learning are found on constructivist theories. Furthermore, the main principle of constructivism is that learning comprises purposeful progressive construction of meaning, not an inactive process of obtaining information (Killen, 2015). Moreover, constructivist theories underscore the links that learners make independently when faced with new challenges (Paulsen & Dednam, 2016). Constructivism theories will be applicable in this study since they engage with the enhancement of teaching and learning. Two constructivist theories, namely, the cognitive constructivism and the social constructivism theories will be employed in this study to inform the development of a conceptual framework. These theories are briefly discussed in the ensuing paragraphs.

1.6.1.1 Piaget's cognitive constructivism theory

Cognitive constructivism has its focal point on the intellectual activities that individuals employ to understand the universe. Furthermore, it is the methodology of learning whereby learners are exposed to constructing links among notions and facts being taught. This puts emphasis on actively engaging learners to construct knowledge for themselves (Borich & Tombari, 1997). This theory is the work of Piaget (1964) whereby reference is made that children are continually exposed to new information which they try to organise and understand. Explanation is given that understanding takes place through connected processes namely, assimilation, accommodation and equilibration. These processes are discussed later in this study (cf. 2.2.1.1). Piaget's theory holds profound educational implications. These implications are active engagement and exploration and unevenness of cognitive development (Donald *et al*., 2016). The implications are clarified in great length later in the following chapter (cf. 2.2.1.3). The subsequent paragraph briefly discusses social constructivism theory.

1.1.6.2 Vygotsky's social constructivism theory

Power-Collins (1994) asserts that in line with social constructivism theory, learners do not rely on the lessons delivered by the teacher only; instead, knowledge is also obtained through their interaction with their surroundings. This perspective is pertinent to Vygotsky's (1978) social constructivism theory. Vygotsky (1978) discusses some significant facets of social constructivism and the implications they hold for mathematics teaching and learning. These are addressed in-depth later, in Chapter Two of this research (cf. 2.2.2 to 2.2.2.4). The ensuing paragraphs provide a brief literature review.

1.7 LITERATURE REVIEW

A methodical search of authorised sources which are relevant to the researcher's topic is known as a literature review. It also involves analysis, evaluation and synthesis of available relevant knowledge (Hart, 2018). This implies that a literature review involves analysing all the available accessible material on a research topic (Li, Liping & Khan, 2018; McMillan & Schumacher, 2014). Moreover, the literature review is a link between the source texts drawn by the researcher and where the researcher is positioned among the sources (Ridley, 2012). The implication is that the researcher has to be well versed with what different authors say about the topic under study and what the current information is, related to the study. It is against this background that the literature review will explore the implementation of formal assessments in intermediate phase mathematics to enhance teaching and learning. Themes to be discussed in this review will include the teaching and learning of mathematics, assessment of learners in mathematics, challenges in mathematics teaching, learning and assessment as well as accommodating challenges in mathematics teaching and learning. These themes are briefly discussed in the ensuing paragraphs.

1.7.1 The teaching and learning of mathematics

The DBE (2011a) specifies the aims and skills which learners must develop in the learning of mathematics (cf. 2.3.4.1 & 2.3.4.2). Mathematics teaching must follow a constructivist's approach whereby learners are taught problem-solving approaches.

In this way, learners become actively involved in the exploration, prediction and conjecturing of facts. These promote learners' abilities to discover solutions for authentic obstacles in everyday life situations (Borich, 2014). Additionally, Paulsen and Dednam (2016) suggest a mathematical proficiency guideline which is an inclusive view of mathematics teaching and learning. It consists of five strands to be followed which include:

- in-depth understanding of basic operations;
- ability to calculate accurately and efficiently;
- proficiency in formulating, representing and solving mathematical problems;
- critical thinking to reflect and justify mathematical problems and come up with solutions; and
- view mathematics as a useful and valuable subject in everyday life situations.

These strands are compatible with the aims and specific skills as stipulated in the (DBE, 2011a). The following paragraph discusses the assessment of learners in mathematics teaching and learning.

1.7.2 Assessment of learners in mathematics

Assessment in South African schools is guided by the DBE (2011a) which stipulates the nature of formal assessments and the minimum requirements for intermediate phase mathematics (cf. 2.4.2). Assessment in mathematics is guided by goals and principles. Butt (2010) and Gipps (2012) assert that formal tasks for assessment purposes must be developed in a manner that they ensure the trustworthiness of results. This can be achieved if assessments are evaluated through three general properties, thus reliability, validity and fairness. Similarly, Killen (2015) mentions that reliability; validity and fairness are the significant principles which punctuate good assessment practices (cf. 2.2.5.1). Additionally, the assessment must provide feedback to the learners on the quality of their work and provide an overview of how to enhance performance (Baird, Hopfenbeck, Newton, Stobart & Stern-Utheim, 2014). The next paragraph presents challenges in mathematics teaching, learning and assessment.

1.7.3 Challenges in mathematics teaching, learning and assessment

Evidently, formal assessments play a notable capacity in the teaching and learning of mathematics, however, there are challenges in the implementation of formal assessments, for both the teachers and learners. Some of the teachers have insufficient instructional knowledge of mathematics as a subject, resultantly; they become bound to the textbooks, resorting back to teacher-centred methods which do not promote constructivist theories (Kim, Kim, Lee, Jeon & Park, 2012; Paulsen & Dednam, 2016). Some learners develop mathematical anxiety; thus, they fear the subject and avoid it wherever possible (Spark, 2011). Boaler (2015) argues that mathematical anxiety can be attributed to teachers' inadequacy to interpret concepts very well (cf. 2.5). However, these challenges can be alleviated so as to enhance teaching and learning of mathematics. Accommodation strategies are discussed in the ensuing paragraph.

1.7.4 Accommodating challenges in mathematics teaching learning and assessment

Accommodation in assessment is a process of modifying the previous strategies which were employed in assessment and coming up with new strategies which will address challenges encountered by the learners (DBE, 2010; Friend & Bursuck, 2006). Inadequacy of instructional expertise on the part of teachers may be addressed through teacher development and Professional Learning Communities (PLC). Through PLCs, teachers gain new ideas on how to enhance teaching and learning of mathematics, stretching to the implementation of formal assessments (Brodie, 2013; Dempsy, 2015). Geist (2010) argues that learners' anxiety in mathematics can be reduced through the implementation of teaching strategies which include critical thinking, cooperative learning, assisting learners to connect mathematics to real-life situations, embrace learners varied learning styles and motivate learners to develop strong skills and positive attitudes towards mathematics (cf. 2.6). The following section provides the research paradigm, ontology, epistemology and approaches for this study.

1.8 RESEARCH PARADIGMS AND APPROACHES

This section concisely highlights the research paradigm and approaches for this study.

1.8.1 Research paradigms

A paradigm is a perspective that forms what is held to be accurate. It is an assumption of what is perceived to be real and true. These assumptions, in turn, play a significant role as they influence the conduct of research (Moyo, Modiba & Simwa, 2015). Additionally, a paradigm is a comprehensive approach to an inquiry that aids to formulate research questions and how research is to be carried out (Devin, 2018). There are at least four major paradigms namely the positivist, post-positivist, interpretive and pragmatic paradigms (Li *et al*., 2018). This study will employ a pragmatic paradigm which combines both the positivist and the interpretivist paradigms. In a pragmatic paradigm, there is a viewpoint that one paradigm is insufficient to produce results which meet the goals of the study (McMillan & Schumacher, 2014). Further understanding of what paradigms are can be enhanced with the awareness of two major terms often used in research; these terms are ontology (positivism) and epistemology (interpretivism) (Hart, 2018; Moyo *et al.,* 2015). Ontology is discussed in the following paragraph.

1.8.2 Ontology

Ontology is defined as a philosophical paradigm which regards the way things occur in the world of nature (van Wyk, 2015). Bakkabulindi (2015) asserts that on the ontological basis of what actually exists; the quantitative researcher interprets truth as detached from the researcher, contrastingly the qualitative researcher views reality as attached to the observer (cf. 3.2.1). Epistemology is discussed in the following paragraph.

1.8.3 Epistemology

Epistemology is defined as the authenticity of assertions about knowledge; it is the science of truth (Bakkabulindi, 2015). Similarly, it is associated with discovery and disclosure of facts; that is how best things can be known (Nieuwenhuis, 2016). On the epistemological basis of obtaining the knowledge, the qualitative researcher's viewpoint sees reality as attached to the researcher, whereas on the ontological basis, the researcher sees reality as independent from the researcher (Bakkabulindi, 2015). Epistemology of this research is illustrated in detail in Chapter Three (cf. 3.2.2). The next section discusses the research approaches that will be utilised in this study.

1.8.4 Research approaches

Blackstone (2012) identifies two major research approaches, namely the deductive and inductive approaches. Considering that this study will employ a mixed-method approach, both approaches will be utilised in this research. The two approaches will be detailed later in the third chapter of this study (cf. 3.3). The deductive approach concerns drawing inferences predicted on general principles or experiences; on the other hand, the inductive approach relates to actually developing generalisations which are based on observations (Gay, Mills & Airasian, 2011).

As reported by Morgan (2014), the questionnaire is well suited for the surveys of this study since the questionnaire to be employed will measure several variables and investigate relationships among them (cf.4.2.2). Quantitative research is deductive in approach, having hypotheses deduced from common law and tested against reality by questing for conditions that affirm or nullify them (Brinkmann & Kvale, 2018; Gibbs, 2018). It is evident that the study is deductive in nature since it will employ a quantitative approach and hypotheses will be tested (cf. 4.2.2). The study is also inductive in the manner that it will employ documentary sources and semi-structured interviews as qualitative data collection methods. Qualitative research is identified as inductive since researchers do not have prejudiced ideas to test (Brinkman & Kvale, 2018). Semi-structured interviews give inductive researchers the ability to probe into topics that emerge during discussions. These additional insights from the participants can then be used later by the researcher to refine and extend original ideas (Morgan, 2014).

Furthermore, induction is the construction and approval of a general explanation based on the accumulation of lots of specific but similar circumstances (Gibbs, 2018). This is relevant to the study as the generation of explanations will be done through the analysis of themes and sub-themes which will emerge during interview data analysis. The following section discusses the research design and methodology that will be utilised in this research.

1.9 RESEARCH DESIGN AND METHODOLOGY

A research design is a procedure which serves to guide the researcher in choosing the ideal research methodology, that is how best to conduct the research (van Wyk, 2015). Similarly, a research design clarifies all the matters in the planning and implementation of the research. It is also a road map utilised by researchers for the planning, implementation and analysis of the study (Li *et al.,* 2018).

Methodology is defined as the gathering of methods through which research is tackled, together with the principles and theories which will be employed in the research (Leedy & Ormrod, 2013). Van Wyk (2015) identifies three different research designs, namely the qualitative, quantitative and mixed-methods research designs. This study has employed a mixed-methods research design.

A mixed-methods research design is one which incorporates both the quantitative and qualitative designs (Denzin & Lincoln, 2013). Furthermore, mixed-methods research have both quantitative and qualitative data gathered, followed by the analysis which is done individually and a comparison of the outcomes is then made to see if they corroborate or contradict one another (Creswell, 2013). Creswell and Plano Clark (2011) classify six mixed-methods designs which are the convergent parallel, explanatory sequential, exploratory sequential, embedded, transformative and the multiphase design. This study will employ a sequential explanatory mixed-methods research design. The following paragraphs highlight the rationale of choosing the mixed-methods research design, as well as describe the explanatory sequential design and how it will be executed in the study.

1.9.1 The rationale of employing the mixed-methods research design

Van Wyk and Taole (2015) highlight some of the notable benefits of employing a mixed-methods research design, as outlined below:

- Collaborates both the quantitative and the qualitative methods, hence strengthens the study.
- Diversify the approach by utilisation of more than one data gathering tool. The first technique of data gathered outcomes leads to developing the second method. As seen in this study, questionnaire responses led to the development of semi-structured interview questions, which were used to clarify quantitative findings (cf.3.5.2.2).

The explanatory sequential method is explained in the subsequent paragraphs.

1.9.1.1 The explanatory sequential mixed-methods design

An explanatory sequential mixed-methods design is one whereby the researcher gathers quantitative data first and analyses it afterwards; qualitative data is collected at the subsequent stage to assist in the explanations of quantitative findings (Creswell & Plano Clark, 2011). The explanatory sequential mixed-methods design is also known as the QUAN-Qual Model, meaning that the quantitative data is collected first and then qualitative data is collected in the second phase. It is a two-stage design which makes use of different phases in the study (Van Wyk & Taole, 2015). The model is explained further in Chapter Three of this study (cf. 3.4.1). The benefit of using the sequential explanatory method is that its clear-cut phases simplify implementation. The sequence enables one step to be implemented at a time. Additionally, the sequence makes it easier for the researcher to report the findings (Ivankova, Creswell & Plano Clark, 2016). The following paragraphs explain how the sequential explanatory design will be implemented in this study, starting off with the quantitative part as the first phase of the design.

1.9.2 Quantitative research design

Quantitative research is a procedure utilising numerical data in an organised and objective way. It derives its data from a selected subgroup and then findings are generalised to the universe that is currently under consideration (Maree & Pietersen, 2016). The aim of quantitative research is to clarify trends amongst given factors in a particular study (Ivankova *et al.*, 2016). Gay *et al.* (2011) mentions three approaches to quantitative research, namely the survey, correlational and the comparative approaches. The survey method as a quantitative research approach will be employed in this study and it is explained in the ensuing paragraph.

1.9.2.1 Survey

A survey as a research instrument is a written document which is utilised to collect information on a certain subject from the respondents. Its main purpose is to generate quantitative statistics that describe some facets of the target population. Additionally, the object of a survey is to acquire knowledge about the attributes of the targeted group (Duarte & Miller, 2015). Similarly, it is the evaluation of status quo, beliefs and opinions through questionnaires or interviews from a population of interest (Maree & Pietersen, 2016). Relevant information on the implementation of formal assessments will be obtained through closed-ended questionnaires and semi-structured interviews. The following paragraphs discuss the qualitative research design as the second phase of the sequential explanatory research design.

1.9.3 Qualitative research design

Qualitative research is an investigation procedure which requires the researcher to develop a comprehensive depiction of the phenomenon. The researcher must analyse the views of participants and write a detailed report afterwards. It must be conducted under natural settings, studying things as they are (Creswell, 2015). The main point of qualitative research is to inquire and gain acquaintance of a fundamental phenomenon currently being explored in a particular qualitative study (Creswell, 2013). Qualitative research is characterised by the use of general and broad questions which endeavour to elicit rich information on the participant’s views. Individuals with sound knowledge and experience of the phenomenon under study are purposefully sampled to participate (Patton, 2014). Creswell (2013) mentions that qualitative designs can be narrative research, a case study, phenomenology, grounded theory and ethnography. This study will employ a phenomenological design which is discussed in the ensuing paragraph.

1.9.3.1 Phenomenology

Phenomenology is the study of an individual's awareness derived from one's opinion. It describes ideas relating to how they are perceived by participants in given circumstances. It goes together with qualitative data gathering methods such as interviews and observations (Tshabangu, 2015). Additionally, it seeks inquiry regarding the meaning of experience from these particular participants (Gay *et al.*, 2011). The researcher will conduct semi-structured interviews with intermediate phase mathematics teachers. The participants chosen are ideal for the study since they have experiences of the phenomenon being studied. The following section discusses how data will be collected in this study.

1.10 DATA COLLECTION PROCEDURE

The study will make use of the questionnaire, document analysis and semi-structured interviews to collect data. The questionnaire, as a quantitative data gathering approach, is discussed in the following paragraph.

1.10.1 Questionnaire

A questionnaire is a document with set questions designed by the researcher which participants must respond to (Creswell, 2012). In this study, questionnaires will be distributed to intermediate phase mathematics teachers in the Lejweleputswa district to obtain information on the implementation of formal assessments in mathematics teaching and learning. The format of the questionnaire utilised in the study and how the distribution was done is discussed later in this study, in Chapter Three (cf. 3.5.1). The subsequent paragraph discusses the documentary sources as a qualitative data gathering approach to be utilised in this research.

1.10.2 Documentary sources

Documents as data-gathering methods are centred on all sorts of written text or communication that may clarify the phenomenon under inquiry (Nieuwenhuis, 2016). In this study, the researcher will analyse intermediate phase mathematics teachers' portfolios and learners' formal assessment tasks. This will be done to establish if the implementation of formal assessments is aligned with the Curriculum and Assessment Policy Statement (CAPS) requirements, as stipulated by the DBE (DBE, 2011a). A checklist will be used to determine whether the requirements of formal assessment implementation are met by intermediate phase mathematics teachers. Full details of how the checklist was designed and utilised are given later in the third chapter of this research (cf. 3.5.2.1). The following paragraph discusses interviews as a second qualitative data gathering tool that will be utilised in this research.

1.10.3 Interviews

Nieuwenhuis (2016) mentions that an interview is a bidirectional exchange of views through which the interviewer questions the interviewee to obtain data. In this way, information about beliefs, views and opinions of the participant is acquired. Similarly, Brinkmann and Kvale (2018) define the research interview as an interview where knowledge is developed in the intercommunication between the interviewer and the interviewee. Okeke (2015) identifies three types of interviews, namely structured, semi-structured and the unstructured interviews. The study will employ semi-structured interviews to clarify quantitative findings. The rationale for choosing semi-structured interviews is that it is an ideal method endorsing data emerging from other data sources (Nieuwenhuis, 2016. The succeeding section discusses population and sampling for this study.

1.11 POPULATION AND SAMPLING

The research site will be primary schools in the Lejweleputswa district, specifically with intermediate phase mathematics teachers.

1.11.1 Population

Lumadi (2015) and McMillan and Schumacher (2014) assert that a population is a category of persons from whence samples are taken for conducting a study and to which the researcher intends to generalise the results of the study. The population of this study will be intermediate phase mathematics teachers in the Lejweleputswa district. The following paragraph describes the sampling.

1.11.2 Sample

A sample is a smaller group of people who are chosen from a larger population with the object of carrying out a survey (Lumadi, 2015). It is the group of subjects or participants from whom the researcher has gathered data (McMillan, 2012). This study will employ simple random sampling for the quantitative phase and purposive sampling for the qualitative phase (cf. 3.6.2.1., 3.6.2.2 & 3.6.2.3). The following section explains how a pilot study will be conducted in this study.

1.12 PILOT STUDY

A pilot study is a research project that is administered on a narrowed scale before a full-fledged study is conducted. It is used to endorse the research questions and perfect the research hypotheses (Li *et al.,* 2018). After obtaining the responses, the researcher modifies the research instrument, if there are changes to be done. This will give a clear indication of how feasible the study is (Creswell, 2012). In this study, questionnaires will be distributed to fifteen respondents for the pilot study. The pilot study is intended to chart the key aspects and to detect any fault in the questionnaire before administering the final questionnaire (Brinkmann & Kvale, 2018; Ganga & Maphalala, 2015). The procedure which was employed for conducting the pilot study and the lessons gained are discussed in the third chapter of this research (cf. 3.7). The subsequent section discusses the data analysis techniques that will be utilised in this study.

1.13 DATA ANALYSIS TECHNIQUES

As indicated before, this study will follow an explanatory sequential research design, hence quantitative data analysis will be explained first and then be followed by the qualitative data analysis. Quantitative data analysis is a process whereby the researcher statistically scrutinises the data collected to establish if the initially generated hypotheses are endorsed. Consequently, the qualitative researcher formulates meaning by identifying and analysing patterns and themes that emerge throughout data analysis (Bakkabulindi, 2015).

In this study, quantitative data analysis will be presented and analysed in two sections, thus descriptive statistics first (cf.4.2.1) followed by the inferential statistics (cf.4.2.2). Qualitative data analysis will be done through the main themes and categories that will emerge from semi-structured interview responses (cf.4.4). The following paragraph discusses the questionnaire data analysis.

1.13.1 Questionnaire data analysis techniques

Two categories of statistical techniques will be utilised in this study, these are the descriptive and inferential statistics. The techniques will be discussed fully in Chapter Three of this study (cf. 3.8.1.1 & 3.8.1.2) and the full analysis will be presented in Chapter Four of the study (cf. 4.2.1 & 4.2.2). The subsequent paragraph explains the checklist data analysis.

1.13.2 Checklist data analysis

Two categories of statistical techniques, namely the descriptive and qualitative statistical techniques, will be used in this study. The techniques will be discussed in Chapter Three of this study (cf. 3.8.2) and the full analysis will be presented in Chapter Four (cf. 4.3). Interview data analysis is discussed in the ensuing paragraph.

1.13.3 Interview data analysis

Interview data analysis will be done guided by the themes and sub-themes that will emerge from the semi-structured interviews to be conducted with intermediate phase mathematics teachers. The steps to be followed in the formulation of themes and sub-themes are discussed in Chapter Three of this study (cf. 3.8.3) and the full analysis will be presented in Chapter Four (cf. 4.4). The following section discusses the trustworthiness and credibility of qualitative data.

1.14 TRUSTWORTHINESS AND CREDIBILITY OF QUALITATIVE DATA

Trustworthiness is the crucial measure of the accuracy of findings and conclusions in qualitative search (Nieuwenhuis, 2016). Gay *et al.* (2011) concur when they mention that qualitative researchers must ground the trustworthiness of their research findings through credibility, transferability, dependability and confirmability. Following this idea, qualitative research findings will be tested along with these four facets of the study. A profound discussion on how trustworthiness was ensured in this study is discussed in Chapter Three (cf. 3.9.1, 3.9.2, 3.9.3 & 3.9.4). The ensuing section discusses the reliability and validity of the research instruments.

1.15 RELIABILITY AND VALIDITY OF THE RESEARCH INSTRUMENTS

McMillan (2012) states that it is of much significance in research to measure the appropriateness of the research instruments to attest the accuracy of results. Two technical characteristics of measurement are referenced, namely reliability and validity. Reliability is the extent to which different researchers make the same observation about the same object of study, while validity is the degree to which the study furnishes the true situation of what is being studied (Gibbs, 2018). Brinkmann and Kvale (2018) concur when they mention that reliability relates to the regularity and trustworthiness of research results. It is concerned with whether the findings are replicable to other researchers, while validity is concerned with whether an instrument inquires what it claims to inquire. These two characteristics will be utilised in the study to guarantee the accuracy of the results (cf.3.10). The next section discusses how ethical considerations will be guaranteed in this study.

1.16 ETHICAL CONSIDERATIONS

Ethics encompasses the values and principles of determining what is right or wrong. In research, it means an establishment of the values and principles which should be a blueprint of how to conduct research which deals with human beings (Sotuku & Duku, 2015). It is of much significance for a researcher to indicate ethical considerations regarding research. This is done to protect the identity of the respondents and participants. It again calls for the researcher to be acquainted with ethical codes of any institute which might be involved in the research (Maree, 2016). Similarly, McMillan and Schumacher (2014) assert that educational research centres mostly on humanity. This calls for the researcher to ensure that the rights of the participants who take part in the research are protected. Similarly, Leedy and

Ormrod (2016) argue that when involved in research, it is the responsibility of the researcher to make certain that clear ethical principles are followed.

It is within this context that the researcher must present the research proposal to the Title Registrations Committee (TRC), seek an ethical clearance certificate from the Faculty Research and Innovation Committee, apply to the Free State Department of Education (FSDoE) to conduct research, furnish the participants with letters of consent and ensure that information obtained from participants will be treated with confidentiality (cf. 3.1.1). The subsequent section discusses the limitations of the study.

1.17 LIMITATIONS OF THE STUDY

A limitation is an element of the study that cannot be controlled by the researcher but which has the potential of influencing the results of the study in a negative way. There are two prevalent anticipated limitations which are the length of study and less than optimal samples size (Gay *et al*., 2011). Similarly, limitations are weaknesses which are identified by the researcher as having possibilities to emanate and affect the study adversely. These can be insufficient measures of variables, lack of participants, sample sizes or complications in data analysis (Creswell, 2012). In this study, the researcher anticipates encountering the following limitations:

- lack of participants for interviews;
- low rate of response for the questionnaire; and
- difficulties in data analysis.

The following paragraphs outline and explain the keywords that will continuously be used in this study.

1.18 DEFINITION OF TERMS

Maree (2016) points out that it is of much significance for a researcher to define the key terms that will be used often in a study to make it easier for readers to comprehend. The keywords in this study are: assessment; cognitive constructivism; constructivist theory; Curriculum and Assessment Policy Statement (CAPS); formal assessment; intermediate phase; learning; mathematics; social constructivism and teaching.

1.18.1 Assessment

Assessment is a systematic procedure that measures the effectiveness of teaching and learning (Donald *et al*., 2014). Similarly, it is a process that guides a teacher to make decisions concerning a learner's performance. It serves a dual purpose; first, as proof of learning to indicate what the learner has achieved, second, it assists the teacher to ascertain whether the learner is performing as specified in the curriculum (Reddy, le Grange, Beets & Lundi, 2015). A difference is made between informal assessments thus daily monitoring of the learner's progress, in contrast with a formal assessment which is the systematic evaluation of learner's progress. Formal assessment is sometimes termed summative assessment (DBE, 2011a; Reddy *et al.,* 2015).

1.18.2 Cognitive constructivism

Cognitive constructivism is a perspective to learning which furnishes learners with the latitude to formulate the meaning of what is being taught (Borich & Tomari, 1997). It rejects the idea that children have no ideas (Paulsen & Dednam, 2016). Cognitive constructivism is born out of the constructivist theory, which is explained in the following paragraph.

1.18.3 Constructivist theory

The constructivist theory views knowledge not as just given, instead, the notion is that knowledge is continuously constructed by individuals or groups in societies (Piaget, 1953). Borich (2014) asserts that constructivism is a belief in learning explaining how people come to understand. However, Taber (2010) points out that constructivist teaching does not expect learners to rediscover knowledge from the onset on their own but to participate in meaningful activities that aid them to construct meaning.

1.18.4 Curriculum and Assessment Policy Statement

The Curriculum and Assessment Policy Statement (CAPS) is a document which comprises the amendment of the National Curriculum Statement (NCS) Grades R to 12. CAPS are an inclusive document that places emphasis on what must be taught in the NSC Grades R to 12 (DBE, 2011a). Furthermore, each subject listed in the NSC has its own CAPS document specifying the aims, skills, content and the assessment procedure (DBE, 2011a).

1.18.5 Formal assessment

As stated, formal assessment is also termed as summative assessment. Its aim is to determine whether a learner has reached a standard of competence for that grade (Donald *et al.*, 2016). The principal purpose of summative assessment is to display the general picture or 'sum total' of a learner's progress from one grade to the next, hence summative evaluation (Borich, 2014).

1.18.6 Intermediate Phase

The DBE has formally grouped grades into two bands namely General Education and Training (GET) which includes Grades RR to 9 and Further Education and Training (FET) thus Grades 10 to 12 (as well as non-higher education vocational training facilities). The GET is separated yet again into foundation phase (Grades RR to 3); intermediate phase (Grades 4 to 6) and senior phase (Grade 7 to 9) (DBE, 2011a). The study is centred on the implementation of formal assessments in the intermediate phase only.

1.18.7 Learning

Sequeria (2017) mentions that learning relates to one's development, which can be contributed by the acquisition of advanced expertise, proficiency in grasping new approaches or a shift in one's perspective. It aids an individual to obtain the necessary skills, knowledge and experience. Much learning occurs through social interaction, hence there is a need for teachers to create conducive environments that support learning (Thomas, 2010).

1.18.8 Mathematics

Mathematics is a system of communication in particular which employs symbols and notations to illustrate numerical data, geometric and graphical relationships. Furthermore, it can be utilised in physical and social phenomena to observe, symbolise and examine practices and trends (DBE, 2011a:8). A comprehensive explanation of mathematics is given later in Chapter Two of this study (cf. 2.3.3).

1.18.9 Social constructivism

Social constructivism asserts that learning takes place if there is the social interaction among the learners (Killen, 2015; Power-Collins, 1994). Vygotsky (1978) claims that before human beings can learn, there must be a presence of social interaction, hence learners must be guided in a socially conducive environment so as to master the concepts.

1.18.10 Teaching

Killen (2015) states that teaching is not just a mere presentation of the content, instead, it encompasses assisting the learners to fully understand the curriculum. Additionally, proper teaching has shifted from simply assisting learners to acquire information as given, to aiding them to merge it with new information and use it in meaningful ways (Sousa, 2010).

1.19 CHAPTER OUTLINE

The study is organised into five chapters as illustrated below.

Chapter One: Orientation to the study

This chapter presents the background to the study, problem statement together with the research aims, questions, objectives and hypotheses. It also briefly discusses the research methodology, data collection and procedures that will be followed in data analysis. Furthermore, it indicates the research ethics and projected limitations of the study.

Chapter Two: Literature review

This chapter presents the literature on the implementation of formal assessments in mathematics teaching and learning. The theoretical and conceptual frameworks enlightening the study are also discussed. The chapter also discusses challenges in mathematics teaching and learning and how challenges those can be accommodated.

Chapter Three: Research design and methodology

This chapter presents and discusses the research design and methodology employed in this study.

Chapter Four: Presentation, analysis and interpretation of data

This chapter presents analyses and interpretations of quantitative and qualitative data.

Chapter Five: Discussion of findings implications, recommendations and conclusion

This is the last chapter of the study. It presents the findings and implications of the implementation of formal assessments. Recommendations are then made for future research.

1.20 SUMMARY

This chapter gave an outline of the study. It detailed the background of the study, the problem under investigation and gave a brief outline of the research design and methodology. Chapter Two will focus on reviewing the literature related to the implementation of formal assessments and how the teaching of mathematics is aligned to the theories underpinning the research.

CHAPTER TWO: LITERATURE REVIEW

2.1 INTRODUCTION

A literature review investigates books, academic articles and any citation pertinent to the area of study. In this way, the review readies an explanation together with an analytical assessment of the works in connection to the issue under exploration (Fink, 2014). Additionally, the literature review determines correlations and incongruences between existing kinds of literature and the work being done (Gasa, Mafora & Maphalala, 2015).

The main object of this chapter is to delve into the teaching and learning of mathematics as well as formal assessments in mathematics. Themes discussed in this review include the teaching and learning of mathematics, assessment of learners in mathematics and challenges in mathematics teaching, learning and assessment as indicated by various authors. The literature review includes books, policy documents of the DBE in South Africa and several journal articles. The theoretical framework is discussed in the subsequent paragraph.

2.2 THEORETICAL FRAMEWORK

Richard and Thomas (2013) point out theories are established so as to clarify, forecast and take note of the phenomenon. In most instances, to question and broaden prevalent understanding, however, within the limits of critical boundary assumptions. Accumulating on their definition of theories, they further explain that a theoretical framework is a construct that is capable of holding a theory of a research study, meanwhile, introducing and relating the theory to the current research problem.

Similarly, Machaba and Mokhele (2013) describe a theoretical framework as a vision utilised by researchers as how they view the world and reflect the viewpoint embraced by the researcher. Thereafter, construct propositions about the study devise assumptions about the study and its relationship with the world, in so doing, structures the work, supports it and stimulates conversation between literature and the study. The following paragraphs discuss the theories supporting the study.

2.2.1 Theories underpinning the research

It is of vital importance for teachers to understand the teaching and learning process. This successively lays the foundation for the proper implementation of formal assessments. This research is framed within constructivism theory, which is based on the constructivist perspective; an aspect that views knowledge as repeatedly formulated by human beings in everyday life situations, not just as stipulated (Donald *et al*., 2014). Additionally, the principal assertion of constructivism is that knowledge is not imposed by external forces; instead, it is internally constructed by an individual. Furthermore, reference is made that the key to constructivism is learner activity. The aim is to understand how teachers teach and assess learners, building from their prior knowledge. This will, in turn, lead learners to purposefully formulate new, worthwhile concepts (Lombard &Themane, 2015).

In this section, two constructivism theories and concepts related to teaching and learning of mathematics are clarified which will inform the development of the theoretical framework of this research. These theories are Piaget's (1953) cognitive constructivism and Vygotsky's (1978) social constructivism.

2.2.1.1 Cognitive constructivism theory of Piaget (1896-1980)

Cognitive constructivism theory is a theory which calls for teachers to deviate from the common practice of direct teaching and be facilitators in teaching and learning (Paulsen & Dednan, 2016). Moreover, Eggen and Kauchak (2010) point out that cognitive constructivism is a view of learning suggesting that instead of imparting knowledge which is formulated beforehand, learners must be given opportunities to make use of their own capabilities and skills to create their own understanding. Outlined below is the cognitive process, as suggested by Piaget (1964).

The process of cognitive development

Piaget (1964) views human beings as occupied in an on-going stage of adaptation and continuously faced with additional information and findings whilst being constantly confronted with new information within their own environments. Simply stated, from the early stages of development beyond, children are capable of creating complicated maps of the world around them, as they endeavour to organise and be acquainted with it. Cognitive constructivism is in harmony with other models of cognition, such as the information processing model or parallel-distributed processing (Berk, 2012). These particular models indicate that knowledge is formulated repeatedly so as to make it worthwhile. Piaget (1964) indicates that cognitive development follows three continuously interacting processes, namely, assimilation, accommodation and equilibration. The processes are discussed in the consecutive paragraphs.

Assimilation: Eggen and Kauchak (2016) define assimilation as the utilisation of prevalent ideas in the clarification of first concurrencies. It is the process of using already operating schema to give meaning to emerging experiences (Paulsen & Dednam, 2016). Piaget (1964) claims that at the time when latest findings arise that are well suited for the child’s present map, assimilation develops and this is also when present ideas are employed to interpret the latest occurrences surrounding the child. Eggen and Kauchak (2016) present a practical example of assimilation in the teaching and learning of mathematics in the intermediate phase. This is illustrated below:

> ***How experiences promote development***
>
> If learners are given a problem like the one illustrated below to solve:
>
> 67
>
> <u>-33</u>
>
> and they get 34 as an answer, their subtracting-whole-numbers scheme suggests that they subtract smaller numbers from larger ones. However, if they are given this problem:
>
> 63
>
> <u>-29</u>
>
> and they also get 34 as an answer, they have mistakenly-assimilated the new experience into their existing scheme. Their thinking didn’t change and they still subtracted the smaller numbers from the larger ones, ignoring the positioning of the numbers (Eggen & Kauchak, 2016). This calls for the teacher to model and

explain the process of regrouping numbers in subtraction so that the learners are, in turn, able to solve a variety of problems.

Ladewig, Potgieter and Pretorius (2012) illustrate assimilation in teaching the number line, in numbers operations and relationships. They explain that for example, a learner who has already mastered the 2 and 10 number lines will be able to count in 8s, as counting in 8s means adding 10 and subtracting 2 or subtracting 10 and adding 2 on a number line. New information of counting in 8s will easily correspond with the child's present map of counting in 2s and 10s.

Accommodation: It is the process of changing one's reasoning to construct fresh ideas or modify outdated ones when they are irrelevant to the current realities. This happens when current information surfaces that dispute with the child's current schemes leading to a need to modify the new format of understanding so as to accommodate current situations (Eggen & Kauchak, 2016). Similarly, accommodation is the procedure of modifying unfit ideas to suit the existing conception (Paulsen & Dednam, 2016). An example of accommodation is demonstrated in teaching space and shape, properties of 2-dimensional shapes where both a square and a parallelogram are quadrilaterals. Learners have prior knowledge of a square, having four sides of equal lengths and four right angles. A new quadrilateral, a parallelogram, is introduced which in this case contradicts the child's existing map. This requires modification of a child's map to accommodate the characteristics of a parallelogram as a new quadrilateral introduced (Jooste, Press, Slamang & Smuts, 2012).

Equilibration: Piaget (1952) describes equilibration as a state of cognitive order, balance and predictability that one describes in the overview. It is a condition which is arrived when one's experiences make sense and make ones' world predictable. Furthermore, this happens when assimilation and accommodation persistently collaborate. Continuous accommodations create wider opportunities for assimilations to occur and conversely, in ever-increasing patterns. These ever-increasing patterns have to be kept in equilibrium throughout the child's emerging maps and with regard to complete perception of the environment (Piaget, 1953).

Eggen and Kauchak (2016) assert that development advances when knowledge and skills increase due to equilibrium being disrupted and restored. Equilibration is likely to happen in the teaching of, for example, equivalent fractions. Jooste *et al.* (2012) demonstrate this concept using the fraction wall and the number line as indicated below:

- Which one is greater; 2/4 or ½ of a pizza?
- 1/5 or 2/10 of R200? This opens up the idea that fractions can be converted to make them equivalent.

Elaborating on cognitive theory, Piaget (1953) introduces the development approach which happens through different stages. The approach is explained below.

2.2.1.2 Development through stages: Piaget's development approach

Piaget (1953) postulates that the advancement of the child's cognitive process peruses an organised system. This system is then divided into categorical stages with specific attributes assigned to each stage. These phases are the sensory-motor phase, pre-operational phase, concrete-operational phase and the formal-operational phase. These four phases and characteristics are tabulated below.

Table 2.1: Piaget's stages and characteristics

Stage	Age	Characteristics
Sensory-motor phase	0-2 years	• Goal-oriented attitude. • Object permanence (memorises objects)
Pre-operational phase	2-7 years	• Prompt growth in language proficiency with oversimplified language • Figurative thought • Influenced by discernment
Concrete-operational phase	7-11 years	• Works reasonably with explicit components • Categorises and seriate sequences
Formal – operational phase	11-15 years	• Puzzles out complex theoretical challenges • Reasons through connection

(Eggen & Kauchak: 2016:70)

Intermediate phase mathematics learners, thus Grade 4 to 6 (who are of much concern in this research) fall in between the concrete and formal operation phases (from about 11 to 13 years of age). Piaget's developmental approach has a significant role in education, which is noticeable in the educational implications delineated below.

2.2.1.3 Educational implications of Piaget's theory in the teaching and learning of intermediate phase mathematics

Reilly and Lewis (1985) affirm that Piaget's interpretation of a child's thinking progression should be known by the teacher. This is so because the theory provides a benchmark for teachers on what to expect at various ages and it helps teachers to develop curricula appropriate to learners' level of development. Eggen and Kauchak (2016) present guidelines relevant to teaching and learning of mathematics which are derived from Piaget's theory. These are as follows:

- furnish detailed experiences that in turn embody concrete ideas;
- assist learners to connect the concrete views to the abstract concepts;
- utilise social interaction to aid learners to promote and improve their conception; and
- plan teaching and learning activities as preparatory avenue progresses to further developmental stages.

Similarly, Donald *et al*. (2014) mention that Piaget's theory has two significant characteristics, each holding intellectual values for education. These are *active engagement and exploration* and *unevenness of cognitive development,* which are individually explained below.

2.2.1.4 Active engagement and exploration

Active engagement and exploration mean that cognitive capability does not just occur within learners. It is built on their effective participation with and analysis of their natural, real-world (Donald *et al.,* 2014). Similarly, learning is developed within an effective process, where meaning is formulated, obtained and created from an individual's skill (Reys, Lindsquit, Lambdin, Smith, Rodgers, Falle, Frid & Bennett, 2012).

The inference of this perception is that mathematics teaching and learning in the intermediate phase demands to be an operational, analytical procedure if teachers are to optimise cognitive development. This implies that teaching, learning and assessment in the intermediate phase should give learners opportunities to try things, to inquire and argue and to demonstrate and solve problems on their own. However, teachers must be cognisant of the unevenness of learners' cognitive levels as discussed in the ensuing paragraph.

2.2.1.5 The unevenness of cognitive development

Cognitive development is not a uniform process of gathering more and more bits of information. The process is unequal but undergoes a progression of stages, as the child constantly improves in the skills of organising and shaping information (Donald *et al.,* 2014). In agreement with the implication of unevenness of cognitive development, Killen (2015) postulates that it is evident that some people learn better than others by virtue of either having a more efficient learning process or more cognitive levels.

The implication is that intermediate phase mathematics teachers have to consider that learners have different cognitive levels of understanding mathematics concepts and consider this when teaching and assessing learners. When designing formal assessment tasks, intermediate phase mathematics teachers should consider different cognitive levels of their learners as outlined in Bloom's taxonomy.

Conversely, Piaget's theory of cognitive development has also been criticised. Outlined below are some of the crucial criticisms:

- The cognitive development of a child into four stages is queried by several developmental theorists. Although some authors agree with Piaget that children develop through several stages, there is dissent on the consistency in thinking implied in Piaget's theory (Shaffer & Kipp, 2007).

- The idea that the formal-operational phase serves as the climax of mental growth has been criticised by some researchers as there is no assurance that all adolescents achieve this ability (Sprinthall & Collins, 1995).
- A disclosure by research studies in Africa is that compared to African children, Western children develop at a swifter rate. Also, another revelation of research is that Black South African children from urban homes perform better than children from rural homes on the level of reasoning operations (Mwamwenda, 2002).

In the subsequent paragraph, the application of Vygotsky's (1953) social constructivism theory to the teaching and learning of mathematics will be discussed.

2.2.2 Social constructivism theory of Vygotsky (1896-1934)

Social constructivism theory is a theory concerned mainly with the manner in which cognitive development happens from 'the outside in'. Social constructivism theory emphasises the conception that cognitive development happens within social connections. Furthermore, reference is made that all better intellectual systems are a result of social interaction (Vygotsky, 1978). Social constructivist theory of learning is centred on the idea that constructive learning transpires when learners are taught ways of using the psychological tools of their culture such as mathematics, language, diagrams and how to solve problems and consequently they are given opportunities to utilise the tools leading to an in-depth understanding of (some) phenomenon (Snowman, McCrown & Beihler, 2011).

Vygotsky (1978) was impacted by Piaget's work, however, he disagreed with the aspect that actual learning occurs at the stages designated by Piaget, instead, stressed part the environment played in children's intellectual development. Piaget (1953) believes that knowledge develops inwardly and is directed outwards, on the contrary, Vygotsky (1978) believes that knowledge starts in the social environment and leads itself inward. Vygotsky (1978) provides some important aspects of social constructivism theory; these are the role of social context, language and mediation. The three aspects are explained below.

2.2.2.1 Social context

Vygotsky (1978) places emphasis on how cognitive development happens from the 'outside-in'. Paramount to Vygotsky's theory is the notion that cognitive development occurs through social interaction, in the social context-activity theory. A pivotal impact of activity theory is that it incorporates both personal life and the real-life in which one resides and works.

All the way from infancy to subsequent years, children formulate common meaning through others in society, such as their peers or parents. They gradually acquire new discoveries and explanations and consequently, modify the former, as they narrow the differences between what they currently know and what confronts them in society. The role of social context advocates that society and culture share a common role in learning (Lave & Wenger, 1991).

This clearly validates the constructivist perspective, whereby knowledge is not precisely given but frequently formulated. It implies that intermediate phase mathematics teachers have to bear in mind that knowledge is adjustable. It differs throughout diverse social contexts and historical times; as a result, intermediate phase mathematics teachers may not deliver mathematics without varying the teaching and learning methods and the assessment strategies. Successively, language as an aspect of social constructivism is discussed in the ensuing paragraphs.

2.2.2.2 Language

Vygotsky (1978) mentions that language is the principal means in which people correspond in their social interactions; therefore, it is a critical element in the cognitive process. Furthermore, it performs a major role in cognitive development. It incorporates spoken and written language as well as sign language, mathematical language and other symbol systems.

The important place of language in cognitive development has critical implications for education. Learners need to be taught the accurate mathematical terminology so that they do not struggle much in solving word problems (Paulsen & Dednam, 2016). The ensuing paragraph clarifies mediation as an aspect of social constructivism.

2.2.2.3 Mediation: Pedagogy as guided assistance

Vygotsky (1978) mentions that mediation is the method by which the child acquires the intellectual equipment that enables the formulation of feasible knowledge. Correspondingly, the world is not approached by a direct route in the context of higher mental activities, instead, it goes through a mediation process (Bateson, 1972). Alternatively, Shulman (1987) refers to pedagogical content knowledge as knowledge about how to teach effectively in particular disciplines, moreover, pedagogical content knowledge must incorporate ideas of what makes teaching a certain subject more difficult or easier. The fundamental idea supporting the notion of mediation is that a learner can achieve progressively through support as opposed to when working alone. This conviction support is expressed in Vygotsky's work as 'mediation within the Zone of Proximal Development (ZPD)'.

> *Instilling [something] in the learner's mind is impractical as it is only practical to prepare him for activities done practically like typing or writing. One, therefore, requires accurately formulated procedures of actual learning in a school situation so as to actualise the zone of proximal development (namely, to engender a series of processes of internal development)*
> *(*Vygotsky, 1978:134).

Additionally, the ZPD is a space medially what a learner can do unassisted, depicting one's existing level of development which represents one's actual level of development and what the learner can do with additional support, thus punctuating the proximal level of development (Paulsen & Dednam, 2016). Owing to Vygotsky's theory, significant educational implications in the teaching and learning of mathematics are discussed in the upcoming paragraphs.

2.2.2.4 Educational implications of Vygotsky's theory in the teaching and learning of intermediate phase mathematics

Vygotsky's theory has far-reaching educational implications for teaching and learning intermediate phase mathematics. These are potential mediators and Mediation and the ZDP.

Potential mediators

Vygotsky's theory indicates the key role of teachers and other members in society in children's acquisition of a particular measure of cognitive development. The theory stresses socialisation for sustained development. The mediator has to perform the role of providing instructional support for the learners so that they can become independent (Donald *et al.,* 2014). Similarly, Paulsen and Dednam (2016) mention that learning must be extended to the home and other out of school settings. At the same time, the teacher still has a significant role to make a decision to choose the most effective, well-informed potential mediator for the learners. This can also be achieved through scaffolding and student-to-student discussions (Abrie, Blom & Fraser, 2016)

Mediation and the ZDP

To fully develop, learners need to be under the supervision of an experienced mediator who can work with skilled partners that can methodically conduct them and systematically lead them into a more challenging problem to solve. Eggen and Kauchak (2016) suggest how Vygotsky's theory can be applied in teaching and learning of mathematics. Below are the guidelines recommended to teachers:

- implant teaching and learning activities in cultural, real circumstances;
- urge learners to make use of language in the description of their understanding by fully involving them in social interactions;
- learning activities created must be in the learners' ZDP; and
- constructive scaffolding must be administered to aid learning and development.

Additionally, the teacher has a role to select relevant teaching and learning content, which will, in turn, close the gap between what the learners know and what can be achieved through the mediation of a knowledgeable person, thus the ZPD. This implies that a teacher must assess previous learning to establish where learners need assistance and then select appropriate strategies to close the gap (Abrie *et al.,* 2016).

Consequently, Vygotsky's theory must lead many intermediate phase mathematics teachers to realise that excellent learning is influenced by others in society. They should, therefore, put the theory into practice as they teach mathematics, as discussed in the upcoming paragraphs.

2.3 THE TEACHING AND LEARNING OF MATHEMATICS

The consecutive paragraphs explain the terms teaching, learning and mathematics.

2.3.1 Teaching

Teaching is a number of developments, which are aimed at providing assistance in the learning process. Teaching takes place outside the learner, whereas learning takes place inside the learner, thereafter; performance of what is learnt is external. Furthermore, teaching is one of the methods by which education is accomplished. Consequently, it is an approach used by teachers to disseminate concepts, intentions and further insights to the learners (Sequeira, 2017)**.** Killen (2015) states that teaching is not just a mere presentation of the content, instead, it encompasses assisting the learners to fully understand the curriculum. Where teaching takes place, learning is supposed to ensue (Sequeria, 2017).

2.3.2 Learning

Cambourne (1988) defines learning as a procedure that requires pattern recognition, making connections and arranging formerly unconnected knowledge and actions into new designs. In a similar manner, learning consists of reinforcing the connections between neurons; it is a change in the brain (Zull, 2002). Teaching is linked together with learning, the reason being learning emanates from teaching. Learning is whereby the person coached actively gains from learning (Sequeria, 2017).

Killen (2015) identifies and put emphasis on three valid points about learning, namely:

- consequently, learning promotes in-depth comprehension;
- transformations in comprehension are an immediate product of learners' experiences and their opinions concerning those experiences; and
- resultantly, these developments in comprehension facilitate learners' attitudes.

The implication is that teachers must necessitate learning experiences that will, in turn, lead learners to discover various degrees of grasping knowledge (Killen, 2015). The general characteristics of teaching and learning are to obtain and transfer knowledge and obtain core skills and get acquainted with them (Sequeira, 2017). This acquisition of knowledge and skills is worthwhile in the teaching and learning of mathematics as a subject, as discussed in the ensuing paragraph.

2.3.3 Mathematics

Mathematics is a method of ordering and disseminating accurate mathematical expressions and terminology and also through the use of symbols (Paulsen & Dednam, 2016). Machaba and Mokhele (2013) mention that mathematics pertains to the minimum skills an individual requires for everyday life situations for basic financial activities.

"Additionally, mathematics assists to improve intellectual methods that in response increase analytical thoughts hence promoting mastery in problem solutions" (DBE, 2011a:8). These analytical and problem-solving skills are crucial in the teaching and learning of mathematics.

2.3.4 The teaching and learning of intermediate phase mathematics according to the Curriculum and Assessment Policy Statement

The DBE (2011a) contains CAPS, thus the policy document for Grade 4 to 6 highlighted above. It is not a completely new curriculum but improves on the previous curriculum, namely Curriculum 2005 which was outcomes-based and amends it and aims to present more precise guidelines of the curriculum and content to be delivered on termly intervals. Its main essence is to reinforce the curriculum delivery process and improve teaching, learning and assessment. Additionally, it stipulates the clarification of mathematics, specific aims, specific skills and the focus of content areas (DBE, 2011a:8). These are explained in the upcoming paragraphs.

2.3.4.1 Specific aims

The DBE (2011a) delineates specific aims for teaching and learning of mathematics. These are to develop:

- *critical awareness of how mathematical relationships are used in social, environmental, cultural and economic relations;*
- *confidence and competence to deal with any mathematical situation without being hindered by any fear of mathematics*
- *a spirit of curiosity and love for mathematics*
- *deep conceptual understanding in order to make sense of mathematics*
- *acquisition of specific knowledge and skills necessary for:*
  -the application of mathematics to physical, social and mathematical problems
  -the study of related subject matter (e.g. other subjects)
  -further studies in mathematics

(DBE, 2011a:8).

Furthermore, these specific aims suggest that teachers have an important function in facilitating teaching and learning towards the achievement of specific skills.

2.3.4.2 Specific skills

The DBE (2011a) predicts the following essential skills for mathematics learners:

- *develop the correct use of the language of mathematics*
- *develop number vocabulary, number concept and calculations and applications*

- *learn to listen, communicate, think logically and apply the mathematical knowledge gained*
- *learn to investigate, analyse, represent and interpret information*
- *learn to pose and solve problems*
- *build awareness of the important role that mathematics plays in real-life situations including the personal development of the learner*

(DBE,2011a:8).

This implies that learners should be equipped with sound mathematical content knowledge in order to develop essential skills. These skills will, in turn, enable them to be competent in the various content areas as explained below.

2.3.4.3 Focus of content areas

The following five content areas as tabulated below make up the intermediate phase mathematics curriculum.

Table 2.2: Intermediate phase mathematics curriculum

WEIGHTING OF CONTENT AREAS			
Content Area	**Grade 4**	**Grade 5**	**Grade 6**
Numbers, Operations and Relationships	50%	50%	50%
Patterns, Functions and Algebra	10%	10%	10%
Space and Shape (Geometry)	15%	15%	15%
Measurement	15%	15%	15%
Data handling	10%	10%	10%
	100%	**100%**	**100%**

*The weighting of Numbers, Operations and Relationships has been increased to 50% for all three grades. This is an attempt to ensure that learners are sufficiently numerate when they enter the Senior Phase.

(DBE, 2011a: 12)

Each content area has a prescribed weighting, in order to ensure complete curriculum coverage. The key objective of the weighting of contents is to show how to spread the content when setting the tests and examinations (DBE, 2011a). The focus of the content is the same across the phase, what differs is the progression of skills to be taught per grade, as will be seen later in this chapter. This is also the reason why the SBA is the same in terms of requirements across the phase. It is important for mathematics teachers to adopt and implement the tenets of constructivism when teaching this content. As can be seen, data handling requires learners to communicate with people in society; it can be learners at school or the community at large. Teachers need to encourage learners' collaboration and working with other harmoniously (Paulsen & Dednam, 2012). This can be reinforced by social interaction as discussed in sub-section 2.2.2.1**.** Space and shape and measurement require learners to be actively engaged, and to perform activities practically as was discussed earlier in this chapter (cf. 2.2.1.3). The ensuing paragraphs discuss the alignment of mathematics teaching and learning to the constructivism theories.

2.3.5 Alignment of mathematics teaching and learning, Curriculum and Assessment Policy Statement and constructivism theories

The teaching and learning of mathematics is explained through the principles of effective teaching and several approaches to teaching and learning, as clarified in the subsequent paragraphs.

2.3.5.1 Principles of effective teaching

Anthony and Walshaw (2009) identify several fundamentals of efficient mathematics enhancement. These fundamentals must not be utilised separately, instead, they must be presented as a connected network of elements. In this way, there is a potential of achieving outstanding results for learning. These principles integrate fundamentals of classroom practices, communication and various tasks which ameliorate learners' reasoning and the significant part of teacher's expertise in the subject. However, only nine will be discussed which are relevant to this section. The ensuing paragraphs explain the principles highlighted above.

An Ethic of Care: Classroom community

Caring classroom environments that are concerned with improving mathematics goals assist in strengthening learners' mathematical skills. Competent teachers have to stimulate learners by engaging them and giving them challenging problems to solve which will provoke critical thinking skills (Anthony & Walshaw, 2009). This idea

is underpinned by the DBE (2011a) as a specific aim in mathematics, thus to develop assuredness together with proficiency to tackle any problems in mathematics with ease (DBE, 2011a).
The teacher must help learners develop optimism that will uplift their degree of comfort, engage their basic skills and give them higher capacitance to master, appreciate and comprehend mathematics (Anthony & Walshaw, 2009). This is demonstrated in the DBE (2011a) as a specific aim too, thus to develop a drive of keenness together with the liking of the subject. Once learners deepen the love and curiosity for the subject, it will be easy for teachers to arrange for learning opportunities as discussed in the successive paragraphs.

Preparation for learning

Efficient teachers give learners chances to digest ideas both individually and cooperatively (Anthony & Walshaw, 2009). In this way, they generate and share ideas on solving mathematical problems. This is affirmed by ‘co-operative learning’, a synthesis of Piagetian and Vygotskian insights (Donald *et al.*, 2014); where they mention that given perfect conditions, learners are capable of elevating each other’s cognitive development through working collaboratively on the clarification of complex procedures in mathematics.

Piaget (1953) proclaims that co-operative learning includes investigation and equilibration on each and every learner concerned. This procedure is then triggered by the cognitive conflict to modify that learners present to each other if they disagree. Vygotsky (1978) validates that the process certainly engages social interaction. Learners who comprehend a concept fully are then able to mediate others to advance their skills by linking them to their ZPD, consequently, building on each other’s thinking as indicated below.

Building on learners’ thinking

As they organise for teaching and learning, competent teachers take learners’ present ability and skills as a guideline for their plans in designing learning content and they make adjustments to their instructions to meet the learning requirements which suit their learners (Anthony & Walshaw, 2009). This principle is acknowledged by Piaget's (1953) unevenness of cognitive development of children, as stated in sub-section 2.2.1.3. Teachers must call to mind the unevenness of cognitive development and communicate individually with learners. In this way, ascertain their difficulties in mathematics communication and assist them duly as discussed below.

Mathematical communication

Anthony and Walshaw (2009) point out that teachers need to be well versed with mathematical communication(s). They should then impart the significant skill to the learners as it is a prerequisite for explaining mathematical problems orally. This calls for effective teachers who can fully explain to the learners so that they fully understand the concepts. This is stated in the DBE (2011a) as a specific skill, thus students should be able to perform investigations and represent collected data, then interpret it afterwards. This recommends that teachers need to equip learners with a good command of mathematical language as stipulated in the succeeding paragraph.

Mathematical language

This principle is advocated in the DBE (2011a) as a specific skill, thus to foster appropriate application of mathematical language use (DBE, 2011a). Appropriate mathematical language can be mastered by the learners if the teacher practices using correct terms in a way that learners understand (Anthony & Walshaw, 2009). Resultantly, learners' proficiency in mathematical language will assist them to tackle worthwhile mathematical tasks in everyday life situations.

Worthwhile mathematical tasks

Knowledgeable teachers are expected to be able to choose activities which assist learners to heighten their levels of understanding of concepts and resultantly find mathematics meaningful to them (Anthony & Walshaw, 2009). Furthermore, they mention that when solving authentic problems, learners come to realise that mathematics is not about calculations only, instead, it is applicable to everyday life situations and in various practices. This idea is reinforced by Killen (2015) who mentions that every subject must have significant knowledge which is in the form of a relationship that exists between its main ideas and knowledge from other subjects.

The above principle is validated in the DBE (2011a) as having the intent to develop crucial enlightenment of the manner in which mathematical relationships are utilised in various contexts (DBE, 2011a). This signals that teachers must expose learners to content areas, for example, data handling in projects, these will be applied later in different fields such as economics and other social environments.

Making connections

As claimed by Anthony and Walshaw (2009), well-versed teachers are those who assist learners to discover links between various methods of analysing concepts and topics in real-life situations. This enhances conceptual mastery, resultantly; learners begin to see mathematics as significant and fascinating.

This principle is justified in mathematics as one of the specified aims, thus to develop an enthusiasm and liking of the subject (DBE, 2011a). Furthermore, the idea is substantiated in the mathematics-specific skills so as to create consciousness of the significant part played by mathematics in authentic everyday circumstances as well as learners' self-growth (DBE, 2011).

Tools and presentations

Anthony and Walshaw (2009) attest that competent teachers employ effective means to ensure learners get adequate support from them. These come in numerous forms such as numerals, symbols, graphical presentations, several visual aids and stories. This is a skill stated in the DBE (2011a) thus, to foster necessary skills in mathematics which enable investigation, analysis, representation and interpretation of gathered knowledge on the part of learners. These tools can be used effectively together with teacher knowledge to achieve the desired results in teaching and learning.

Teacher knowledge

Proficient teachers employ effective measures to identify their learners' needs and address those needs. How teachers organise lessons effectively depends on their expertise and beliefs regarding mathematics teaching and learning. Therefore, they need excellent content knowledge to enable them to illustrate mathematics as a comprehensible and linked system (Anthony & Walshaw, 2009). Teacher knowledge must be accompanied by the application of teaching principles as explained below.

2.3.5.2 Teaching principles

Kune, Lombard and Moodley (2013) review some of the principles of teaching mathematics. These are the level, activity, interaction and guidance principles. Each of these principles is briefly discussed below.

The level principle

The level principle is based on the notion that for children to learn mathematics, they need to go through various extents of mastering concepts. This reinforced by the idea of the unevenness of cognitive development (cf.2.2.13). As teachers apply the level principle, they will then be in a position to identify the learners' strengths and weaknesses in grasping the concepts. In this manner, teachers can then be mediators to learners, leading them to improved levels of intellectual development in the subject. This is supported by the ZPD concept (Vygotsky, 1978); likewise, it is complemented by the activity principle which supports the idea that mathematics is a human activity as explained below.

The activity principle

The activity principle is rooted in the understanding that mathematics is a human activity. The implication is that learners must be actively engaged in the teaching and learning process (Kune *et al*., 2013). Whilst the teachers play a significant role as the facilitator, learners must be actively engaged (Donald *et al*., 2014). This principle is underpinned by one of the mathematics aims, thus, to build a realisation that mathematics is an innovative role of an individual act (DBE, 2011). Corroborating the idea is Piaget (1953) through the active engagement and exploration development characteristics, where the emphasis is made that children should be actively engaged in their cognitive development. The activity principle is interconnected to the interaction principle, which places emphasis on social learning.

The interaction principle

The interaction principle is grounded on the proposition of the role of social context, in this subject, the relationship between the teacher and the learners (Kune *et al.*, 2013). This is supported by the socio-constructivist theory of learning as a social activity (Vygotsky, 1978; Woolfolk, 2010). The notion is that where there is an opportunity for classroom discourse leading to questioning, effective learning takes place (Vygotsky, 1978). Moreover, the interaction guides the teacher to identify the learners' levels of understanding, hence come up with strategies to close the gaps where necessary (Kune *et al.*, 2013).

The DBE (2011a) confirms this principle through one of its specific aims, namely that learners should be good listeners, communicators, be thoughtful, have logical reasoning and be able to put into effect mastery obtained. Enhancing the idea is one of the mathematics specific aims - having the intent to develop crucial enlightenment of the manner in which mathematical relationships are utilised in various contexts (DBE, 2011a). Nevertheless, learners cannot reach these levels on their own; they need to be guided by the teachers as specified in the subsequent paragraph.

The guidance principle

The guidance principle suggests that the teacher has to guide learners in a manner which will enable the learners to understand the learning process. This can be attained if the teacher and the curriculum include opportunities which are capable of elevating learners' understanding (Kune *et al.*, 2013). This principle is connected to the concept of mediation and pedagogy as guided assistance (Vygotsky, 1953). This is whereby a teacher must guide a learner into more progressive methods of learning. This idea is confirmed through one of the mathematics specific aims - to build in-depth knowledge of mathematical concepts so as to have the meaning of the subject (DBE, 2011a). Thus, a broad understanding of mathematical concepts can be accomplished through the applicability of appropriate approaches to teaching mathematics.

2.3.5.3 Approaches to teaching primary level mathematics

Long and Dunne (2014) mention three approaches to guide teaching and learning in primary school. These approaches may be applied individually or jointly when formulating lessons and academic content. These are the topics approach, the process approach and the conceptual fields approach.

Topics approach

This is the approach followed by CAPS in the Grade 4 to 6 mathematics curriculum as having the intent to develop crucial enlightenment of the manner in which mathematical relationships are utilised in various contexts (DBE, 2011a). It provides a comprehensive curriculum, daily lesson plans and time allocations per topic and content to be covered. Evidently, Bowie, Gleeson-Baird, Jones, Morgan, Morrison and Small-bones (2012) present work schedules for covering content in *Platinum Mathematics Grade* 6, allocating time as per the CAPS document. Reinforcing the idea is Ladewig *et al.* (2012) who present a teaching plan in the *Oxford Mathematics Teacher's Guide* which follows time allocation as set out in the policy document. This is the implementation of the topics approach, as discussed by Long and Dunne (2012).

The topics approach has a notable benefit which, in particular, supports the composition of the intermediate phase mathematics curriculum and its operationalisation. This benefit is recognised in the manner in which topics are well organised according to the curriculum requirements. It becomes easier for teachers to deliver the curriculum in a prescribed order, hence improving proficiency in mathematics (Long & Dunne, 2014).

Another merit is that topics are already arranged according to their levels of complexity. This eliminates teaching more challenging topics before easier ones

(Long & Dunne, 2014). Markedly, mathematics at the intermediate phase prescribes that fractions must be taught in Grades 4 and 5 and only in Grade 6, when the fraction concept is assumed to be mastered, will the more complex decimal fraction concept be introduced. This is so because the decimal fraction is connected preceding mastery of fractions introduced in Grades 4 and 5. This is supported by Piaget (1971) who claims that the child's cognitive development pursues an organised pattern. In this case, cognitive development would have improved from the concrete to the operational phase. Additionally, anticipated benefits of the topics approach are based on the premise that teachers are well versed with the mathematical principles and have a clear view of the difficulties which might be faced by learners.

As noted by Piaget (1971), unevenness of cognitive development must be considered, the implication is that teachers must consider that learners have different cognitive levels of understanding concepts and use this when teaching concepts which might have been taught in the previous grades. Correspondingly, teachers need to call to mind that learners' skills development is a continuous process; it cannot be achieved immediately.

A process approach

As reported by Long and Dunne (2014) the process approach identifies and analyses problem-solving and higher-order thinking skills. The conceptual proponents of this approach are similar to the likes of Piaget and Inhelder (1969), who propose that thoughts and expertise are achieved by the application of activity. In the process approach, the focal point is more precisely on the learners and the advancement of their skills in problem-solving. Problem-solving, as a skill is also mentioned in the CAPS policy document (DBE, 2011a). 10% of the required cognitive level of a learner is allocated to problem-solving and 20% to complex procedures. These skills must be demonstrated through the process approach. This agrees with one of the mathematics aims - to build in-depth knowledge of mathematical concepts so as to have the meaning of the subject (DBE, 2011a).

Reinforcing the ideas of the theoretical proponents of this approach is the perspective that learners are intelligent individuals who engage with the world they encounter. This requires teachers who give learners an opportunity to find solutions to challenges outside of the classroom (Long & Dunne, 2014). The understanding of a new subject practiced outdoors serves the purpose of knowledge construction and transformation, as opposed to simple obtainment (Renkl, 2009). This is in agreement with Piaget's (1953) constructivist view, whereby knowledge must not just be accepted as specified but be constantly improved within societies.

Long and Dunne (2014) indicate that the usefulness of the process approach is that it gives a guideline of developing lessons which match the concepts to be taught. Consequently, learners have opportunities to partake with problems which are relevant to the context; this will actuate their curiosity and lead to new findings. This is reinforced with one of the mathematics specific aims - the mathematics curriculum seeks to foster a spirit of curiosity and love for mathematics (DBE, 2011). This calls for the teachers' cognisance of the precise skills essential in mathematics and their ability to promote those skills to ensure that crucial learning is in the ZPD of the learner (Vygotsky, 1978).

However, a teacher has to be cautious when selecting a concept to be presented, thus, content must not arise out of the learners' general ZDP or not be conceptualised for purposes of learning. This necessitates the teachers to be acquainted with levels of mathematical proficiency of their learners (Long & Dunne, 2014). The problem associated with this may be that certain basic principles of mathematics, for instance operations, may be lacking adequate proficiency in the solution of certain problems. Despite the fact that skills may be built connectedly, Piaget (1964) suggests that the teacher must be mindful of the cognitive development stages and the characteristics per stage. This will bring an awareness of the critical concepts to be taught per every stage of development, bearing in mind unevenness of cognitive development.

The process approach, just as the topics approach, demands an improved mastery of mathematics, especially with the theoretical precursors and the mathematical concepts that come afterwards. Furthermore, an unambiguous recognition of the relationships which exist between the distinguishable elements of the subject is vital. Notably, with the intermediate phase curriculum, problem-solving skills must synthesise the concepts between all mathematics basic operations up to probability as a concept (Long & Dunne, 2014). This entails that as the content is taught, it must integrate the problem-solving requirements which will be applicable in the conceptual approach.

A conceptual fields approach

The approach builds its concepts particularly from the ideas of Vergnaud (2009), whereupon the complicated nature of mathematics knowledge and the manner in which it is acquired, gradually by learners postulate a complex conceptual framework. The gradual acquisition of knowledge is noted in the cognitive development process where the emphasis is placed that the unevenness of cognitive development as an educational implication must be observed by teachers (Piaget, 1953). A conceptual fields approach merges agreeably with mathematics knowledge and mainly with problem-solving skills (Vergnaud, 2009). Moreover, the acquirement of specific knowledge and skills is mentioned in the (DBE, 2011a).

Contrastingly, all concepts in mathematics are deep-seated in problematic situations, as stated by Vergnaud (2009). Consequently, one concept may be applicable to numerous problematic situations. Concurrently, a single problem can involve several unique concepts for it to be solved. Apparently, a conceptual fields approach may pose a teacher who lacks proficiency in mathematics teaching and learning (Long & Dunne, 2014). This may affect learners' performance as they are assessed.

2.4 ASSESSMENT OF LEARNERS IN MATHEMATICS

Assessment in mathematics does not pertain to the learners' scores in tests. Rather, it includes a complete version of the learners' comprehension, skills and attitudes about mathematics. It conveys to the learners what is believed to be important to them and what they must be able to do (Cathcart, Pothier, Vance & Bezuk, 2011). The subsequent paragraphs explain the concept of assessment.

2.4.1 Assessment

Ladewig *et al.* (2012) mention that assessment is about collecting evidence of the students' learning. Moreover, it is essential to teaching and learning, hence it ought to include lesson planning content. Likewise, assessment is a tool teachers use to gather information about how much learners have learnt (Mays, Grosser & de Jagger, 2012).

William (2011) argues that assessment can be used as a yardstick to measure if certain teaching and learning procedures have achieved the expected objectives and goals. Similarly, it is the procedure of gathering factual statistics so as to adopt resolutions on the adjustments in learning, teaching, curriculum delivery and relevant educational policies (Brookhart &Nitko, 2011).

Taras (2009) states that the utilisation of assessment in the improvement of learning was initially found in the United Kingdom around the 1980s. Ever since, the growth in the utilisation of formal assessments increased universally in education departments to enhance students' learning and to improve lesson delivery in classrooms (Baird, 2009). The South African Department of Basic Education is no exception.

As stated, one of the key imperatives of CAPS is to implement a valuable and functional assessment program which will give pertinent information to all role-players so as to enhance teaching and learning procedures (DBE, 2011a). Additionally, the enhancement of a national assessment system which will meet the needs of policymakers and teachers was given urgent attention (DBE, 2011a). Thereupon, the nature of formal assessment in intermediate phase mathematics teaching and learning was executed, as discussed below.

2.4.2 The nature of formal assessments in intermediate phase mathematics in South African schools

Formal assessment consists of SBA and end of the year examinations (DBE, 2011a). It is the duty of the concerned teachers to monitor and control the assessment tasks and record them for promotional purposes thereafter. Before being administered to the learners, all formal assessment tasks must be moderated to ensure control of quality and retention of proper measures. The SBA element may come in different formats. Regarding mathematics, assignments, projects, investigations, tests and examinations are suitable as outlined in Table 2.3 below.

Table 2.3: Minimum requirements for formal assessment in the Intermediate Phase

	Form of Assessments	**Term 1**	**Term 2**	**Term 3**	**Term 4**	**Number of tasks per year**	**Weighting**
Continuous, SBA	Tests	1	1	1		**3**	
	Examinations		1			**1**	
	Assignments	1			1	**2**	
	Investigation				1	**1**	75%
	Project			1		**1**	
	Total	**2**	**2**	**2**	**2**	**8**	
End of the year Examination						1	25%

(DBE, 2011a:294)

As indicated in Table 2.3, formal assessments, in the form of SBA have a significant role in learners passing their grades in mathematics. Formal assessments count 75% towards the final grade mark. The forms of assessment are tests and examinations, assignments, projects and investigation. These forms of assessment, according to requirements, are explained below

2.4.2.1 Tests and examinations

Tests and examinations are written individually by the learners. These tasks must be accurately set to enable a clear indication of content mastery in mathematics by the learners (DBE, 2011a). This necessitates taking into account learners' different cognitive levels when setting questions. Cathcart *et al*. (2011) indicate that when evaluating the learners' progress, tests are the initial tools of measurement to be utilised. Additionally, the main point is not merely to get a mark to record, but to discover what learners have learned and on what concepts they need more practice.

Similarly, Borich (2014) mentions that tests precisely measure the skills which are expected to be acquired by the learners. Moreover, authentic tests must ask learners questions which will enable them to display their skills in real-life situations. This implies that mathematics teachers must ensure that their methods of instruction in the classrooms will, in turn, enable learners to display what was taught in the real world. Borich (2014) further suggests The Test Blueprint (TTB) which must complement test objectives and guarantee that teachers include all the information crucial to a good test. TTB ensures that the test will cater for different cognitive levels of learners. The table below illustrates the blueprint for mathematics.

Table 2.4: Test blueprint for a unit on subtraction without borrowing

Content Outline	Knowledge	Comprehension	Application	Total	Per cent
1. The student will discriminate the subtraction sign from the addition sign.	1			**1**	**4%**
2. The student will discriminate addition problems.	2			**2**	**8%**
3. The student will discriminate correctly solved subtraction problems from incorrectly solved subtraction problems.		4		**4**	**16%**
4. The student will solve correctly single-digit subtraction problems.			6	**6**	**24%**
5. The student will solve correctly subtraction problems with double-digit numerators and single-digit denominators.			6	**6**	**24%**
6. The student will solve correctly double-digit subtraction problems.			6	**6**	**24%**
Total	**3**	**4**	**18**	**25**	
Percent	**12%**	**16%**	**72%**		**100%**

(Borich, 2014: 382).

Information in Table 2.4 implies that teachers must ensure that the six cognitive levels of Bloom's taxonomy are applied when setting tests and examinations. The next paragraph explains the assignment as a form of assessment.

2.4.2.2 Assignment

An assignment is given to the learners as an individual task. This may be obtained from past examination papers, however, it must centre on challenging content as there are a variety of resources to refer to. It can be done at home, not under class supervision (DBE, 2011a). Borich (2014) suggests that assignments must be given immediately after the lessons or activities to which they relate. Furthermore, teachers must display the assignment in the classrooms so that learners who have missed information can always refer to the displays. The following paragraph explains the use of projects as another form of assessment.

2.4.2.3 Projects

A project is an activity which extends learning beyond the classroom and positions it in the real world (Coombs, 1995). Moreover, they are employed to evaluate a variety of abilities and capabilities. Projects should enable learners to implement their mathematical concepts in practical situations. Through projects, learners are expected to gather data, analyse it thereafter and draw conclusions (DBE, 2011a:294).

Gawe, Jacobs and Vakalisa (2016) concede that the project method is learner-centred learning and highly based on the constructivist principle. This, in turn, gives learners an opportunity to work on their own in collecting relevant information required for the project and be able to present it thereafter. Furthermore, the project method assesses a variety of skills and at the same time integrating various activities, like planning, research data analysis and reporting. This is essential when intermediate phase mathematics learners have data handling as a topic. Moreover, Mays *et al*. (2016) acknowledge that a project widens the kinds of skills needed by learners as they are assessed. Additionally, Borich (2014) confirms that project-

based learning conveys to learners the significance of the learning process, aids them to set goals and affords them opportunities to work co-operatively.
This implies that teachers must ensure that skills like research and presentations are taught effectively before handing out projects for assessments. The upcoming paragraph explains the investigation as a formal task.

2.4.2.4 Investigation

An investigation is a formal task which can be employed to determine rules or concepts. It can include connections of patterns, arriving at conclusions and identification of patterns (DBE, 2011a). Investigations are well explained through the investigation model. An investigative model is an excellent form of assessment in mathematics. It exposes learners to construct mathematical knowledge when given opportunities to examine and analyse with ideas, procedures or data, hence building mathematical knowledge. It concentrates on giving learners the chance to experiment and also inquire (Cathcart *et al.*, 2012).

It is indicated by the DBE (2011a) that as a measure to minimise copied work, after doing the initial investigation at home, it is recommended that the ultimate report has to be supervised by the teacher in a classroom condition without any assistance. Rubrics with specific marks to be given per skill are used to assess investigations. The skills come in various forms such as organising and recording, communicating ideas, calculations and generalising and drawing a conclusion (DBE, 2011a).

Teachers must take note that all tasks must be catered to all the cognitive levels of learners. The forms of assessment used should take the suitability of learners' ages into considerations. Tasks should be designed in a manner that allows the subject content to be achieved and all the aims and objectives to be attainable. Moreover, suitable marking tools, for instance, rubrics and memoranda, must be utilised (DBE, 2011a).

Nieuwoudt and Reyneke (2016) mention a rubric as a valuable tool in assessing learners' responses. They assert that this is so because of the main elements that a rubric contains. Two of the three main elements are outlined below.

2.4.2.5 Evaluative criteria

Evaluative criteria are used to distinguish between acceptable and unacceptable responses. The criteria will differ according to the skills being tested. This suggests that teachers must assist learners in developing skills through teaching and learning (Nieuwoudt &Reyneke, 2016).

2.4.2.6 Quality definitions

Quality definitions are level descriptors which are used to specify the number of points to be earned per specific skill. Complementing the use of rubrics is the work of Elrod and Strayer (2015), which reveals that a rubric is an essential tool for teachers to monitor the learners' work. Furthermore, it can be used as a mechanism to indicate cultural behaviours and practices in the classroom, hence being an essential part of teachers' assessment practices for learners. This is so because working with rubrics helps teachers and learners understand competencies required and can be used to provide feedback. Formal assessment tasks must cater to different levels of cognitive development as seen in Table 2.5 below.

Table 2.5a: A range of cognitive levels to be catered for intermediate phase mathematics teaching and learning

Cognitive levels	Description of skill to be demonstrated	Examples
Knowledge (=25%)	• Straight recall • Estimation and rounding off • Identification and correct use of formula • Use of mathematical facts • Appropriate use of mathematical vocabulary.	1. Write down the next three numbers in the sequence: 107; 109; 111… **[Grade 4]** 2. Determine the factors of 44 **[Grade 5]** 3. Write down the prime numbers that are factors of 36 **[Grade 6].**
Routine procedures (=45%)	• Perform well-known procedures • Simple applications and calculations • Derivations from given information • Identification and use of correct formula	1.Determine the value of y+5=15 **[Grade 4]** 2.Use three different techniques of calculating 59910 [**Grade 5]** 3. Calculate 12/4+3/12-1/3. **[Grade 6]**
Complex procedures (=20%)	• Complex calculations and higher-order reasoning • Investigations to describe rules and relationships • Problems not based in real-world contexts • Conceptual understanding	1. Mandy is 6 years old and Betty is 12 years old. Determine the ratio between their ages. Write the ratio in simplest form. **[Grade 4]** 2. Investigate the properties of rectangles and squares and identify similarities and differences. **[Grade 5]** 3. There are 20 sweets in the packet. William and his friends ate 2 fifths of the sweets. How many sweets are left? **[Grade 6]**

Table 2.5b: A range of cognitive levels to be catered for in intermediate phase mathematics teaching and learning

Cognitive levels	Description of skill to be demonstrated	Examples
Problem-solving (=10%)	• Unseen non-routine problems • Higher-order processing and understanding required • May require breaking down into constituent parts to solve	1. The sum of three consecutive numbers is 29. Find the numbers. **[Grade 4]** 2. John divides a certain number by 16. He found an answer of 246. What is the number? **[Grade 5]** • 3. Busi has a bag containing six coloured balls: 1 blue, 2 red balls and 3 yellow balls. She puts her hand in the bag and draws a ball. What is the chance that she will draw a red ball? Write the answer in the simplest fractional form **[Grade 6]**

(DBE, 2011a: 296).

Intermediate mathematics teachers should adhere to this continuum of cognitive levels when setting tests and examinations so that the unevenness of cognitive development of learners is addressed. This implies that there must be accurate moderation of assessments to guarantee that different cognitive levels of learners are catered for. The ensuing paragraph discusses the moderation of assessments.

2.4.3 Moderation of assessment

Moderation of assessments is the measure of ensuring fairness, validity and reliability of assessment tasks (DBE, 2011a). Moderation of assessment smust be done at school level and by the district, at the provincial level up to the national levels. The SBA contributes 75% towards a learner's end of year pass mark, for this reason, the moderation process has to be authentic to make certain that:

- valid and reliable assessment tasks are utilised so that learners are not disadvantaged; and
- advanced but attainable standards are sustained by giving quality assessments (DBE, 2011a).

Moderation is associated with the notion of guarantying quality and equitableness in assessment (Reddy, Grange, Beets & Lundie, 2015). This suggests that teachers must meet the principles of assessment. This is also underpinned by Nieuwoudt and Reyneke (2016) who mention that teachers must ensure that the principles of high-quality assessment should be met. Thereupon, learners' progress can be monitored through recording and reporting as explained in the next paragraphs.

2.4.4 Recording and reporting of formal assessment

The following paragraphs highlight the importance of recording and reporting of formal assessment.

2.4.4.1 Recording

The recording shows the learner's level of performance in a certain task as it appears on the teachers' file. It reveals the learner's progression concerning acquirement of the expected grasp of the set concept(s). Through recording, there must be indications of the learner's progress in the mastery of concepts in the current grade and the ability to progress to the upcoming grade. For good measure, enhancement made by teachers and learners can be proven through records kept. This will ensure the validity of the reporting part (DBE, 2011a).

Complementing the idea are Mays *et al.* (2016), who remarked that teachers must retain records to keep track of learners' progress with the purpose of improving classroom teaching. They recommend the use of checklists and rating scales as ways of recording assessment. A checklist will serve the purpose of confirming that all the significant concepts are covered. At the same time, the rating scale will aid the teacher to record the level of notion gained while observing learners.

2.4.4.2 Reporting

Reporting puts emphasis on marks compiled from tests written during the term or at the end of the year (Reddy *et al.,* 2015). Reporting is a result of sound assessment. Moreover, it should be fair and reliable, relevant, meaningful, accurate and balanced (Killen, 2015). That being so, a compilation of the learner’s report is vitally important and should be done on a quarterly term basis (DBE, 2011a). It ensures that whatever substandard performance is immediately conveyed and proper procedures of intervention are promptly put into effect. Additionally, Wyatt-Smith, Klenowski and Colbert (2014) concede that teachers must be acquainted on how to utilise evidence based on an assessment to determine which methods to change in teaching and learning. This will ensure that there is the proper alignment of assessment in the teaching of mathematics as discussed in the ensuing paragraphs.

2.4.5 Alignment of assessment in mathematics teaching and learning and how it relates to the CAPS document and the theories underpinning the research

Alignment of assessment in mathematics teaching and learning can be achieved through developing high-quality assessment; co-operative learning; providing feedback that moves learners and knowledge and skills that teachers require.

2.4.5.1 The principles of high-quality assessment

Nieuwoudt and Reyneke (2016) mention the eleven principles of high-quality assessment which teachers must follow; these are tabulated in Table 26 below.

Table 2.6: Principles of high-quality assessment

Principle	Explanation
1. Fair	Learners should be allocated adequate time to work on the assessment task. Issues like age, gender and socio-economic status must also be taken into consideration when giving out assessments
2. Valid	It must be aligned with the aims and objectives to be achieved and the questions asked are relevant to the content.
3. Reliable	Teachers must avoid judging learner's performance incorrectly. This can be attained using well-constructed memoranda and rubrics.
4. Meaningful	It should be aligned with the content covered.
5. Challenging yet achievable	Assessment must draw a distinction between learners who have been taught and those who are yet to be taught.
6. Balanced	It must vary, cater to different forms like projects, tests and not concentrate on one for.
7. Formative	Inform learners on how they are performing and how they can improve.
8. Timely	It cannot be given when the learning program ends, learners need to be given time to practice in the form of informal activities to prepare them for the final formal assessment.
9. Efficient and manageable	It must not be a burden to the teachers in terms of workload. There must be one file kept for assessments and moderations.
10. Authentic	The aim must be to assess and enhance the knowledge and skills that need to be accomplished.
11. Clarity	The guidelines of assessment must be clarified to the learners; it must not come as a surprise.

In consonance with the above assessment principles are the ideas of Mays *et al.* (2012), who suggest that teachers must question themselves as to whether the assessment being implemented can achieve the following purposes:

- Does the assessment help teachers understand the difficulties learners face as they engage in assessments and what strategies can be implemented to improve the learners' level of understanding?
- Are the learners gaining any awareness of their mistakes as they engage with assessments?
- Does the assessment furnish teachers with reliable information to come up with proper evaluations and come up with strategies thereafter?
- What other strategies can be implemented to improve the current assessment practices?

Notably, the questions agree with the highlighted principles. The first question strengthens meaningfulness as an assessment quality. This implies that teachers must ensure that they assess relevant concepts which have been covered for that particular topic. The second question reinforces the principle of assessment. This implies that teachers must provide feedback to the learners and how they can improve if their performance is inadequate. The third question consolidates the principle of reliability. This serves as an emphasis to the teachers that assessment should enable them to have the correct judgment of the quality of learners they have, hence paving way for correct strategies of improvement. The last question enhances the principle of formative and feedback, calling for teachers to implement improved assessment strategies. The subsequent paragraph explains how to activate learners to be each other's learning resources

2.4.5.2 Activating learners to be each other's learning resources (cooperative learning)

Cooperative learning is a set of instructional strategies whereby learners work in mixed ability groups to reach specific cognitive and social development objectives (Eggen & Kauchak, 2016). Additionally, co-operative learning provides learners with an opportunity of working together and make certain that every member of the group has a chance to participate. Moreover, it encourages learners to act as learning resources for one another (Gawe *et al.*, 2016). This is supported by active engagement as discussed by Donald *et al*. (2014). Vygotsky (1971) also underpins this idea through the role of social interaction.

In mathematics teaching and learning, learners can work together on projects, for example in data handling projects, during the collecting, organising, representing, analysing, interpreting and reporting of data. They can also work together regarding space and shape, to construct 3-D shapes.

Outcomes of cooperative learning

Borich (2016) discusses some of the outcomes of co-operative learning. These are illustrated in the figure 2.1 below and are individually explained in the subsequent paragraphs.

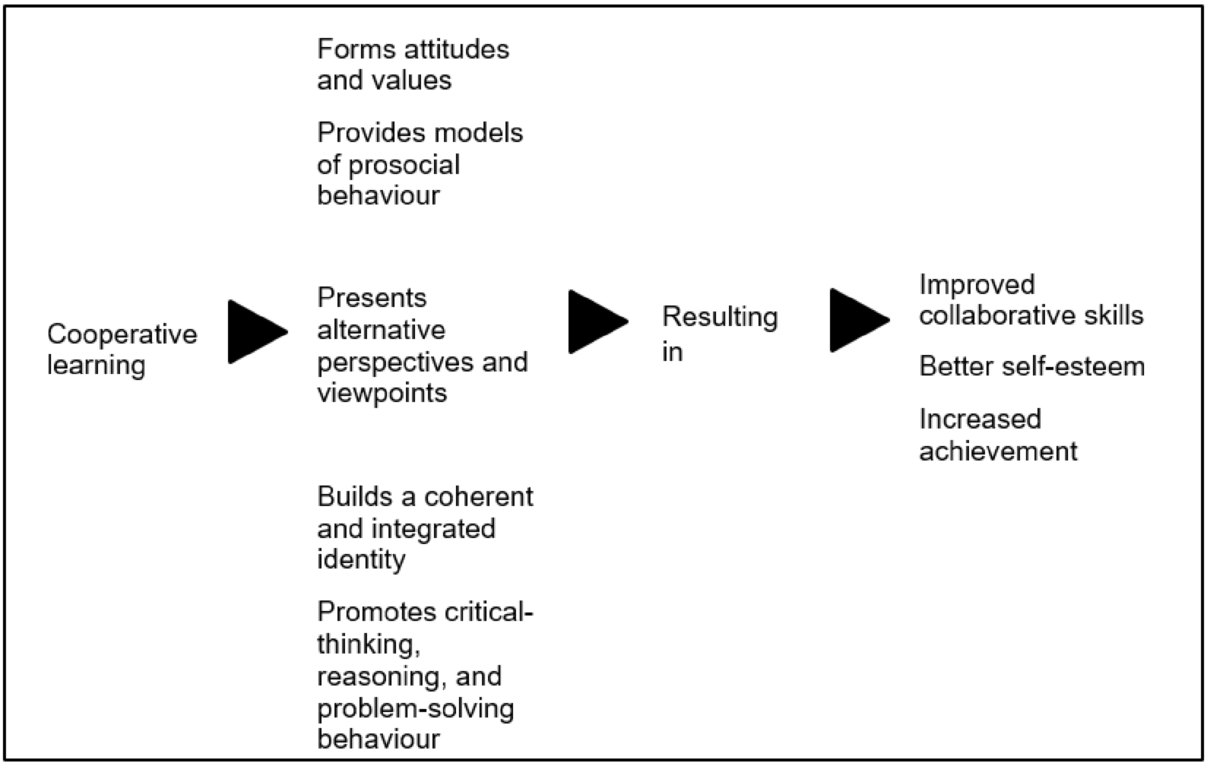


Figure 2.1: Outcomes of Co-operative learning (Borich, 2014:356).

Attitudes and values

People's values and attitudes are modelled by interacting with society through the exchange of information. Learners can achieve this by working in groups or in pairs, sharing ideas and exchanging information. It plays a crucial role in shaping their values and attitudes, which they, in turn, need to deepen their independent thought (Borich, 2014). This idea is endorsed by Vygotsky (1978) who mentions the significance of social interaction in cognitive development.

Prosocial behaviour

Borich (2014) mentions that classrooms are now a significant medium for reinforcing prosocial behaviours due to the high volume of working parents or guardians. Therefore, teachers must plan for and implement co-operative learning programmes so as to bring learners together. This implies that teachers must come up with tasks and activities which will promote working together on the part of learners (Borich, 2014). Similarly, teachers have to create learning experiences which give learners opportunities for working cooperatively in interesting, challenging and open-ended tasks such as projects and investigations (Killen, 2015).

Alternative perspectives and viewpoints

Cooperative learning furnishes the context where several views and ideas can be exchanged (Borich, 2014). This is closely linked to participative learning whereby learners are motivated to state their views on the subject matter. It rests on the premise that learning takes place when negative criticism does not exist in class (Vakalisa, 2016). This is applicable when learners work together in projects and assignments which develop critical thinking skills.

Higher thought processes

Furthermore, cooperative learning is associated with the outstanding academic achievement of learners. It improves learners' critical-thinking and problem-solving skills. Withal, the higher thought process cannot occur without an amalgamation of attitudes and values, prosocial behaviour, viewpoints and integrated identity. This implies that teachers must come up with tasks and activities which will stimulate learners' higher thought processes (Borich, 2014). These skills may include, for example, mental mathematics activities. In the same way, Arends (2011) recommends that teachers have to design learning activities which require more than simple routine procedures. Higher-order thinking has to be stimulated by complex thinking tasks. This implies that teachers have to engage learners in, for example, research and problem-solving skills which encourage high-order thinking.

Acclaiming the idea of the aforementioned outcomes are the ideas of Gawe *et al.* (2016), who accentuate the benefits of co-operative learning. They mention learner achievement and social consequences as some of the noticeable benefits. These are discretely expounded in the upcoming paragraphs.

Learner achievement

Gawe *et al. (*2016) acknowledge that outstanding achievement has been reported in the classroom where co-operative learning takes place. Furthermore, higher-order concepts can be taught effectively through co-operative learning. As stated by Gawe *et al.* (2016:267) “The expression that ‘two heads are better than one’ suggests the superiority of ideas that emerge when more than one person is engaged in a project…some of the complex tasks that learners are given to investigate”. Additionally, Van Dat (2013) points out that cooperative learning results in substantially improved academic achievement and higher-order thinking skills of learners. Pursuing this further, Hsiung (2013) suggests that cooperative learning gives rise to significantly more learning than individual learning, coupled with an in-depth understanding of the content. This entails that teachers must ensure that learners have opportunities to work co-operatively to prove their thinking skills, leading to learner achievement.

Social consequences

Furthermore, co-operative learning prompts the growth of improved self-esteem of learners. This is due in main part because they know their opinions are valuable in their respective groups. Moreover, learners who take part in co-operative learning get along well with each other and they like school much better than their counterparts, resultantly, they tend to have more social skills (Pawattana, 2014). Additionally, co-operative learning can contribute to integrating learners into networks of social peer relationships which in turn assist them with constructive conflict resolution, leading to academic performance (Johnson, Johnson & Roseth, 2010). Teachers have to ensure that every learner has a chance to participate in a group (Gawe *et al.*, 2016). This, in turn, makes it easier for teachers to provide feedback to learners on the learners’ performance.

2.4.5.3 Providing feedback that moves learners

McMillan (2011) maintains that each and every learner accomplishment ought to be measured compared to the learning objectives. Moreover, the main goal of each respective assessment must be to determine learning gulfs amongst learners. Correspondingly, these results must be utilised by teachers as a reflection on teachers’ teaching approaches. Immediately after a teacher is conscious of a gulf in the learner’s performance, the subsequent move will facilitate the closure of the gap, thus to attain the intended performance level. Sustaining this idea is Vygotsyk's (1971) work, through mediation and the ZPD where cognitive mediation will take place.

Mays *et al.* (2012) broaden the ZDP idea through advocating the idea of scaffolding which refers to the support and guidance to help a learner master a difficult task. This must concur with profound knowledge and skills which a teacher must possess.

Similarly, assessment incorporates the use of different high standard tasks that are in line with attainment objectives; interpreting learner performance in consideration of the specific assessment; administering and recording assessments and correctly reporting results to concerned stakeholders Gotch & French (2014). The following paragraphs highlight the challenges in mathematics teaching, learning and assessment.

2.5 CHALLENGES IN MATHEMATICS TEACHING, LEARNING AND ASSESSMENT

Despite the significant role meant to be played by effective implementation of formative assessment in classrooms, the literature indicates various challenges faced by teachers in this aspect. Assessing learners has many facets. Additionally, the procedure of making sense of learner's mathematical reasoning and explanation of approaches is more convoluted than can be assumed and poses challenges to teaching and learning (Suurtamm, Thompson, Kim, Moreno, Sayac, Schukajlow, Silver, Ufer, & Vos, 2016). Evidentially, ongoing assessment methods and/or procedures for tackling learners' needs have been observed to be insufficient in South African schools (Vandeyer & Killen, 2009). Mercer, Mercer and Pullen (2011) endorse that whilst there is an improvement in the level of research in the area of mathematics teaching and learning, there is still a lot to be studied. These challenges are outlined below and are individually discussed.

2.5.1 Teachers' view formal assessments as an administrative burden

Time-related issues in relation to teacher workload was a theme highly raised by most teachers. They were worried that preparation of learners' portfolios for assessments, for example, was time-consuming and confirmed that all assessment tasks take up a lot of time intended for teaching and learning (Chisholm, Hoadley, Prinsloo, Mosia & Rule, 2009)

Complementing the idea of workload mentioned above are the research findings of Mutendwahothe (2013) on challenges besetting teachers in classroom assessments. One of the participants in the research responded as follows:

> *As teachers we tend to focus much on paperwork than actually teaching learners. There is a lot of administrative workloads concerning departmental and policies on assessment, projects, tasks; recording performance; reporting to parents and end of year common tasks of assessment, assessment period really increases my workload*
>
> (Mutendwahothe, 2013:215).

Perry (2013) reports that in many cases, regularly noted in the literature on Sub-Saharan Africa, large class sizes cause teachers to see assessments as an extra administrative burden. Providing individualised attention is difficult in a large class and making or grading each learner several times per term is time-consuming. Kapambwe (2010) underpins the idea of assessments adding to workload when highlighting that large class sizes and staffing ratios are posing a challenge to teachers' assessment strategies as teachers are finding it difficult to handle the workload.

Wyk and Wolhuter (2016) also note that it takes time to compile a quality portfolio for learners. Hardcopies for projects can be cumbersome to handle, with large amounts of information needed as evidence in a portfolio. Over time, attention and quality feedback to individual learners becomes a challenge too. This clearly states that assessments have an enormous workload and are time-consuming. The subsequent paragraph highlights the lack of knowledge of formal assessments as a challenge on the part of teachers.

2.5.2 Lack of knowledge of formal assessments

Research findings on formal assessment reveal formal assessment is ineffective in several classrooms owing to teachers' lack of sufficient knowledge and skills to execute them (Brown, Kennedy, Fok & Chan, 2009). Similarly, reference is made that teachers lack mathematical knowledge because they were not trained in this area. Furthermore, most of the teachers did not have a clear idea of what exactly formal assessment was and the process of implementing it in the classrooms. The literature reveals that teachers' insufficient expertise in the implementation of assessment impedes classroom practice considering that the effectiveness of assessment relies on teachers' competencies in developing efficient methods to reinforce it (Brown *et al*., 2009).

Putnam (2015) affirms that inadequate mathematical content knowledge might hinder teachers' capabilities to recognise and examine learners' mathematical reasoning. Additionally, Kanjee (2015) indicates that a larger number of teachers do not know how to efficiently utilise assessment for tackling the learners' learning need, this is ascribed to their inadequate proficiency in this subject. Specifically, this is related to teachers' poor content and pedagogical knowledge which is discussed in the successive paragraph.

2.5.3 Teachers' inadequate content and pedagogical knowledge

Brookhart *et al.* (2010) ratify teachers' poor content and pedagogical knowledge as a challenge which has a negative impact on formal assessment implementation, whereas teachers who have good content knowledge can communicate clear learning objectives. Ruiz-Primo (2011) emphasises that teachers must possess abundant instructional knowledge for formal assessment.

Kuze and Shumba (2011) point out that some teachers in South Africa lack proper qualifications and experience in the subjects they are teaching hence they are not competent and fail to implement assessments effectively. Similarly, Rowland and Ruthven (2011) mention that teachers in South Africa and many other developing countries face major impediments with regard to their lack of content knowledge in mathematics and the adequate skills of content application as they teach. Furthermore, SACMEQ III (2012) research reveals that a considerable number of mathematics teachers in South Africa have minimal understanding of curriculum delivery on the subject (Stols, Ferreira, Pelser, Olivier, van der Merwe, De Villiers & Venter, 2015). Additionally, Taylor and Taylor (2013) found that some teachers' subject knowledge was insufficient to provide their learners with an adequate understanding of the subject discipline.

It has been discovered that most South African learners perform terribly in mathematics. This poor performance is due to teachers' poor knowledge of mathematics (Pournara, Hogen, Alder & Pillay, 2015). Similarly, Paulsen and Dednam (2016) reference that most teachers in the intermediate phase did not specialise in mathematics teaching and learning, they are instead trained to be competent in different subjects offered in the intermediate phase; hence they lack the knowledge of mathematics as a subject. Likewise, Suurtamm *et al.* (2016) claim that teachers encounter didactic challenges as they execute assessments. These difficulties can be encountered as teachers try to design tools such as rubrics or checklists.

Reys *et al.* (2012) assert that teachers are found with a duty of teaching new mathematical concepts in a different method from how they were taught when qualifying. Noticeably of late, learning is now centred on active participation by the learners, instead of the passive learning process. Resultantly, this shift in turn, poses a challenge to their teaching effectiveness and calls for ongoing professional development, which is lacking as discussed in the ensuing paragraph.

2.5.4 Lack of ongoing professional development

Professional development must be continuously done throughout the entire professional period of the teacher. The development should address areas of teachers' pedagogical challenges. Meaningful teachers' professional development must be derived from connections that are present between the skill and knowledge of the teacher and the learner (Du Plessis, 2014). Likewise, Van Damme (2014) argues that the development of programs and practices for teacher professional growth are meant to enrich teacher practices and developing and validating new assessments or validating existing ones, hence improving student learning and achievement.

Kapambwe (2010) mentions that there is a lack of teacher networking; there is no sharing of ideas in teaching and learning. Kuze and Shumba (2011) confirm that teachers do not receive adequate training in the implementation of formative assessments; hence they are highly challenged in this aspect. Closely related to inadequate training is lack of support for the concerned teachers. Kanjee (2015) attests that the nature of support offered by the subject advisors in the challenges of formal assessment implementation is inadequate. This inadequacy is further worsened by the difficulties in understanding assessment policies on the part of teachers, as indicated in the next sub-section.

2.5.5 Difficulties in understanding assessment policies

The assessment policies came up with complete rules and procedures that became a challenge for teachers to tackle. Vandeyer and Killen (2009) mention that intermediate phase mathematics teachers are still following the teacher-centred methods to implement assessments which do not tally with the DBE (2011a). The authors recommend further training of teachers in the current pedagogy since they lack understanding in this aspect. Despite the fact that the policy illustrates the procedures to be followed, many South African mathematics teachers still find it challenging to follow and adapt to the new assessments system (Vandeyer & Killen, 2009).

Augmenting the idea are the research findings of Mutendwahothe (2013), who indicates that teachers did not understand the National Protocol on Assessments very well. Kanjee (2013) mentions that most of the teachers confirm that the policy document is confusing and complex. Likewise, Kanjee and Sayed (2013) note that there is no additional information provided in the CAPS document explaining precisely the knowledge and skills needed in the enhancement of formal assessment or how these should be implemented in the classroom. Additionally, although there have been amendments in the policies, strategies and different methods of intervention, most of the learners are still underperforming in mathematics in South African schools (Motala, Morrow & Sayed, 2014). This is also by virtue of limited English proficiency which hinders learners from understanding instructions for assessment.

2.5.6 English language as a medium of learning and teaching

Haliday (2010) claims that fairness in assessment is based on the learner's proficiency in language, in this case, the English language as a medium of instruction. Moreover, learners are challenged in the oral, comprehension and writing areas - since mathematics has its own terminology. Limited English proficiency poses a challenge for the learners to fully interpret given tasks. Resultantly, mathematics teachers face the challenge of achieving the twin objectives of teaching mathematics and English simultaneously (Botes & Mji, 2010). Similarly, Sepeng (2014) notes that the factors that influence learners' attainments in mathematics, especially in complex procedures and word problems, include language accuracy and word structure. Both factors call for English proficiency. This is confirmed by the DBE (2011b) report on the Annual National Assessments (ANA) results where the Grade 6 learners' competency in word problems was only 9%, indicating it was the most difficult skill to pass.

Spaull (2013) attests that poor mathematics performance is due to learners' inability to read, write and compute. Similarly, Machaba and Mokhele (2013) also reference language as a major reason for poor performance in mathematics. Furthermore, Webb and Webb (2013) point out that in bilingual and multilingual South African classrooms, learners are not capable of communicating their ideas in English. The ensuing paragraphs discuss accommodating challenges in mathematics teaching and learning.

2.6 ACCOMMODATING CHALLENGES IN MATHEMATICS TEACHING, LEARNING AND ASSESSMENT

Accommodation can be explained as a change in regular test conditions, layout, presentations durations and even the questions technique, without, however, defying the whole purpose of the assignment to support challenged learners (Dettemer, Knackendoffel & Thurston, 2013). Underpinning the idea of support is DBE (2010). It explains instructions and principles embedded in inclusive learning programmes which emphasise that learners require learning support or interventions. Furthermore, the inclusion policy states that its practice is focused on providing support to all learners, teachers and the whole system in general so as to cater for all critical learning needs. Bouwer (2016) suggests that if teachers adequately support their learners, the accomplishment of learning goals can be evident in their classrooms.

Teachers need to withdraw from the achievement-oriented view of assessment to the learning-in-process (formal assessment) view, especially when dealing with a learner who seems to be experiencing a challenge of some kind in respect of learning (Bouwer, 2016). Similarly, Gilies (2014) supports the idea of learning-in-process as it focuses on learners' coping up level as they learn a complex skill. This is done so that changes, if necessary, can be promptly made. In this manner, learners' progress is closely supervised while at the same time providing standard instruction. Subsequently, learners who face challenges are given extra support whilst their progress is closely followed throughout. Learning support, in essence, embraces the combination of all role players, such as supporting teachers, individual support plans for learners, parental involvement and various education programmes as explained below.

2.6.1 Supporting teachers

Crespo and Rigelma (2015) attest that teachers should be assisted by other colleagues in adopting and using assessment. Wylie and Lyon (2012) assert that professional development must be a significant element of any viewpoint that seeks to establish the constructive use of formative assessment. Three aspects which relate to assessments are the nature of tasks and materials to support teachers' use of formative assessments; professional development that supports changes in teaching practice and classroom observations with a formative assessment focus, as suggested by Wylie and Lyon (2012). These aspects are individually discussed in the ensuing paragraphs.

2.6.1.1 The nature of tasks and materials to support teachers' use of formative assessments

The nature of tasks and materials explores assessment instruments that can reinforce and substantiate a successful achievement in assessments by both teachers and learners. Wylie & Lyon (2012) further explain that these tools will then provide assessment resources to teachers which can improve their instructional practice. This is achieved by concentrating on tools that are rich in content and which will improve the learning process. This calls for in-depth content knowledge on the teachers' part so as to construct and implement content relevant assessments. Furthermore, teachers should be able to arrive at conclusions concerning where learners are in accordance with performance and recommend the suitable intervention strategies (Coffrey, Hammer, Levin & Grant, 2011).

2.6.1.2 Professional development that supports changes in teaching practice

Wylie and Lyon (2012) further suggest characteristics of professional development which are mandatory so as to reinforce amendment changes in teaching, particularly in formal assessment tasks. These characteristics include professional development that is:

- in-depth, continuing and relevant to practice;
- devoted to specific curriculum delivery;
- in coordination with school improvement plans; and
- directed at establishing strong collaboration among teachers.

The implications are that the teachers must display some of the characteristics outlined below which, when followed, might support professional development and results in effective teaching and learning of mathematics.

Knowledgeable: Killen (2015) recommends that teachers must have an in-depth mastery of their areas of specialisation and how to facilitate learning.

Optimistic: Teachers must have a strong belief that learners will and can learn. Valazza (2011) suggests that teachers must have a positive attitude with regards to their curriculum delivery. Furthermore, they must be confident that however complex the concepts might be, learners can understand them following clear explanations.

Confident: Akbari and Alivar (2010) reference that there is an obvious connection between teacher confidence and learner achievement. Following the idea, it implies that teachers must have sound knowledge of the subject so as to be able to assist learners.

2.6.1.3 Classroom observations with a formative assessment focus

Wylie and Lyon (2012) suggest that at school and district level, there must be a close examination of the classroom observation tools that are currently being utilised. This will enable them to ascertain the validity of the tool in giving valid feedback on formal assessment tasks. Furthermore, classroom observation will assist teachers to improve their assessment strategies when they are given feedback (Wylie & Lyon, 2012). Feedback from learners' assessment will then assist teachers to identify learners who are challenged and then come up with individual support plans, as discussed in the subsequent paragraphs.

2.6.2 Individual learner support plans

The DBE (2010) emphasises that the inclusive education policy insists upon having schools acknowledge the diversity of their learners and to ensure they all get comparable educational opportunities of high quality for all. Struggling or challenged students should also be supported through the policy.

Paulsen and Dednam (2016) assert that learning support is almost entirely constructivist in its procedure since it maintains a higher level of accommodation regarding the individual learner's progression of intellectual development. Consequently, Vygotsky's principle of the ZPD, as mentioned and explained in sub-section 2.2.2.3 must feature prominently, especially in utilising the learners' strengths. They mention that these learners need some measure of individualised support.

The DBE (2010) specifies the necessity to design individual support plans (ISPs) in order to monitor the support given to learners. This implies that mathematics teachers should address the issue of unevenness in cognitive development (c.f 2.2.1.3) and have individual intervention strategies based on the individual performance of every learner. For individual support to be a success, it must be complemented with parental support.

2.6.3 Parental support

Lemmer and Van Wyk (2010) point out that parental involvement has significant consequences in children's education. Underpinning the idea is the work of Vogel (2011) when referencing parents/guardians who are in the best position to furnish teachers with their children's information, which can assist teachers in cultivating support for learners who are challenged. For this purpose, schools and families must collaborate in giving learners support. Furthermore, it is a requirement that parents have to share the responsibility of the education of their children with the state (DoE, 1997:27). Teachers may engage parents in assisting in the supervision of homework and signing to show that they have seen it. Parents who are professionals can be invited to teach in class in areas related to their expertise (Lindeque, Gawe & Vandeyar, 2016).

2.7 CONCLUSION

The purpose of this chapter has been to present literature that is relevant to the implementation of formal assessments in intermediate phase mathematics teaching and learning. Theories underpinning the research together with their implications to education were also discussed. Teaching and learning in mathematics were also presented in terms of principles and alignment to the CAPS document. Lastly, challenges in mathematics teaching and learning were presented alongside how they can be accommodated. The succeeding chapter presents the research design and methodology employed in this study.

CHAPTER 3: RESEARCH DESIGN AND METHODOLOGY

3.1 INTRODUCTION

The object of this chapter is to discuss the research paradigm, research approach as well as the research design and methodology utilised in this study. It will also discuss the data collection procedure, population and sampling as well as the pilot study conducted. Furthermore, data analysis techniques and reliability and validity of the research instruments, ethical considerations and limitations of the study will be presented. The research paradigm is discussed in the ensuing paragraphs.

3.2 RESEARCH PARADIGM

Nieuwenhuis (2016) defines a paradigm as a combination of presuppositions or views about principal facets of reality which bring about a certain view of the world. Ma (2016) agrees with this definition when pronouncing that a paradigm is linked to values and beliefs which are commonly relied on by a scientific population for their research expeditions. Bakkabulindi (2015) asserts that a research paradigm is a sort of a camp to which a researcher belongs in terms of assumptions, propositions, thinking and approach to research.

Nieuwenhuis (2016) further explains that a paradigm outlines essential surmises based on faith, for instance, convictions about nature of reality (ontology), the connection between knower and known (epistemology) and premises regarding methodologies. Plowright (2011) discusses that traditionally, the paradigms that underpin research are seen as bipolar opposites. It is a continuum consisting of the positivist paradigm and the constructivist paradigm. The positivist paradigm argues that the world we inhabit has an ontological reality; it is referred to as being mind-independent. A constructivist paradigm, in contrast, follows epistemological assumptions. It claims that reality is mind-dependent (Plowright, 2011). Additionally, two major paradigmatic approaches are clarified in Ma (2016) as a positive research paradigm or positivism and interpretive research paradigm or interpretivism.

The study followed a mixed-methods approach, which combines both the positivist and interpretivist paradigms, to be known as the pragmatist paradigm. These paradigms, positivism and interpretivism, will be discussed in the following paragraphs which also elaborate on their attachments to the ontology (positivism) and epistemology (interpretivism) philosophies.

3.2.1 Ontology

Ma (2016) defines ontology as the philosophy of what actually exists, particularly referring to the nature of living and actuality. It asks philosophical questions such as what exists, what is there to be known and also what is the nature of social sciences and physical phenomena (Ma, 2016). In agreement to the same conviction, Moses and Knutsen (2007) confirm that ontology poses a question of what the world is really made of.

Indistinguishable to ontology is the positivist paradigm. Needham (2016) defines a positivist paradigm as the philosophical structure that gives direction on the procedures of undertaking scientific research. Additionally, it is where factuality is separated from beliefs so that knowledge acquired is based on facts and can be mathematical proven. Similarly, Wheeldon and Ahlberg (2012) point out that positivism holds the idea that to establish the truth about the world; knowledge can be quantified and empirically studied through the scientific methods. In this view, they maintain that reality is the same for everyone and the only research of value focuses on what can be directly observed and measured.

Bakkabulindi (2015) discusses that the positivist researcher perceives reality as objective and detached from the researcher. Moreover, positivists believe that reality is unconnected from the person who studies it. In contrast, interpretivists hold that reality is connected to the observer. The researcher ensured that reality is not detached from the observer through the document analysis that was employed in this study. Document analysis revealed exactly how intermediate phase mathematics teachers implemented formal assessments. Epistemology (interpretivism) philosophy is discussed in the ensuing paragraph. This is discussed in the ensuing paragraph.

3.2.2 Epistemology

Wheeldon and Ahlberg (2012) define epistemology as the philosophy of knowledge incorporated in theoretical viewpoints. They assert that it attempts to answer questions based on what knowledge is; how it is acquired and how individuals make the acquaintance of what they already know. Complementing the idea is Ma (2016) who mentions that epistemology is concerned with the theory of knowledge, with specific reference to the nature and forms of knowledge.

Tantamount to epistemology is the interpretivist paradigm. It is defined by Needham (2016) as clarification of the complicated social phenomena in view of the subject or environment which is the main focus of the research procedure. The constructivist paradigm is sceptical of the idea of one universalistic notion of truth. It views meaningful realities as contingent on human practices (Wheeldon & Ahlberg, 2012). This conviction was catered for in this study through the utilisation of a mixed-methods research design, namely the sequential explanatory design. The design incorporated three different research instruments, namely the questionnaire, document analysis and semi-structured interviews. This ensured triangulation of the results.

The rationale for using the pragmatist paradigm is that the researcher was able to combine quantitative and qualitative results effectively. This ensured that an accurate conclusion about the implementation of formal assessments in the intermediate phase was drawn. The next section discusses the research approaches employed in this study.

3.3 RESEARCH APPROACHES

Two major research approaches were used, namely the deductive and the inductive approaches. These theories are quite different but they complement each other (Blackstone, 2012). Considering that the study embraced a mixed-methods approach, it also employed both the deductive and inductive approaches. The deductive and inductive approaches are both discussed in the subsequent paragraphs.

Bakkabulindi (2015) distinguishes the two approaches by designating that a positivist or quantitative research is deductive. Conversely, qualitative or interpretive research is inductive. Moreover, further reference is made that the deductive approach outsets from a broad theory concerning a particular study context. The implication being that the research is motivated by theory; it is a follow up of theory. On the contrary, an inductive approach starts from specified study contexts to grounded theory, suggesting that it is theory-driven (Bakkabulind, 2015).

Additionally, Harding (2019) asserts that a deductive approach starts from the ordinary to the certain. This implies that the researcher has to conduct an extensive exploration of relevant literature prior to selecting the precise field of investigation. Deductive research is, in some cases, distinguished as testing theory by generating hypotheses and employing research to ascertain accurateness (Harding, 2019). This idea is supported by Creswell and Creswell (2018) who outline the steps of a deductive approach as depicted in Figure 3.1 below. Blackstone (2012) concurs with Creswell (2018), that a deductive approach begins with social theory and experiments its implications with data. The researcher studies the work of others, reads existing theories and tests hypotheses that emerge thereafter (Blackstone, 2012). This idea was followed and implemented in this study as the researcher did a literature review in Chapter Two (cf.2.2). The literature review informed the researcher on how formal assessments are implemented in intermediate phase mathematics teaching and learning. Hypotheses were also tested as indicated in Chapter One (cf.1.5). The steps of a deductive approach as referenced by Creswell and Creswell (2018) are depicted in Figure 3.1 below:

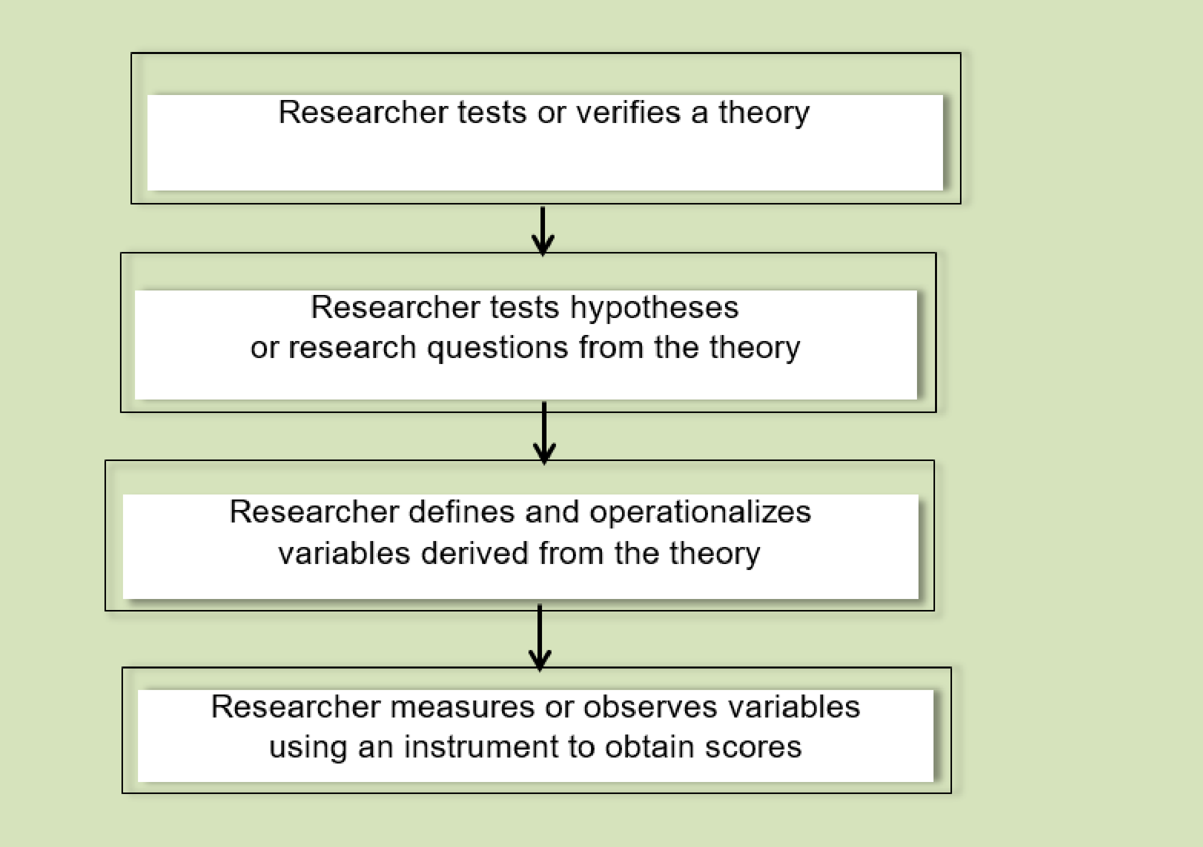


Figure 3.1: The Deductive Approach Generally employed in Quantitative Research: (Creswell & Creswell, 2018: 58)

In contrast to the deductive approach, an inductive approach starts with the certain and moves to the ordinary; the researcher starts with the collection of data and analysis rather than what is previously known about the subject concerned. Endeavours to construct more facts are done at a later stage, after taking into consideration the relationship that exists between the findings and the prevailing knowledge (Harding, 2019). Blackstone (2012) mentions that in an inductive approach, the researcher gathers data first, looks for patterns and then develops a theory. Creswell and Creswell (2018) assert that the inductive approach starts with the researcher gathering detailed information, looking for emerging patterns, analysing the data and then conducting interviews or observations. The logic of the inductive approach is shown in Figure 3.2 below:

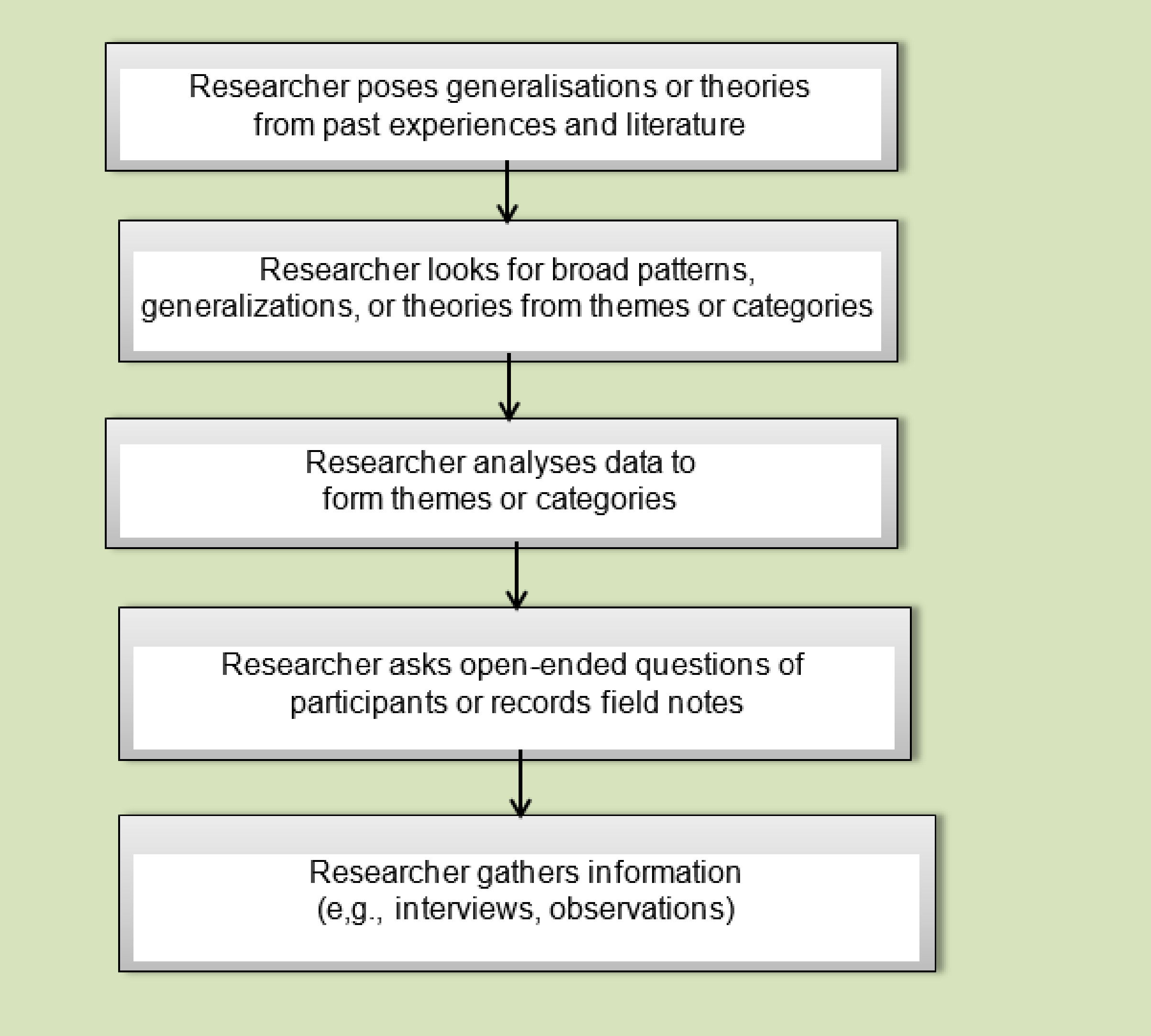


Figure 3.2: The Inductive Logic of Research in a Qualitative Study (Creswell & Creswell, 2018: 64).

The inductive approach guided the researcher on how formal assessments were implemented in intermediate phase mathematics teaching and learning. Following the sequential explanatory design, data were collected through the questionnaires and analysed. General truth was built through a comparison of the questionnaire findings with what was revealed by the document analysis. Finally, individualised semi-structured interviews were conducted to find out from the teachers why there were discrepancies in the implementation of formal assessments. The next section discusses the design and methodology followed in this study.

3.4 RESEARCH DESIGN AND METHODOLOGY

This section aims to explain the research design and methodology applied in this research. Flick (2018) mentions that a research design concerns issues of how to plan a study; how one should set up the data collection and analysis as well as the selection of empirical material of the study such as situations, cases or persons. Likewise, Nieuwenhuis (2016) contends that a research design is a scheme or approach that moves from the fundamental philosophical presumptions to identifying the participants, the data gathering methods to be utilised and data-analysis to be procedures to be employed in the study. Taylor, Bogan and DeVault (2016) define the term methodology as the way problems are approached and answers are sought. It pertains to how research is executed.

The study employed a mixed-methods research design, which is a process of gathering, analysing and combining both quantitative and qualitative approaches in one study (Creswell & Plano Clark, 2011). Gay *et al*. (2011) define a mixed-methods research design as one which synthesises quantitative and qualitative approaches by incorporating both their data in a single study. It involves a combination or integration of qualitative and quantitative data in a research study (Creswell & Creswell, 2018).

By virtue of quantitative design implementation, the researcher was able to quantify the relationships between given variables in the study. These variables, collected from the respondents' personal data, consist of gender, age, and total years of teaching experience, professional teaching qualifications, and the average number of learners per class, highest grade taught and the quintile number of the school. The researcher also obtained the respondent's attitudes through a numerical measure using a semantic differential scale as recommended by Maree and Pietersen (2016). Subsequently, document analysis followed as an instrument for the qualitative analysis. The use of a checklist permitted the researcher to obtain rich data on the implementation of formal assessments and the application of cognitive levels in the setting of formal assessments. Ultimately, the semi-structured interviews in the qualitative analysis allowed the researcher to acquire descriptive data from the participants.

3.4.1 The rationale of employing the mixed-methods research design

Creswell (2014) mentions that the central reason for a mixed-methods research design is that the integration of the two forms of data contributes to an improved understanding of a study. Gay *et al.* (2011) are in accordance with the idea as they affirm that the motive of a mixed-methods research design is to depend on the coordination and potency existing between quantitative and qualitative research designs. McMillan (2012) reveals that mixed-method research is advantageous as there is room for the researcher to explore multiple forms of data hence paving way for an extensive comprehension of the research problem. Moreover, it offers the aptness to give answers to complex research questions.

On the contrary, Harding (2019) highlights that in view of the fact that quantitative and qualitative methods are found on such diverse methodologies, it is at times proposed that merging them in one study is not recommended. McMillan (2012) states it needs a researcher who is competent in carrying out the research and interpreting the results. The method also requires large-scale data collection and it might be time-consuming. Gay *et al.* (2011) mention that it calls for a comprehensive understanding of both quantitative and qualitative approaches, which is scarcely possessed by the majority of researchers.

However, the notable advantages of a combined approach are still indisputable. These are: interpreting and responding to more questions from diverse points of view; heightening the validity of findings and expanding the dimensions to verify one data set opposed to the other (Grbich, 2013).

The study employed a mixed-methods research design, namely a sequential explanatory research design. The researcher carries out quantitative research first, then the results analysis, thereafter, they further clarify findings fully with qualitative research (Creswell & Creswell, 2018). McMillan (2012) points out that in a sequential explanatory design, quantitative data is gathered first and analysed, succeeded by qualitative data collection and analysis in the second phase. Similarly, Gays *et al.* (2011) define the sequential explanatory design as the QUAN-Qual Model, the implication being that quantitative data are collected first and hold much weight compared to qualitative data. Creswell and Plano Clark (2011) state that quantitative results furnish a broad view of the research problem, at the same time; the qualitative results clarify the general picture of the research problem. The QUAN-Qual model is illustrated in Figure 3.3. below.

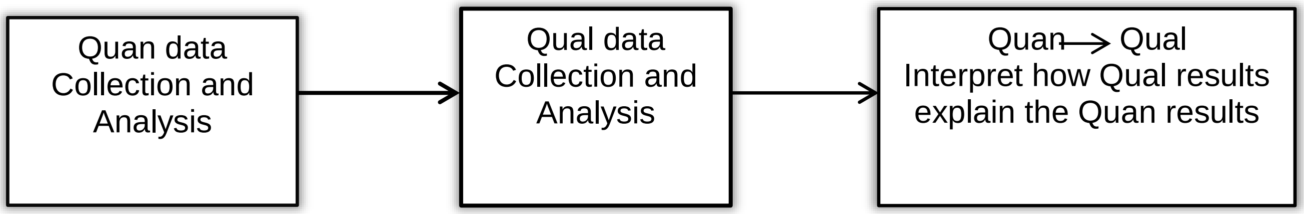


Figure 3.3: Explanatory sequential mixed-methods design (Ivankova, Creswell & Plano Clark, 2016: 316).

Figure 3.3 shows that the first quantitative data is collected and analysed. Subsequently, the researcher has to use the quantitative results to plan for a qualitative phase collection and analysis of data (Creswell & Plano Clark, 2011). As delineated on the illustration above, the researcher followed the same sequence. Quantitative data was gathered first with the utilisation of a questionnaire as a data collection instrument. The closed-ended questions were asked to the respondents to obtain data. The questionnaire was in accordance with the seven-point semantic differential scale. As affirmed by Ganga and Maphalala (2015), the questionnaire allowed the same respondents a possibility to listen to or read the same questions. It was utilised as a proper instrument to elicit information appropriate for analysis. The questionnaire was quicker and easier for the respondents to complete and their answers were easier to code and analyse.

Thereafter, qualitative data were collected by means of document analysis. A checklist of formal assessments and application of cognitive levels in the setting of tests was used. Results from document sources were triangulated with those from the questionnaire to check whether they contain objective truth, as suggested by Nieuwenhuis (2016).

Conclusively, the semi structured-interviews were held with intermediate phase mathematics teachers. Nieuwenhuis (2016) claims that a semi-structured interview is generally employed in research to endorse data that emerges from other data sources. The researcher followed this idea and resultantly, the interview responses assisted the researcher to scrutinise data which was obtained from the other two data-gathering instruments which were utilised in this research.

The benefits of employing the sequential explanatory design are that the two-phase framework paves the way for smooth implementation and report writing becomes easier thereafter (McMillan, 2012). Advocating the idea is the work of Creswell and Plano Clark (2011) who state that the suitability of the explanatory sequential design is its well-defined phases which makes it easy to apply. Conversely, McMillan (2012) mentions the requirement of extra time for the implementation of the design. The ensuing section discusses the quantitative research design as the first stage of the sequential explanatory design.

3.4.2 Quantitative research design

A quantitative research design is one which emphasises numbers, measurements, deductive logic, control and experiments. It ideates that phenomena ought to be examined objectively so as to justify reality. It is grounded on a positivist perspective (McMillan, 2012). Concurring with McMillan's idea is the work of Gay *et al.* (2011) who define quantitative research as the process of collecting and analysing of numerical data to clarify, predict and/or control phenomena of interest. There are several quantitative approaches which can serve the purpose of either describing status quo (survey), explore connections (correlational) and study cause-effect phenomena (comparative research) (Gay *et al.*, 2011). The survey approach was employed for this research because of its appropriateness to describe current conditions in the implementation of assessments in intermediate phase mathematics teaching and learning. The survey, as a non-experimental quantitative research design, is discussed in the subsequent paragraphs.

3.4.2.1 Survey

A survey research design is a procedure in quantitative research whereupon a researcher administers a survey to a sample or to the whole population to identify the beliefs, views, behaviours or attributes of that particular population (Creswell, 2012). Moreover, a survey encompasses collecting data to respond to questions regarding people's views on a particular matter (Gay *et al.*, 2011). It is a mechanism of investigating the perceptions, convictions, experiences or behaviours of individuals or the society at large (Duarte & Miller, 2015). Additionally, it scrutinises the prevalence and connections between psychological and sociological factors and examines viewpoints, beliefs, preconceptions, priorities and thoughts (Salkind, 2018). McMillan (2012) mentions that surveys are functional in dealing with questions when the aim is to give a description of patterns of behaviour or opinions of what respondents believe and this can be achieved with responses obtained from questionnaires.

A significant merit of the survey is that sampling from a population can be employed to bring about generalised conclusions about a larger population (McMillan, 2012). As indicated above, in a survey design, the researcher needs to find out teachers' beliefs and opinions on the implementation of formal assessments. On the contrary, survey studies habitually struggle with insufficient participant response which results in difficulties on the part of the researcher to draw accurate conclusions (Gay *et al.*, 2011). The second stage of the sequential explanatory design, the qualitative part, is discussed in the ensuing paragraphs.

3.4.3 Qualitative research design

A qualitative research design is one which emphasises natural settings and verbal narratives. It underlies a phenomenological design where various matters are established firmly from the subjects' insights. It is established on a constructivist perspective (McMillan, 2012). Taylor *et al*. (2016) point out that qualitative methodology relates to research that generates descriptive data. The phenomenological approach was implemented in this study; it is discussed in the forthcoming paragraph

3.4.3.1 Phenomenology

Giorgi (2009) defines phenomenological research as a plan of investigation that arises from philosophy and psychology whereby the researcher narrates the lived experiences of individuals regarding a certain phenomenon as narrated by the stakeholders themselves. Complementing the idea is Grbich (2013), who describes phenomenology as a method that endeavours to figure out concealed meanings and the level of experience along with how participants interpret these. Moreover, it comprises extensive probing of experiences or subject matter to explain their essence. Taylor *et al* (2016) declare that the phenomenological point of view is focal to the researchers' idea of a qualitative approach. What qualitative researchers investigate how they execute the study and the interpretation procedure relies on the theoretical views they hold. Phenomenologists' consider the behaviour of people, what they utter and undertake, as a result of how they interpret the universe. Additionally, Van Wyk and Taole (2015) point out that a phenomenological study design scrutinises social practices by means of the explanations presented by the individuals concerned.

In view of the foregoing, the study employed the phenomenology approach for this study with the intention of gathering vast information on the views of intermediate phase mathematics teachers in relation to the implementation of formal assessments. The following section outlines how data was collected in this research.

3.5 DATA COLLECTION PROCEDURE

Data collection is a process of recognising and choosing suitable persons for a study, obtaining their authorisation to investigate them and obtaining information by observing their behaviours (Creswell, 2012). The instruments utilised for data collection in this study were closed-ended questionnaires, document analysis and semi-structured interviews. They are discussed in the ensuing paragraphs.

3.5.1 Data collection instrument for quantitative research design

Quantitative data collection methods are employed to measure, document and provide numerical values. This is achieved through the use of objective and standardised data collection for all respondents (McMillan, 2012). A questionnaire as a quantitative data collection method was employed for this research; it is interpreted in the succeeding section.

3.5.1.1 Questionnaire

A questionnaire is a written document which serves to gather subject responses to written items. These items can be in the form of questions or statements utilised to obtain various traits of respondents, such as their beliefs and attitudes (McMillan, 2012). Likewise, Gay *et al.* (2011) define a questionnaire as a documented set of survey questions directed to a chosen category of individuals.

Ganga and Maphalala (2015) predicate that, basically, questionnaire questions belong to two prime categories. These are closed-ended, also known as structured types and open-ended, which are unstructured types. This is underpinned by Gay *et al.* (2011) who reference that most surveys consist of structured items (also called close-ended items) or unstructured items (open-ended items). This study utilised a closed-ended questionnaire which required the respondents to choose among the provided options. Overall, 200 questionnaires were distributed to 48 primary schools, to intermediate phase mathematics teachers in the Lejweleputswa district only. Of the total distributed, 151 questionnaires were returned and usable, therefore a 76% return rate was achieved.

Format of the questionnaire

Paper-based questionnaires were delivered to the respondents. The intent of the study was clarified on the letter with the consent form attached to it. The questionnaire comprised of closed-ended questions requiring answers to be rated on the seven-point semantic scale. Closed-ended questions have a disadvantage of leaving out other choices which could be of interest to the respondents. However, Ganga and Maphalala (2015) point out prompt responses from respondents, simple comparison of answers from respondents, easier to code and analysis of answers as great advantages for using closed-ended questions. The questionnaire for intermediate phase teachers comprised nine sections, namely:

- Section A: Personal data with six closed items.
- Section B: Marking, Recording and Moderation of Formal Assessment Tasks with seven closed items.
- Section C: Tests and Examinations with five closed items.

- Section D: Assignments with five closed items.
- Section E: Projects with eight closed items.
- Section F: Investigation with 14 closed items.
- Section G: Moderation with five closed items.
- Section H: Recording and Reporting with eight closed items
- Section I: Challenges in Mathematics Assessment with 28 closed items.

Illustrated below is the seven-point semantic scale which was utilised in the questionnaire:

1	**2**	**3**	**4**	**5**	**6**	**7**
Not at all						**Always**

The documents distributed to the schools comprised the following:

- A covering letter to the principal seeking authorisation to undertake research in the school (Appendix D). The letter also explained how the study will be undertaken and its main aim.
- A covering letter to the teachers requesting them to participate in the research, explaining how the research will be conducted and ensuring them that their responses will be treated with confidentiality (Appendix E).
- A letter from the Free State Department of Education, permitting the researcher to conduct research and explaining the usefulness of the research (Appendix C).
- The questionnaire directed to the teachers (Appendix F). It had two sections, A and B. Section A had six items, requesting the biographical details of teachers. Section B was divided into eight sections taken from the CAPS policy document on the implementation of formal assessments in intermediate phase mathematics. These sections were designed to elicit information from teachers on the implementation of formal assessments. This information was sought using a seven-point semantic differential scale.

Gay *et al.* (2011) identify five common approaches used to distribute questionnaires, namely through the mail, electronic mail, telephonically, personal administration and an interview. Each has its own merits and demerits which must be taken into account by the researcher when making a choice. Similarly, Duarte and Miller (2015)

reference that questionnaires can be sent in different ways such as mailed survey, group survey, phone survey interviews or a web survey. In this study, the personal administration method was utilised. The procedure of how this was conducted is discussed in the following paragraph.
The researcher visited the schools identified for the study and discussed the aim of the research with the principals. In most cases, the discussion was held with the deputy principals because the principals were having departmental meetings. Depending on the school, the questionnaires were either handed to the teachers themselves or to the heads of department. Agreements were reached on when to collect the completed questionnaires, which was usually between 24 to 48 hours from the day of administration. The researcher took the opportunity to identify potential schools for the document analysis and interviews thereafter and the principals were notified about this as questionnaires were being collected.

However, for every research question to receive adequate feedback, characteristics of good questioning must be applicable. Maree and Pietersen (2016) suggest that a questionnaire should start with an introduction which serves as an explanation to the survey to the respondents. This was adhered to by the researcher, the cover letter was written to the respondents. Additionally, Maree and Pietersen (2016) propose that it must start with simplified questions such as biographical detail, so as to relax the interviewee. Then move on to the main topics of the study. Also, questions on a similar subject must be kept together and maintain a logical flow (Maree & Pietersen, 2016). Gay *et al.* (2011) point out that the researcher must incorporate only matters that pertain to the objectives of the research. The researcher fulfilled this point as Section B to Section I of the questionnaire served to respond to the research objectives and sub-questions which are outlined below. The objectives of the study are as follows:

- How are formal assessments used as a foundation for teaching and learning enhancement?
- What challenges do teachers and learners experience in the implementation of formal assessments?
- How could these challenges in mathematics teaching and learning be alleviated?

- To what extent do differences in biographical variables (gender, age, teaching experience, professional teaching qualification, class size and school quintile) and intermediate phase mathematics teachers' responses relate to their implementation of formal assessments?

This process calls for the researcher to be cognisant of the key principles to follow when constructing a questionnaire. Ganga and Maphalala (2015) suggest the following characteristics illustrated in Figure 3.4 below:

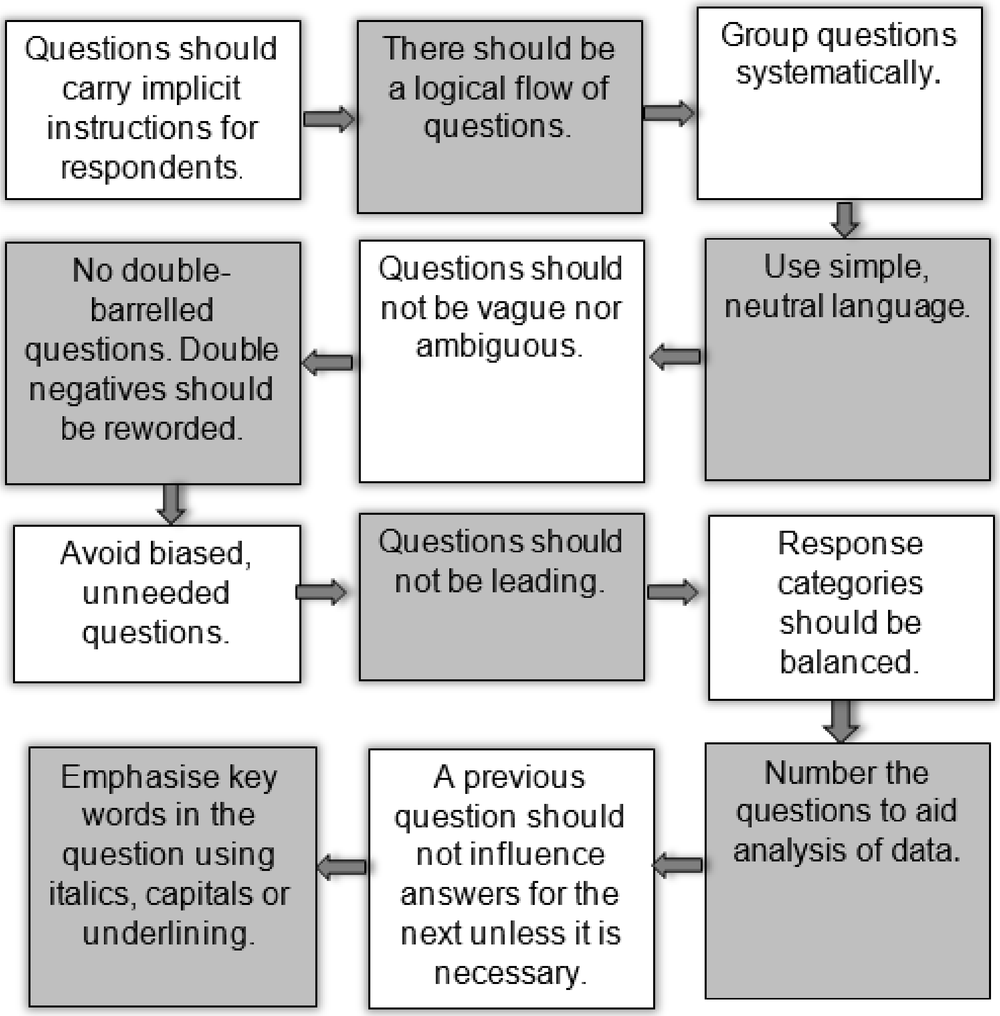


Figure 3.4: Characteristics of good questioning (Ganga & Maphalala, 2015: 326).

As suggested in Figure 3.4 above, the researcher used well understood instructions. For instance, Part A of the questionnaire requires the respondents' personal data in terms of gender, age, years of teaching experience, to mention a few. It consisted of straight forward questions. Secondly, the researcher grouped questions in a systematic and logical way as recommended in Figure 3.4. This is also supported by Gay *et al.* (2011) who mention that questionnaire items should be ordered in a logic way, for example from general to specific. The questions of Part B to Part I of the questionnaire were derived from Section 2.5 of the literature review, namely Assessment of Learners in Mathematics. They follow the order of how items are discussed in the literature review.

Of much significance again is to develop questions which are well understood by the participants. This is emphasised in Figure 3.4 through the use of simple neutral language and avoiding vague questions. Creswell (2012) mentions that the researcher has to eliminate jargon and use words which are familiar to the respondents. The researcher used simple and straight forward statements which were easily understood by the respondents.

Insistence again is on avoiding double-barrelled questions as shown on the progression of Figure 3.4. Creswell (2012) states double or triple-barrelled questions should be reduced to a single question. The researcher ensured that these types of questions were avoided so as to eliminate confusion on the part of respondents.

Maree and Pietersen (2016) state that a researcher has to avoid leading questions, these are questions which lead the respondent to answer in a certain way. This is also apparent in Figure 3.4 above. The researcher avoided such questions to ensure obtaining unbiased responses from the respondents.

Ganga and Maphalala (2015) further mention that response categories should be balanced. The idea is additionally explained by Creswell (2012) who emphasises that the researcher has to select a particular response alternative and utilise it invariably for all response categories. The researcher followed this idea and maintained one response option throughout the questionnaire. The seven-point semantic differential scale was utilised for this study to ensure that the response categories were balanced.

Ganga and Maphalala (2015) indicate that questions should be numbered to aid data analysis. The researcher was aware of this and all the statements were numbered.

Moreover, reference is made that a preceding question ought not to influence responses for the next subsequent question, except if imperative. The influence of the previous occurred in this questionnaire between question I8 and I9 in Part I: Challenges in mathematics assessment. As can be seen, a respondent cannot be negative in I8 and be positive in I9 and the other way round. The ensuing paragraphs serve to discuss the qualitative data collection instruments utilised in this study.

3.5.2 Data collection instruments for qualitative research design

Qualitative data collection instruments are rooted in the narrative and diverse viewpoints of participants (McMillan, 2012). In qualitative research there are five major methods for collecting data, these are interviews, document review, observation, questionnaires and use of audio-visual materials (McMillan & Schumacher, 2010). Documentary sources and semi-structured interviews were applied in this study, consequently, they are explained below.

3.5.2.1 Documentary sources

Harding (2019) describes documentary scrutiny as a comprehensive analysis of documents over a diverse dimension of social customs. This takes varied forms ranging from printed matter to visual presentations. Likewise, the documentary approach, also known as the secondary source of data gathering, is one of the qualitative data collection instruments (Okeke, 2015). Further reference is made that documentary analysis is not a primary qualitative data collection method, rather, it is found playing a supplementary part to other approaches, moreover, it is utilised by quantitative researchers (Okeke, 2015). It was used both quantitatively and qualitatively in this study. Gay *et al.* (2011) specify that it is a requisite for qualitative researchers to examine various types of documents. Also, with permission, researchers need to examine archival documents in schools, such as students' records and standardised tests. This source of data can be used to gain valuable historical insights and identify potential trends. Creswell (2012) confirms that documents are an essential source of clues in qualitative data. Following this notion, the researcher used a checklist for 2018 formal assessments as a qualitative tool to establish the implementation of formal assessments in mathematics intermediate phase teaching.

Gasa and Mafora (2015) mention that the researcher's blueprints concerning the location of secondary data are the research questions to be responded to and an in-depth understanding of corresponding publications. Therefore, the checklist was formulated from Section 2.4.2 of the literature review.

The researcher followed the decision path of consideration when the document source was utilised, as proposed by Gasa and Mafora (2015). The path is divided into two stages, starting off with stage one (1) which seeks to verify how relevant the data is to the study's objectives. The researcher has to verify if the data is applicable to the population of concern as well. The researcher ensured the data was relevant to the research objective by establishing how formal assessments were used as tools to achieve quality education for intermediate phase mathematics learners.

Pursuing the path further, the second stage suggests the data must be accurate. Gasa and Mafora (2015) emphasise that to ensure accuracy of data, the researcher must be able to access the original data source. This was attainable in the study since the researcher managed to conduct document analysis in schools which was the ideal context for the study.

A flow chart is illustrated in Figure 3.5 below and further explanation based on the information displayed is given in the subsequent paragraphs.

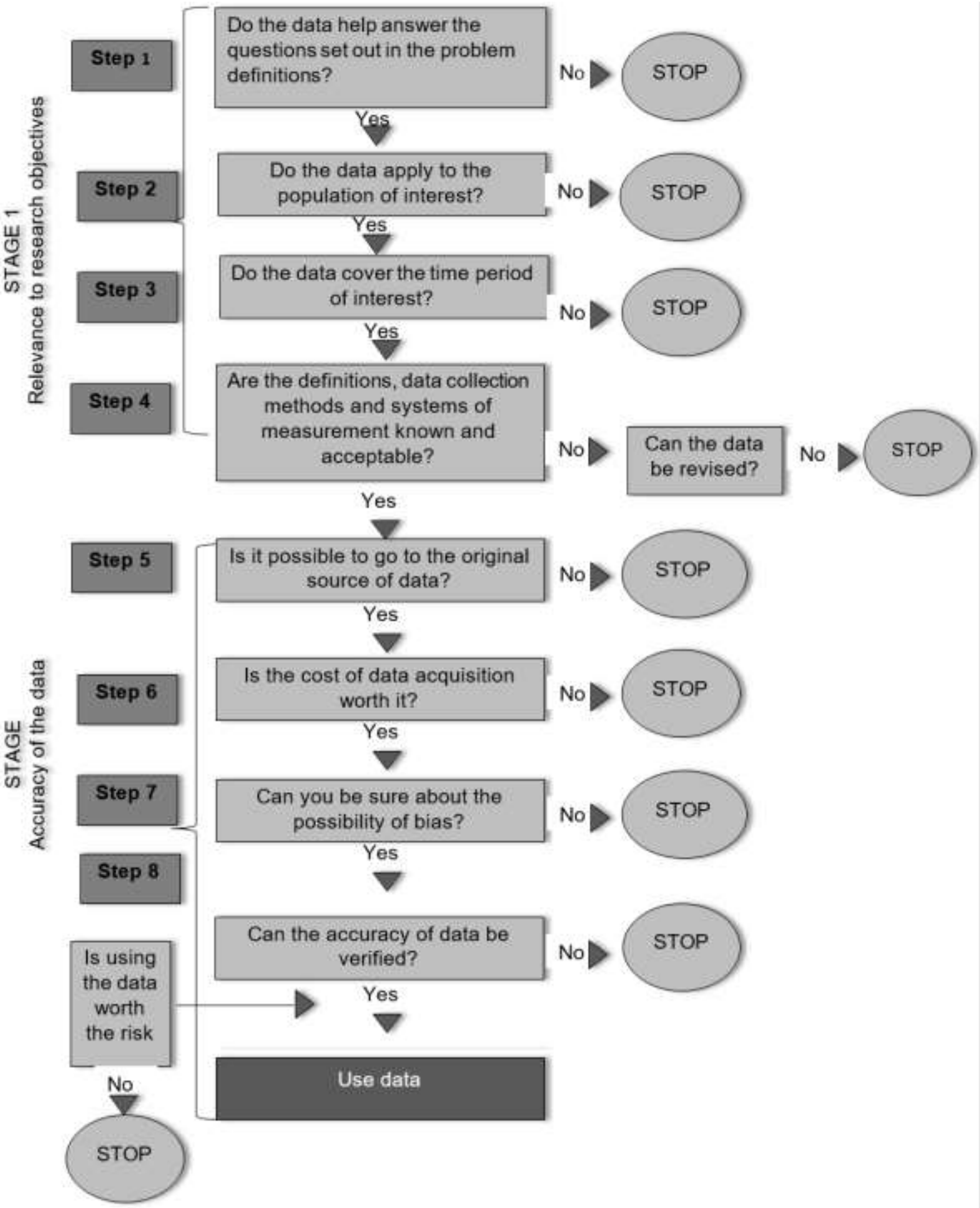


Figure 3.5: Flow chart on decision-making to use secondary data (Gasa &Mafora, 2015:358)

The steps illustrated in Figure 3.5 above were followed by the researcher. The document sources, thus the CAPS policy document and the teachers' files were ideal documents to respond to the research question:

How do intermediate phase mathematics teachers implement formal assessment methods to enhance teaching and learning?

Textual data also applied to the population of interest, intermediate phase mathematics teachers. Furthermore, data analysed covered the period of interest, namely the 2018 SBA tasks.

Creswell (2012) further mentions that documents represent a credible source of testing data when conducting a qualitative study. They provide the advantage of being in the language and words of the participants. They are also ready for analysis without transcription found necessary in other qualitative methods. On the contrary, documents are occasionally strenuous to procure. Documents may be incomplete, inaccurate or inauthentic (Creswell, 2012). To avoid the negatives, Gasa and Mafora (2015) suggest that secondary data should be assessed for suitableness before being employed in a study. They suggest some of the following issues for consideration:

- **Attainability:** The data has to be promptly accessible, orderly, purposeful and in a comprehensible presentation. This was achieved in the study because the researcher clarified the issues to the prospective respondents when questionnaires were being administered. Resultantly, the relevant documents for analysis were readily available.
- **Appropriateness:** The information source ought to be reliable and the methodology utilised is suitable for the research questions. The checklist addressed the implementation of formal assessments and the sub-research question of the study: *How are formal assessments used as tools to achieve quality education for intermediate phase mathematics learners?*
- **Relevant:** It is a necessity that data has to be current so as to address research questions. This issue was attained. McMillan and Schumacher (2010) underpin the idea when they mention that the researcher should consider the time period in which the data was collected. If the research has current implications, data collected must be current as well. Data collected was relevant and current, namely the formal assessment tasks of 2018 in intermediate phase mathematics teaching and learning.

- **Dependability:** The source has to give a truthful description of the circumstances; therefore attentiveness has to be exercised to ensure information is not distorted in some way to look better. The credibility of documents was ensured in the study because there was evidence of South African School Administration and Management System (SA SAMS) records for the period under investigation.
- **Adequacy:** This explains that information needs to be of sufficient amount to answer the questions from various angles. The checklist was formulated in a manner so that extensive data on the implementation of assessments were collected.

McMillan and Schumacher (2010) further indicate that data should be collected from the population of interest. The researcher conducted the document analysis from the primary schools because they offered intermediate phase mathematics, which is a sample that is a representation of the population.

Format of the checklist

The checklist comprised three sections, namely:

- Section A: Biographical Data with three items.
- Section B: Minimum Requirements for Formal Assessment: Intermediate Phase Mathematics with seven items.
- Section C: Tests Cognitive Levels with Description Skills to be demonstrated with sixteen items.

Document analysis was conducted in the school environment. Ethical issues were considered by the researcher. Gasa and Mafora (2015) emphasise that if the information is not openly accessible, written consent for the utilisation of data ought to be obtained from the possessors. This is reinforced by Creswell (2012) who mentions that once documents are located, the researcher must request authorisation to utilise them from the owners. The researcher obtained permission through the consent form which was annexed to the letter addressed to the principals and intermediate phase teachers (Appendix F). Document analysis was explained to the participants before it was conducted. The ensuing paragraphs discuss interviews as a qualitative data collection instrument and how they were carried out in the study.

3.5.2.2 Interviews

Dakwa (2015) defines an interview as a dialogue among the interviewer and the interviewee, which is punctuated by the interviewer asking the interviewee questions so as to obtain responses to be used in qualitative conditions. Comparably, it is a bilateral discussion in which the interviewer interrogates the interviewee so as to perceive the views of that particular individual (Nieuwenhuis, 2016). Hennink, Hutter and Bailey (2011) note a range of topics in which interviews are mainly helpful:

- the establishment of in what way resolutions are made by individuals;
- investigating the beliefs and opinions of people in societies; and
- the establishment of how people feel.

Gay *et al.* (2011) reinforce the helpfulness of interviews when they posit that interviews can aid the researcher to examine and analyse participants' responses so as to accumulate intensive information pertaining to what they have experienced and felt. The utilisation of interviews can assist the researcher to examine attitudes, feelings and issues such as concerns and values of participants (Gay *et al*., 2011). Compactly, qualitative interviews aim to attain bountiful descriptive data that will in turn aid the researcher to interpret how participants construct knowledge; they aim to view the universe by virtue of the participants' perception (Nieuwenhuis, 2016).

Creswell (2012) underscores that in qualitative research, interviews display both merits and demerits. Notable merits are that they furnish the researcher with fruitful information whereby direct observation of participants is impractical. Moreover, the interviewer has greater control over the information obtained and can as also ask specific questions to evoke rich information (Creswell, 2012). This idea is supported by Dakwa (2015) stating that the interviewer can further inquire if the interviewee's response is inadequate so as to get substantial information.

Conversely, the presence of the interviewer might be a frightful factor to the interviewee, leading to unbalanced information (Creswell, 2012; Dakwa, 2015). Additionally, interviewees may be deceitful and suppress useful information (Dakwa, 2015). Similarly, Creswell (2012) attests that data obtained from the interview have possibilities of deceit when the interviewee wishes to please the interviewer.

Regardless of the negatives highlighted above, the study employed interviews as a tool to clarify the findings of quantitative data. Nieuwenhuis (2016) identifies three kinds of interviews, namely structured, semi-structured and unstructured interviews. The study utilised semi-structured interviews. Okeke (2015) highlights that with semi-structured interviews; the researcher determines the structure of the interview questions. Additionally, Nieuwenhuis (2016) emphasises that a semi-structured interview is built on an area of interest established by the researcher ahead of the interview. Interviews are frequently employed in research projects to authenticate data found from other sources (Nieuwenhuis, 2016). As evidenced, it was the ideal tool to be used to discover how formal assessments are implemented in intermediate phase mathematics teaching and learning.

It is crucial to explain how the interviews were conducted. The procedure for conducting interviews, as suggested by Creswell (2012), was followed, namely:

- potential interviewees were identified;
- decision and selection of the semi-structured interview utilised to collect qualitative data;
- a consent form which was signed by the interviewees was designed;
- a conducive environment was created for the interview sessions;
- interviews were recorded with a cell phone;
- the researcher took field notes during the interview sessions;
- where applicable, the researcher probed the interviewees for further elaboration; and
- after each interview session, the researcher thanked the interviewees for participation and cooperation. This shows that the researcher ended the interviews in a professional manner.

The researcher followed the procedure highlighted above to conduct semi-structured interviews with intermediate phase mathematics teachers in school settings. Outlined below is a list of questions which the researcher formulated and asked of the teachers:

- Which forms of formal assessments do you use as tools to achieve quality learning in intermediate phase mathematics?
- What suggestions do you have for the improvement of these forms of formal assessments?
- What challenges do you experience when you implement formal assessments in intermediate phase mathematics?
- How do you think these challenges could be alleviated?
- What challenges are experienced by your learners when they are engaged in formal assessments?
- How do you think these challenges could be alleviated?
- How do you support and guide learners after they have received their marked formal assessment tasks?
- Why is it a challenge for most intermediate phase mathematics teachers to apply the six cognitive levels of Bloom's taxonomy when setting tests?
- How do you think this challenge can be alleviated?
- Complex procedures and problem-solving skills are not tested in intermediate phase mathematics. How can this be improved so as to achieve quality learning in mathematics?

These interview questions enabled the researcher to gain clarity on the implementation of formal assessments in intermediate phase mathematics teaching and learning. The next section discusses population and sampling for this study.

3.6 POPULATION AND SAMPLING

This study was conducted in the Lejweleputswa District schools, specifically with intermediate phase mathematics teachers.

3.6.1 Population

Salkind (2018) defines a population as a category of possible participants to whom one wants to generalise the findings of the research. Similarly, it is a group of individuals who have the same characteristics which one intends to study (Creswell, 2012). The population of the study was intermediate phase mathematics teachers in the Lejweleputswa district.

3.6.2 Sample

A sample is a subdivision of a population (Salkind, 2018). Similarly, it is a sector of the target population that the researcher intends to investigate so that results obtained thereafter are generalised back to the target population (Creswell, 2012). It mirrors or is a representation of the population of interest (Delvin, 2018). The sample of the study was 151 intermediate phase mathematics teachers selected in Lejweleputswa schools. The study employed simple random sampling for the quantitative section and purposive sampling for the qualitative part; these are discussed in the subsequent paragraphs.

3.6.2.1 Sample for the respondents to the questionnaire

The study employed a probability sampling technique namely, simple random sampling. This type of sampling corroborates that each and every individual in a group stands a chance to be selected for sampling purposes (McMillan, 2012). Forty-eight schools were selected from Lejweleputswa district to form a sample. The researcher chose schools from the Lejweleputswa district database. The questionnaire was delivered face-to-face by the researcher to the respondents. The questionnaire was followed by document analysis, which is discussed in the subsequent paragraph.

3.6.2.2 Sample for the documentary sources

Purposive sampling, which is classified under a non-probability sampling method, was utilised for document analysis. Maree and Pietersen (2016) mention that this method of sampling is applied with a clearly defined aim in mind, in this instance, with the purpose of obtaining information on how formal assessments are implemented in intermediate phase mathematics teaching and learning. Nine teachers were sampled for document analysis, three from each grade, thus from Grades 4 to 6. Their portfolios which included learners' formal tasks for the year 2018 were analysed too. The checklist was succeeded by the semi-structured interviews, which served the purpose of clarifying the findings of the questionnaire and the checklist analysis.

3.6.2.3 Sample for the interviewees

Similarly, as in documentary analysis, a non-probability sampling (purposive sampling) was employed. Nine intermediate phase mathematics teachers were interviewed so as to clarify the findings of the other two data collection tools. The following paragraphs discuss how a pilot study was conducted in this research.

3.7 PILOT STUDY

A pilot study regards executing an initial test of the principal research in order to establish how feasible and valid it is (Gumbo, 2015). Similarly, Gay *et al.* (2011) affirm that it must be conducted before the final study.

Gay *et al.* (2012) mention that even if a researcher has very few participants, they still produce worthwhile results in a pilot study and it must be conducted regardless of the number of participants. Following this idea, the researcher conducted a pilot study with 15 intermediate phase mathematics teachers who had similar characteristics as the population to be studied for the final study. Fifteen questionnaires were handed out to the respondents. The return rate was 100% and all questionnaires were fully completed. It was proven then that the questionnaire was feasible and valid to be used. Cronbach's alpha of the questionnaire during the pilot study was .92. This was a good result since DeVellis (2012) mention that the Cronbach alpha coefficient of a scale must be above .7 for it to produce internal consistency. Moreover, the entire questionnaire items loaded .5 and above, as a result, the final questionnaire was not adjusted, it was the same as the one used in the pilot study. The following section discusses some of the observations and lessons learnt from the trial run.

3.7.1 Observations and lessons gained from the pilot study

The object of this part is to show a general point outline of what the researcher observed and learnt during the pilot study. Ganga and Mphalala (2015) mention that the main intent of the trial study is to determine any errors in the questioning technique; then corrections can be done before conducting the final study. The observations and experiences acquired are discussed in the following paragraphs.

3.7.1.1 Observation 1: Response rate

The response rate was very high. All 15 questionnaires sent out were returned and usable. However, some respondents took a long time to return them. The reason being that some of the novice teachers did not understand questions about the National Protocol on Assessment and the policy documents.

Lesson gained from observation 1

The high response rate gave the researcher confidence that the questionnaire had good characteristics and the results after the study can be generalised to the population under study, an idea supported by Creswell (2012). Moreover, it indicated to the researcher that there was a need to further explain some of the questions to the respondents when conducting the final study. Also, the delay was a good indication that during the final study, the timeframe of completing the questionnaire must be increased.

3.7.1.2 Observation 2: Reliability

The pilot study questionnaire demonstrated an excellent internal coherence with the Cronbach's alpha coefficient of .92.

Lesson gained from observation 2

The results obtained indicated that the questionnaire was very reliable and suitable to be administered for the final study.

3.7.1.3 Observation 3: fear to complete the questionnaire

Some of the respondents showed a certain level of fear to complete the questionnaire. They were not sure of the level of anonymity as stated in the cover letter.

Lesson gained from observation 3

This alerted the researcher that the informed consent and protection of harm had to be explained and clarified at length to the respondents during the final study before they completed the questionnaires. The subsequent section explains data analysis methods utilised in this research.

3.8 DATA ANALYSIS TECHNIQUES

Wolhuter (2015) explains that data analysis is a process of searching for similar ideas in the data set in order to make sense of it. On a similar note, data analysis means making sense of information obtained from individuals in research. It means splitting the data separately to ascertain participants' responses and then bringing it all together for the purpose of summarising it (Creswell, 2012).

3.8.1 Questionnaire data analysis techniques

Two categories of statistical techniques were utilised in this study, namely descriptive and inferential statistics. These are discussed in the ensuing paragraphs.

3.8.1.1 Descriptive statistics

Salkind (2018) suggests that the initial procedure in data analysis is to come up with a clear description of data so as to obtain a set of descriptive statistics. Field (2013) defines descriptive statistics as a general term used to refer to various numerical techniques that are utilised to arrange and sum up data in a systematic and understandable manner. After data has been collected, the researcher needs to use descriptive data to indicate the important features in the way they are distributed (Yawe & Mubazi, 2015).

Additionally, an explanation is given that the two general characteristics of the distribution are measures of central tendency and measures of dispersion. As the name suggests, a measure of central tendency is in the central part of gravitational distribution, whereas a measure of dispersion determines the spreading of data distribution from the gravity centre (Yawe & Mubazi, 2015). Descriptive statistical techniques which were employed in this study to summarise data are as follows: measures of central tendency, namely mean and median and a measure of dispersion, namely the standard deviation. The following section discusses the inferential statistics as used in the study.

3.8.1.2 Inferential statistics

Bakkabulindi (2015) defines inferential statistics as an endeavour by an individual executing a study to infer or deduce parameters of the population through sample figures. Further reference is made that it draws assumptions, in other words, forming conclusions or generalisations on the population where the sample was selected. Moreover, inferential statistics are employed to ascertain whether or not two sets of data have a significant difference (Wolhuter, 2015). The t-test and analysis of variance (ANOVA) statistical techniques were employed in this study.

When testing hypotheses through the t-test and ANOVA, most researchers in behavioural sciences attest that it is essential to determine the effect size or Cohen's *d* (which is the magnitude of the difference) (Churches & Dommett, 2016; Elliott & Woodward, 2016; Morgan, Leech, Gloeckner & Barrett, 2013; Pallant, 2016). Different researchers use different formulae to calculate the effect size. The researcher preferred the formulae that were recommended by Pallant (2016) because they were simple to understand. When calculating the effect size of the t-test results, the researcher used the following formula:

$$\text{Eta Squared} = \frac{t^2}{t^2 + (N1 + N2 - 2)}$$

Furthermore, to calculate the effect size of the ANOVA results, the researcher used the following formula:

$$\text{Eta Squared} = \frac{\text{Sum of squares between groups}}{\text{Total sum of squares}}$$

In order to interpret effect size values properly, the researcher made use of the guidelines indicated below, as given by Pallant (2016):

.01 = small effect

.06 = moderate effect

.14 = large effect.

The next section discusses checklist data analysis and techniques utilised in the study.

3.8.2 Checklist data analysis techniques

Two categories of statistical techniques namely, the descriptive and qualitative statistical techniques, were used in this study. The descriptive analysis comprised biographical details of the teachers whose formal assessment records were analysed. The following paragraph presents and discusses the interview data analysis.

3.8.3 Interview data analysis techniques

Data was recorded using a cellular phone by the researcher and interviews were done after normal teaching time. Leedy and Ormord (2016) mention that the paramount task in data analysis is to establish familiar themes as they emerge in participants' description of their experiences. After transcribing the interviews, the researcher must take the following steps:

- **Determine terms to the topic under study:** the researcher identifies and selects information relevant to the topic and breaks it into sections that indicate a resolute opinion.
- **Group segments into meaningful units:** The researcher classifies segments into groups according to connotations they denote for the phenomenon under study.
- **Explore contradictory perspectives:** The researcher looks for and examines diverse ways that different individuals empathise with the phenomenon.
- **Formulate a composite:** The researcher utilises the several meanings discovered to form an all-inclusive description of the phenomenon as experienced by different human beings.

Data was then transcribed following the steps discussed below.

- The researcher re-examined the statements that related to the topic, then semantic units such as paragraphs and phrases relevant to the questions were noted.
- The researcher verified if the phrases were relevant to the phenomenon (the implementation of formal assessments in intermediate phase mathematics teaching and learning). Themes which answered clarity questions from the questionnaire and checklist emerged and were noted down.
- Data was consolidated, which was the process of changing provisional themes which emerged and formulating sub-themes under each main theme identified from the individualised semi-structured interviews with teachers on how formal assessments were implemented.
- The researcher further evaluated the data for adequate confirmation and applicability to the study.
- Themes and sub-themes were finally tabulated and this made it more clear-cut for the researcher to do data analysis and draw conclusions thereafter.

The following section discusses the trustworthiness and credibility of qualitative data.

3.9 TRUSTWORTHINESS AND CREDIBILITY OF QUALITATIVE DATA

Nieuwenhuis (2016) attests that determining trustworthiness is the crucial verification of analysing data, confirmation of results and drawing of inferences. In this research, four criteria used to enhance the trustworthiness of qualitative research findings were implemented. These criteria are credibility, transferability, dependability and conformability (Guba, 1981) and they are explained in the ensuing paragraphs.

3.9.1 Credibility

As reported by McMillan (2012), credibility is the magnitude of which data gathered, data scrutiny and drawing of inferences are certified to be authentic and dependable. Additionally, it is the researcher's capabilities and competences to be mindful of possible entanglements that have the potential of occurring in the process of conducting the research and to handle practices that may be difficult to clarify (Gay *et al.*, 2011). Strategies for ensuring credibility were applied in this study as recommended by Gay *et al.* (2011). These are as follows:

- Prolonged participation at study site: This was done so as to test biases and perceptions
- The practice of triangulation: Triangulation is the procedure of utilising various data gathering approaches to acquire a comprehensive overview of what is currently under investigation and to verify all the relevant details (Gay *et al*., 2011). It is a process of verifying proof from different individuals or data collection methods (Creswell, 2012). Interviews with teachers were used to verify questionnaire-gathered information and document analysis findings on the perceived implementation of formal assessments.

The subsequent paragraph explains how transferability was ensured in the study.

3.9.2 Transferability

Transferability points out the seemliness of how applicable the outcomes are to the other various contextual perspectives (McMillan, 2012). It also means the inclusion of descriptive, context-relevant statements by the researcher so that any readers interacting with the research can identify with the setting (Gay *et al.*, 2011). Strategies applied to establish transferability in the study as endorsed by Gay *et al*. (2011) are:

- gathering comprehensive data so as to have a meaningful contrast of a given context which can be a school or classrooms setting to other feasible contexts to which comparison may be considered; and
- establishing accurate narrations of the circumstances so as to ensure it fits very well with other contexts when there is a need to correlate it with other contexts.

This was achieved in the study since data collected can be compared to other schools.

3.9.3 Dependability

Dependability refers to the consistency of the data collected. It was obtained through an audit trail as suggested by Gay *et al*. (2011). The researcher's supervisor acted as an external auditor to inspect the researcher's data collection, analysis and interpretation.

3.9.4 Confirmability

Confirmability means the extent to which data is neutral or objective (Gay *et al.*, 2011). Confirmability in this study was achieved through triangulation as discussed in 3.9.1. Reliability and validity of the research instruments are detailed in the subsequent paragraphs.

3.10 RELIABILITY AND VALIDITY OF THE RESEARCH INSTRUMENTS

Reliability and validity assess how good an instrument is. Further reference is made that these two terms are connected to each other in complicated ways. They are sometimes convergent and at other times conflicting (Creswell, 2012). They, however, have good characteristics of measurement. Reliability of the questionnaire employed in this study is discussed in the following paragraph.

3.10.1 Reliability of the questionnaire

Reliability is defined as the level of which respondent and/or evaluator results are correct (McMillan, 2012). It means the grades from a research tool have a high degree of stability and consistency (Creswell, 2012).

Pursuing this further, Pietersen and Maree (2016) have identified several different types of reliability, namely equivalent form reliability, test-retest reliability, split-half or split-halves reliability and internal reliability. The internal reliability was employed in this study. This type of reliability explains that when several factors are developed as a measurement of a specific concept, the degree of similarity should be very high, since one common construct is being measured, in turn indicating the dependability of the tool utilised (Petersen & Maree, 2016). The reliability of the study was .94 as shown in the table below. This is an indication of high reliability as referenced in

Pietersen and Maree (2016) as a score of .90 and above shows high reliability of the scale.

Table 3.1: Reliability of the questionnaire

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardised Items	N of Items
0,937	0,947	80

The subsequent paragraph discusses how the validity of the questionnaire was achieved in the study.

3.10.2 Validity of the questionnaire

The validity of a research tool relates to the degree to which it is measuring what it intends to actually assess (Pietersen & Maree, 2016). The questionnaire was constructed from Section 2.4 of the literature review. The questionnaire is valid since it is supposed to measure how formal assessments are implemented in mathematics teaching and learning. Reliability and validity of the checklist are discussed in the following paragraph.

3.10.3 Reliability of the checklist

The checklist is reliable as it was formulated from the CAPS policy document Grades 4-6 Mathematics (DBE 2011a: 294-296).

3.10.4 Validity of the checklist

The validity of the checklist was justified since it actually measured what it was intended to be measure. Evidently, it measured the minimum requirements for formal assessment in intermediate phase mathematics and tested cognitive levels together with a description of skills to be demonstrated. All the checklist items were derived from Section 4, Table 4.2 of the CAPS document (2011a: 294).

3.11 ETHICAL CONSIDERATIONS

As it was indicated in Chapter One (cf.1.16), the researcher ensured that the following ethical guidelines were observed by doing the following:

- The researcher made a presentation of her research proposal to the Title Registration Committee (TRC) of the Faculty of Humanities for its approval. The research proposal was submitted to the Faculty Research and Innovation Committee (FRIC) of the Faculty of Humanities for approval (Appendix A).
- Ethical clearance certificate was granted a number by FRIC [D.FRIC.08/18/7] (Appendix B).
- The researcher completed a research application form to seek permission from the Free State Department of Education to conduct the research at schools in the Lejweleputswa district. The FSDoE granted approval with attached conditions (Appendix C).
- The researcher carefully considered all possible consequences for educators who participated in this research.
- The researcher ensured that the consent of sampled educators was discretionary and informed, devoid of any inferred punishment for rejecting to take part and with respect to their anonymity. The researcher told the participants that they could withdraw from taking part at any point of the research.
- The researcher protected all participants from groundless personal injury mental pain, torment and suffering due to participation.
- The researcher guaranteed all participants that information obtained from them would be handled with confidentiality.
- The researcher took honour only for the role undertaken in reference to academic and proceedings with research and gave acknowledge to the inputs of other participants.

3.12 LIMITATIONS OF THE RESEARCH

A limitation refers to a certain characteristic of the research that the researcher is not able to limit but anticipates could unfavourably influence the outcomes of the research (Gay *et al.*, 2011). The study included teachers from one district only. In addition, these teachers are supported by the same subject advisors. This limited the scope of the study. Therefore, the findings of the study might not be generalisable to all intermediate phase mathematics teachers in South Africa (in general) and Free State province in particular.

3.12.1 Limitations related to contextual characteristics

McMillan (2012) states that contextual characteristics refer to specific locations and surroundings where one carries out the study. Further reference is made that what might happen in one setting, for example, in a school might happen in the same manner in another school. This is due to variances in their context and characteristics. This also happens in research; there are impediments which happen due to settings which affect researchers carrying out research effectively. These conditions are specified as determinants that affect the ecological validity of the study. Ecological validity has strength if the research findings are generalisable to various setups. This is inarguably a restriction in studies that are undertaken in a singular setting, for example, a classroom or school.

Regarding this research, the ecological validity was limited since the outcomes are to be generalised to different settings, yet the research was conducted in only one district. Therefore, results are not valid enough to be generalised to all Grade 6 mathematics teachers in South African schools.

3.12.2 Limitations related to data collection tools

The use of closed-ended questions posed a disadvantage since respondents could only respond to the listed items; there was not much room for them to share their own views.

3.13 CONCLUSION

In this chapter, research and design methodology were discussed, the logic for using a mixed-method procedure was also explained. The researcher discussed data gathering procedure, sampling and the pilot study, alongside the ethical considerations. The next chapter will present and analyse data that has been gathered.

CHAPTER 4: DATA PRESENTATION AND ANALYSIS

4.1 INTRODUCTION

This chapter details a presentation and analysis of data obtained from the questionnaire, document analysis and semi-structured interviews regarding the implementation of formal assessments in intermediate phase mathematics teaching and learning. Data presentation and analysis was done emulating the sequential explanatory mixed-methods research design as explained in Chapter Three. The researcher will start by presenting and analysing quantitative data first and then qualitative data thereafter. The analysis of quantitative data is in two sections, thus descriptive statistics first, followed by inferential statistics.

Pietersen and Maree (2016) define descriptive statistics as a common name for a sum of statistical procedures that are utilised in the organisation and summary of data in a coherent manner. This, in turn, contributes to the improvement of grasping the characteristics of data (Field, 2013). Yawe and Mubazi (2015) recommend that once the researcher has collected quantitative data, descriptive statistics need to be applied to convey the significant aspects of distribution. They further reference that the two general attributes of the distribution are measures of central tendency and measures of dispersion. Following this idea, the measures of central tendency that were utilised for data analysis purposes in this research are the mean (*M*) and the median (*MD*). Thereupon, standard deviation *(SD*) was employed to measure the dispersion of data from the mean.

4.2 PRESENTATION AND ANALYSIS OF QUANTITATIVE DATA

In this section, quantitative data is presented and analysed. Descriptive statistics are analysed first, followed by the inferential statistics.

4.2.1 Presentation and analysis of descriptive statistics data

The following section will present and analyse data obtained from the questionnaire. Descriptive statistics will address the following research question: *How do intermediate phase mathematics teachers implement formal assessment methods to enhance teaching and learning?* All the descriptive statistics data which are presented and analysed in this section are found in Appendix I. The following table presents the biographical data of the respondents.

4.2.1.1 Biographical details of the respondents

Table 4.1: Biographical details of teachers **N=151**

Personal Items			% Respondents According to Category	% Total
A1. Gender	Male		58 (38%)	100
	Female		93 (62%)	
A2. Age	20 – 35 years old		72 (48%)	100
	36 – 55 years old		79 (52%)	
	Mean	37 years old		
	Minimum	20 years old		
	Maximum	55 years old		
A3. Teaching experience	1 – 5 years		55 (36%)	100
	6 – 28 years		96 (64%)	
	Mean	10 years		
	Minimum	1 year		
	Maximum	28 years		
A4. Professional teaching qualification in the Intermediate Phase	Yes		69 (46%)	100
	No		82 (54%)	
A5. Number of learners in class	25 – 35 learners		60 (40%)	100
	36 – 55 learners		91 (60%)	
	Mean	42 learners		
	Minimum	25 learners		
	Maximum	55 learners		

Analysis of data in Table 4.1 indicates that the intermediate phase is dominated by female teachers (62%), whilst their male counterparts make up 38%. This can be associated with most of the intermediate phase learners who are at a concrete-operational stage whereby they need much care in terms of mastering the basics. This is connected to the female teachers who are perceived to be loving and caring.

Statistics indicate that 48% of the teachers in this phase fall within the youth age group (20-35 years) and 52% of the teachers are between the ages of 36-55 which is the old age group. There is not much difference in terms of age groups; this is a good indication of staff allocation. Another revelation is that the youngest teacher is 20 years old, whereas the oldest teacher is 55 years old and their mean age is 37 years of age. 64% of the intermediate phase teachers have teaching experience of between 6-28 years, whereas 36% of them have between 1-5 years of teaching experience. This is not a good indication, as the percentage has the potential of creating challenges in the teaching and learning of mathematics in this phase due to inadequate experience, the percentage of teachers with less experience is very high. Furthermore, only 46% of these teachers are trained to teach the phase, with 54% not trained for this particular phase; this may also pose a challenge on the effective teaching and assessment methods in the phase. Data in this table also indicate that 60% of the intermediate phase classes are overcrowded, exceeding the teacher-learner ratio of 1:40. The implication is that there is too great a workload for the teachers and individualised attention for the learners and feedback may not be adequately achieved. This might have a negative consequence on teaching and learning and the implementation of formal assessments in intermediate phase mathematics.

4.2.1.2 The implementation of formal assessments in the intermediate phase mathematics as a foundation of teaching and learning

The following table presents the teachers' responses about marking and recording of formal assessments.

Table 4.2a: Recording and moderation of formal assessment tasks N=151

Questionnaire items		Mean	Median	Standard Deviation
B1	I mark formal tasks for learners' promotion purposes.	6.91	7.00	0.30
B2	I record formal assessment marks for learners' promotion purpose.	6.91	7.00	0.40

Table 4.2b: Recording and moderation of formal assessment tasks N=151

Questionnaire items		Mean	Median	Standard Deviation
B3	Submit formal assessment tasks for moderation for the purpose of quality assurance and maintaining appropriate standards.	6.91	7.00	0.35
B4	I use various forms of assessment like tests, examinations, projects and assignments according to the CAPS document.	6.88	7.00	0.36
B5	The forms of assessment I use are appropriate to the ages and cognitive levels of learners.	6.80	7.00	0.54
B6	The tasks I design cover the content and achieve the broad aims of the subject.	6.83	7.00	0.42
B7	I use appropriate instruments such as rubrics and memoranda for marking tasks.	6.92	7.00	0.29

Analysis of data in Tables 4.2a and b disclose that teachers use appropriate instruments such as rubrics and memoranda for marking tests (*M* = 6.92; *MD*= 7.00; *SD*= 0.29). The statistics stipulate that the data is negatively skewed as the mean is lower than the median. However, this implies that there is agreement among the respondents because the standard deviation is closer to the mean. Another revelation is that teachers submit formal assessments for moderation (*M*=6.91; *MD*=7.00; *SD*= 0.35).

The statistics indicate that data is negatively skewed again as the mean is lower than the median. However, there is agreement amongst the respondents because the standard deviation is very close to the mean. The ensuing table serves to present and analyse data on the administration of tests and examinations in intermediate phase mathematics teaching and learning.

Table 4.3: Tests and examinations **N=151**

	Questionnaire items	Mean	Median	Standard Deviation
C1	I design tests and examinations to ensure that learners demonstrate their full potential in mathematics content	6.36	6.00	0.65
C2	I spread questions to cater for different cognitive levels.	6.17	6.00	0.78
C3	I assess tests and examinations using a memorandum.	6.67	7.00	0.55
C4	I set authentic tests that ask learners questions, which will enable them to display their skills in real-life situations.	6.29	6.00	0.73
C5	I apply six cognitive levels of Bloom's taxonomy when setting tests and examinations.	5.97	6.00	1.07

Analysis of data in Table 4.3 reveals that teachers assess tests and examinations using a memorandum (*M*=6.67; *MD*=7.00; *SD*= 0.55). This is so because the standard deviation is nearer to the mean. Statistics indicate that data is negatively skewed because the mean is lower than the median. Furthermore, respondents are in agreement that they design tests and examinations to ensure that learners demonstrate their full potential in mathematics content (*M*=6.36; *MD*=6.00; *SD*=0.65). The standard deviation is nearer to the mean. The statistics indicate that the data is positively skewed because the mean is higher than the median. The following table presents and analyses data on the implementation of assignments as a formal assessment in intermediate phase mathematics teaching and learning.

Table 4.4: Assignments **N=151**

	Questionnaire items	Mean	Median	Standard Deviation
D1	I ensure that assignments are individualised tasks.	6.25	6.00	0.68
D2	I make use of a collection of past examination questions, which have the same concept to be covered for that assignment.	6.50	7.00	0.62
D3	I focus on the more demanding work for which resource material can be used.	6.26	6.00	0.76
D4	I give assignments immediately after the lessons or activities to which they relate.	5.95	6.00	1.04
D5	I display the assignment in the classroom so that learners who have missed the information can always refer to the display.	5.20	6.00	1.63

Analysis of data in Table 4.4 shows that teachers make use of past examination questions which have the same concept as preparing learners for assessment (*M*=6.50; *MD*=7.00; *SD*=0.62). There is accordance among the respondents about this item because the standard deviation is closer to the mean. The data is negatively skewed since the mean is lower than the median. There is no agreement among the teachers in giving assignments immediately after the activities to which they relate (*M*=5.95; *MD*= 6.00; *SD*=1.04). Statistics reveal that the standard deviation is far from the mean. Furthermore, teachers are not in agreement with the idea of displaying assignments in the classroom to cater for learners who would have missed the information (M=5.20; *MD*= 6.00; *SD*= 1.63); as disclosed, the standard deviation is far from the mean, confirming the dissimilarity among the respondents. Data in both items are negatively skewed because the means are lower than the medians. Consecutively, projects as forms of formal assessment in mathematics are discussed below.

Table 4.5: Projects **N=151**

Questionnaire items		Mean	Median	Standard Deviation
E1	I use projects to assess a variety of skills and competencies.	5.92	6.00	0.81
E2	I ensure the integration of various activities like planning, research, data analysis and reporting when setting projects.	5.85	6.00	0.87
E3	I ensure that learners are able to demonstrate their understanding of different mathematical concepts through projects and apply them in real-life situations.	5.99	6.00	0.83
E4	I set projects, which are not above learners' cognitive levels.	6.04	6.00	0.82
E5	I clearly indicate the assessment criteria on the project specification.	6.23	6.00	0.80
E6	I focus on the mathematics involved and not on duplicated pictures and facts copied from reference material.	6.11	6.00	0.90
E7	The projects I give contain the collection and display of real data.	5.95	6.00	0.84
E8	I ensure that I teach skills like research and presentations before handing out projects for assessment.	6.19	6.00	0.84

Analysis of data in Table 4.5 reveals that most of the respondents are in agreement that projects are utilised properly as a form of formal assessment. There is an agreement that teachers clearly indicate the assessment criteria on the project specification (*M*=6.23; *MD*= 6.00 *SD*= 0.80). Moreover, teachers ensure that they teach skills such as research and presentations before handing out projects for assessment (*M*=6.19; *MD*=6.00; *SD*=0.84). Both items discussed above have the standard deviations closer to the means, affirming that there is agreement among the respondents. The data for both items is positively skewed because the mean is higher than the median. The next table presents an analysis of data about investigation as a form of formal assessment in mathematics teaching and learning.

Table 4.6: Investigation **N=151**

	Questionnaire items	Mean	Median	Standard Deviation
F1	I set investigation tasks, which promote critical thinking and creative thinking.	5.89	6.00	0.83
F2	I ask questions, which will help learners to discover rules and concepts.	5.88	6.00	0.79
F3	I ensure that the investigation question involves inductive reasoning.	5.80	6.00	0.82
F4	I ask questions, which will lead learners to identifying patterns or relationships.	5.92	6.00	0.82
F5	My investigation question (s) allows learners to draw conclusions and establish general trends.	5.83	6.00	0.84
F6	I allow my learners to seek assistance when doing the initial investigation at home; however, the final write-up is done in class, under my supervision.	6.45	7.00	0.78
F7	I assess investigations with rubrics.	6.68	7.00	0.74
F8	I award marks for each skill tested in the task.	6.77	7.00	0.58
F9	I include organising and recording ideas and discoveries, e.g. diagrams and tables.	6.53	7.00	0.81
F10	I award marks for communicating investigation ideas with appropriate explanations.	6.72	7.00	0.70
F11	I award marks for calculations, which show clear understanding of mathematical concepts.	6.81	7.00	0.57
F12	I award marks for generalising and drawing conclusions.	6.60	7.00	0.88
F13	The forms of investigation task I use are appropriate to the age and cognitive levels of learners.	6.10	6.00	0.94
F14	My investigation question (s) allows learners to inquire, as well as experiment.	5.83	6.00	1.04

Analysis of data in Table 4.6 reveals that respondents are in agreement with the issue of awarding marks for calculations, which show a clear understanding of mathematical concepts (*M*=6.81; *M*=7.00; *SD*=0.57). Data for this item is negatively skewed because the mean is lower than the median. Data about the appropriateness of investigation tasks versus the age and cognitive levels of learners are sufficiently achieved (*M*=6.10; *MD*=6.00; *SD*=0.94). The standard deviation is nearer to the mean. Data is positively skewed as the mean is higher than the median. Ultimately, data in this table shows that educators' investigations question allow learners to inquire as well as experiment (*M*=5.83; *MD*=6.00; *SD*=1.04). The standard deviation is nearer to the mean, showing that most of the teachers are in agreement with this item. Data is negatively skewed considering that the mean is below the median. The subsequent table discusses moderation as a form of formal assessment in intermediate phase mathematics teaching and learning.

Table 4.7: Moderation **N=151**

Questionnaire items		Mean	Median	Standard Deviation
G1	I submit my assessment tasks for moderation to ensure that they are fair, valid and reliable.	6.78	7.00	0.56
G2	I submit my formal assessment tasks for moderation internally at school.	6.68	7.00	0.80
G3	I submit my formal tasks for moderation externally to the subject advisors.	3.90	4.00	1.91
G4	I ensure that quality assessment is given and high but achievable standards maintained through the moderation process.	6.50	7.00	0.80
G5	My formal tasks meet the principles of high-quality assessment through the moderation process.	6.57	7.00	0.64

Analysis of data in Table 4.7 shows that formal assessments are moderated internally to ensure fairness, validity and reliability (*M*=6.78; *MD*=7.00; *SD*=0.56). Data shows that there is an agreement between the respondents as the standard deviation is not far from the mean. Data for this item is negatively skewed since the mean is lower than the median. On the other hand, there is a variance on the external moderation of formal assessments by the subject advisors (*M*=3.90; *MD*=4.00; *SD*= 1.91). This mean implies that there is less external moderation of formal assessments by the subject advisors. As reflected, the standard deviation is far from the mean confirming the disagreement among the respondents. Data is negatively skewed in this item as the mean is lower than the median. The following table presents and analyses data on recording and reporting of formal assessments.

Table 4.8: Recording and reporting of formal assessments N=151

Questionnaire items		Mean	Median	Standard Deviation
H1	I document the level of a learner's performance in a specific assessment task through recording the marks.	6.89	7.00	0.37
H2	I track learner's development through recording in order to improve classroom teaching.	6.91	7.00	0.33
H3	I make use of records to indicate the learners' progress towards the achievement of the knowledge as prescribed in the CAPS document.	6.93	7.00	0.25
H4	I record learners' performance to provide evidence of their conceptual progression within a grade and their readiness to the next grade.	6.94	7.00	0.26
H5	I use checklists as ways of recording assessment.	6.25	7.00	1.47
H6	I use rating scales as ways of recording assessments.	6.19	7.00	1.51
H7	I use records of learner performance in formal assessments to verify the progress I make in the teaching and learning process.	6.81	7.00	0.65
H8	I communicate learner performance to learners, parents, school and other stakeholders through the reporting process.	6.78	7.00	0.69

Data in Table 4.8 show that teachers are in agreement that they record learners' performance to provide evidence of their conceptual progression within a grade and their readiness to the next grade (*M*=6.94; *MD*= 7.00; *SD*=0.26). The standard deviation is nearer the mean, data in this item is negatively skewed since the mean is smaller than the median. There is disagreement among the respondents on the use of checklists as ways of recording assessment (*M*=6.25; *MD*=7.00; *SD*=1.47). This is shown by the position of the standard deviation, which is far from the mean. Data from this item is negatively skewed because the mean is lower than the median.

Furthermore, data reveals that respondents are also not in agreement with the use of rating scales as ways of recording assessments (*M*=6.19; *MD*= 7.00; *SD*= 1.51). Statistics show that data is negatively skewed since the mean is lower than the median; the standard deviation is far from the mean showing that there is disagreement amongst the respondents. The upcoming table presents and analyses the challenges in mathematics assessments.

Table 4.9a: Challenges in mathematics assessments **N=151**

Questionnaire items		Mean	Median	Standard Deviation
I1	Formal assessments allow me to have adequate teaching time.	4.62	4.00	1.15
I2	My class sizes are suitable for formal assessments.	4.23	4.00	1.28
I3	I am able to mark formal assessment tasks and give my learners individualised attention.	4.21	4.00	1.08
I4	I find it easy to pay attention to the learners' individualised needs.	4.17	4.00	1.06
I5	I find it easy to provide quality feedback when implementing formal assessments.	4.44	4.00	1.17
I6	I have adequate knowledge and skills for the implementation of formal assessments.	5.90	6.00	1.07
I7	I underwent training for the implementation of formal assessments.	5.48	6.00	1.75
I8	I know exactly what formal assessment is.	6.34	6.00	0.80
I9	I know exactly how to implement formal assessments.	6.30	6.00	0.83
I10	I have the mathematical content knowledge to notice and analyse learners' mathematical thinking.	6.31	6.00	0.67
I11	I have adequate content knowledge on the implementation of formal assessments in mathematics.	6.21	6.00	0.79
I12	I have adequate pedagogical knowledge on the implementation of formal assessments in mathematics.	6.16	6.00	0.84
I13	I have proper qualifications in the subject.	5.84	6.00	1.07
I14	I have proper experience in the subject.	5.83	6.00	1.07

Table 4.9b: Challenges in mathematics assessments **N=151**

Questionnaire items		Mean	Median	Standard Deviation
I15	I have prior knowledge of all my learners' cognitive levels before I assess them.	5.76	6.00	0.99
I16	I receive professional development, which addresses areas of my pedagogical challenges.	5.47	5.00	1.18
I17	I am competent in developing and validating new assessments.	5.74	6.00	0.97
I18	I am competent in validating existing assessments.	5.72	6.00	0.93
I19	I am part of teacher networking, where we work together as teachers to share ideas on formal assessment tasks (Professional Learning Committee.)	5.70	6.00	0.83
I20	I receive adequate support from the subject advisor.	5.04	5.00	1.01
I21	I understand the National Protocol on Assessment very well.	5.66	6.00	1.16
I22	I am able to adapt my assessment practices on the changing demands of the contents' school education system.	5.91	6.00	0.97
I23	I view the National Protocol on assessment as confusing and complex.	3.70	4.00	1.71
I24	I view the National Protocol on Assessment as clear and simple.	5.09	6.00	1.39
I25	The language of teaching and learning makes it easy for my learners to understand the instruction for assessment questions.	3.66	3.00	1.42
I26	I am able to perform dual tasks, namely teaching both Mathematics and English at the same time.	5.95	6.00	1.25
I27	My learners are able to solve word problems due to language clarity and word structure.	3.23	3.00	1.24
I28	My learners are able to perform in mathematics because they can read and write fluently in English.	3.24	3.00	1.26

Analysis of data in Tables 4.9a and 4.9b reveal that besides the challenges teachers face in the implementation of formal assessments, there is an agreement that they know exactly what formal assessment is (*M*=6.34; *MD*=6.00; *SD*=0.80). This is confirmed by the standard deviation which is nearer to the mean. Moreover, teachers are in agreement that they have the mathematical content knowledge to notice and analyse learners' mathematical thinking (*M*=6.31; *MD*=6.00; *SD*=0.67). Statistics also show that the standard deviation is again nearer to the mean, affirming the agreement of respondents. Data from both items analysed is positively skewed since the means are higher than the medians.

However, there is noticeable disagreement among the respondents in various items as discussed in the ensuing paragraphs. Data reveals that respondents are not in agreement with formal assessments allowing them to have adequate teaching time (*M*=; 4.62; *MD*=4.00; *SD*=1.15). Furthermore, there is disparity among respondents on the suitability of class sizes for formal assessments (*M*=4.23; *MD*=4.00; *SD*=1.28). The standard deviations for both items immediately discussed are far from their means, showing that there is disagreement among the teachers on these items. Data for both items is positively skewed as the means are greater than their medians. Data also reveal that there is much disagreement among the respondents on how they view the National Protocol on Assessment; on its clarity and simplicity (*M*=3.70; *MD*=4.00; *SD*=1.71). As indicated by the statistics, the standard deviation is far from the mean for this item, showing that there is disagreement among the respondents. Data is negatively skewed since the mean is lower than the median. There is much discrepancy among the respondents in the ability of learners to solve word problems due to language clarity and word structure and the notion that the use of the language of teaching and learning makes it easy for learners to understand the instruction for assessment questions (*M*=3.66; *MD*=3.00; *SD*=1.42). As indicated, the standard deviation is far from the mean confirming disagreement among the respondents for the item discussed. Data for this item is positively skewed since the mean is higher than the median.

Another notable revelation is that there is disagreement among the respondents in receiving professional development, which addresses areas of their pedagogical challenges (*M*=5.47; *MD*=5.00; *SD*=1.18). The standard deviation is far from the meaning showing that there is disagreement among the respondents. Data for this item is positively skewed as the mean is higher than the median. Moreover, statistics reveal that respondents are not in agreement with receiving adequate support from the subject advisor (*M*=5.04; *MD*=5.00; *SD*=1.01). The standard deviation is far from the meaning affirming a disagreement among the respondents. Data for this item is positively skewed since the mean is higher than the median. The next section presents and analyses the inferential statistics data.

4.2.2 Presentation and analysis of inferential statistics data

As indicated earlier in Chapter Three of this study (cf. in 3.8.1.2), Bakkabulindi (2015) defines inferential statistics as an endeavour by an individual executing a study to infer or deduce the parameters of the population through sample figures. Further reference is made that it draws assumptions, in other words, forming conclusions or generalities on the population where the sample was selected. Pietersen and Maree (2016) confirm that the motive of research is to utilise sample data in drawing conclusions for the whole population. Moreover, through inferential statistics, an assessment of whether the differences in means or the relationship among the variables is much greater or smaller than what was predicted. All the inferential statistics data which are presented and analysed in this section are found in Appendix J.

4.2.2.1 Comparison of male and female intermediate mathematics teachers on formal assessment

The table below presents data that test the following hypotheses, as suggested by several authors (Elliot & Woodward, 2016; Morgan, Leech, Gloeckner & Barrett, 2013; Pallant, 2016).

H_0: There is no statistically significant difference between male and female intermediate mathematics teachers on formal assessment scores.

H_1: There is a statistically significant difference between male and female intermediate mathematics teachers on formal assessment scores.

Table 4.10: Comparison of male and female intermediate mathematics teachers on formal assessment (n = 58 males, 93 females)

Variable		*M*	*SD*	*t*	*df*	*p*	*d*
Formal assessment				1.40	149	.16	0.01
	Males	199.86	12.84				
	Females	196.42	15.73				

An independent-sample t-test was conducted to make a comparison of male and female intermediate phase mathematics teachers on formal assessment. Analysis of data in Table 4.10 reveals that there is no statistically significant difference in scores for males (*M*=199.86, *SD*=12.84) and females (*M*=196.42, *SD*=15.73; *t* [149] =1.40, *p*=.16, two-tailed). The magnitude of the differences in the means (mean difference=3.44, 95% *CI*: -142 to 8.30) was very small (eta squared=.01). Furthermore, when making a decision based on the confidence interval, statistics in the table reveal that the intervals include 0 (zero) which again indicates that there is no statistically significant difference between the means. Therefore, the null hypothesis is accepted whereas the alternative hypothesis is rejected.

4.2.2.2 Comparison of young and old intermediate mathematics teachers on formal assessment

The table below presents data that test the following hypotheses:

H_0: There is no statistically significant difference between young and old intermediate mathematics teachers on formal assessment scores.

H_1: There is a statistically significant difference between young and old intermediate mathematics teachers on formal assessment scores.

Table 4.11: Comparison of young and old intermediate mathematics teachers on formal assessment (n = 72 young teachers, 79 old teachers)

Variable		*M*	*SD*	*t*	*df*	*p*	*d*
Formal assessment				-3.45	149	.00	0.07
	Young teachers	193.56	11.92				
	Old teachers	201.56	16.05				

Analysis of data in Table 4.11 shows that there is a statistically significant difference in the mean scores for young and old teachers on the implementation of formal assessment (*M*=193.56, *SD*=11.92) and old teachers (*M*=201.56, *SD*=16.05; *t* [149] =-3.45, *p*=.00, two-tailed). The magnitude of the differences in the means (mean difference=-8.00, 95%*CI*-12.58 to -3.42) was moderately large (eta squared= 0.07). Moreover, when making a decision based on the confidence interval, statistics in the table reveal that the intervals do not include 0 (zero) which again indicates that there is a statistically significant difference between the means. Therefore, the null hypothesis is rejected whereas the alternative hypothesis is accepted.

4.2.2.3 Comparison of intermediate mathematics teachers with teaching experiences of 1-5 years and 6-28 years on formal assessment

The table below presents data that test the following hypotheses:

H_0: There is no statistically significant difference among intermediate mathematics teachers with teaching experiences of 1-5 years and 6-28 years on formal assessment scores.

H_1: There is a statistically significant difference among intermediate mathematics teachers with teaching experiences of 1-5 years and 6-28 years on formal assessment scores.

Table 4.12: Comparison of intermediate mathematics teachers with 1 to 5 years of teaching experience and 6 to 28 years of teaching experience on formal assessment (n = 1 to 5 years of teaching experience 55, 6 to 28 years of teaching experience 96)

Variable	*M*	*SD*	*t*	*df*	*p*	*d*
Forms of formal assessment			-3.13	149	.00	0.06
1-5 years teaching experience	192.93	11.71				
6-28 years teaching experience	200.50	15.62				

Analysis of data in Table 4.12 shows that there is a statistically significant difference in the mean scores for teachers with 1 to 5 years of teaching experience (*M*=192.93, *SD*=11.71) and 6 to 28 years of teaching experience (*M*=200.50, *SD*= 15.62; *t*[149] =-3.13, *p*=.00, two-tailed). The magnitude of the differences in the means (mean difference=-757, 95% *CI*:-12.36 to -2.79) was moderately large (eta squared= 0.06).

Moreover, when making a decision based on the confidence interval, statistics in the table reveal that the intervals do not include 0 (zero) which again indicates that there is a statistically significant difference between the means. Therefore, the null hypothesis is rejected whereas the alternative hypothesis is accepted.

4.2.2.4 Comparison of intermediate mathematics teachers with or without professional teaching qualification in the intermediate phase on formal assessment

The following table presents data that test the following hypotheses:

H_0: There is no statistically significant difference among mathematics teachers with or without professional teaching qualification in the intermediate phase on formal assessment scores.

H_1: There is a statistically significant difference among mathematics teachers with or without professional teaching qualification in the intermediate phase on formal assessment scores.

Table 4.13: Comparison of intermediate mathematics teachers with or without professional teaching qualification in the intermediate phase on formal assessment (n = 69 with a professional qualification in the intermediate phase, 82 without a professional qualification in the intermediate phase)

Variable	*M*	*SD*	*t*	*df*	*p*	*d*
Formal assessment			2.58	149	.01	0.04
Yes	201.06	16.60				
No	194.95	12.40				

An independent–sample t-test was conducted to compare teachers with or without professional teaching qualification in the intermediate phase on formal assessments. Analysis of data in Table 4.13 reveals that there is a statistically significant difference in scores of means for teachers with qualifications (*M*=201.06, *SD*=16.60) and without qualifications (*M*=194.95, *SD*=12.40; *t* = [149] =2.58, *p*=.01, two-tailed). The magnitude of the differences in the means (mean difference=6.11, 95% *CI*: 1.44 to 10.78) was moderately small (eta squared=.04). Furthermore, when making a decision based on the confidence interval, statistics in the table reveal that the intervals do not include 0 (zero) which again indicates that there is a statistically significant difference between the means. Therefore, the null hypothesis is rejected whereas the alternative hypothesis is accepted.

4.2.2.5 Comparison of intermediate mathematics teachers who teach an average of 25 to 40 learners and 41 to 55 learners on formal assessment

The following table presents data that test the following hypotheses:

H_0: There is no statistically significant difference among intermediate mathematics teachers who teach an average of 25-40 learners and an average of 41-55 learners on formal assessment scores.

H_1: There is a statistically significant difference among intermediate mathematics teachers who teach an average of 25-40 learners and an average of 41-55 learners on formal assessment scores.

Table 4.14: Comparison of intermediate mathematics teachers who teach an average of 25 to 40 learners and 41 to 55 learners on formal assessment (n = 25-40 learners 60, 41-55 learners 91)

Variable	*M*	*SD*	*t*	*df*	*p*	*d*
Formal assessment			1.94	149	.05	0.02
25-40 learners	200.58	12.94				
41-55 learners	195.87	15.60				

An independent-sample t-test was conducted to make a comparison between teachers who teach an average of 25 to 40 learners and 41 to 55 learners. Analysis of data in Table 4.14 reveals that there is a statistically significant difference in scores for teachers who teach an average of 25 to 40 learners (*M*=200.58, *SD*=12.94) and those who teach an average 41 to 55 learners (*M*=195.87, *SD*= 15.60; *t*= [149] =1.94, *p*=.05, two-tailed). The magnitude of the differences in the means (mean difference=4.72, 95% *CI*: -0.8 to 9.51) was small (eta squared=.02). Furthermore, when making a decision based on the confidence interval, statistics in the table reveal that the intervals do not include 0 (zero) which again indicates that there is a statistically significant difference between the means. Therefore, the null hypothesis is rejected whereas the alternative hypothesis is accepted.

Independent-sample t-tests were conducted to compare male and female intermediate mathematics teachers on various forms of assessment. The following table presents data of the independent-sample t-tests which were conducted**.**

Table 4.15: Comparison of male and female intermediate mathematics teachers on various forms of assessment (n = 58 males, 93 females)

Variable		*M*	*SD*	*t*	*df*	*p*	*d*
Tests and Examination				-.13	149	.90	0.00
	Males	31.43	3.00				
	Females	31.49	3.04				
Assignment				.91	149	.37	0.01
	Males	30.48	2.97				
	Females	29.97	3.63				
Project				.63	149	.53	0.00
	Males	48.64	5.14				
	Females	48.06	5.65				
Investigation				1.88	149	.62	0.02
	Males	89.31	5.67				
	Females	86.89	8.68				
Moderation				.65	149	.52	0.00
	Males	37.55	3.30				
	Females	37.20	3.16				
Recording and Reporting				1.47	146.86	.14	0.01
	Males	61.14	2.92				
	Females	60.29	4.16				

Analysis of data in **Table 4.15** discloses that with reference to **tests and examinations**, there is not a statistically significant difference in the mean scores for males (*M*=31.43, *SD*= 3.00) and females (*M*=31.49, *SD*= 3.04; *t*= [149] =-.13, *p*=.90, two-tailed). The magnitude of the differences in the means (mean difference=-.06, 95% *CI*: -1.1 to .94) was very small (eta squared= 0.00). Concerning **assignments** as a variable, there was also no significant difference in the mean scores for males (*M*=30.48, *SD*= 2.97) and females (*M*=29.97, *SD*=3.63; *t* [149] =.91, *p*=.37, two-tailed). The magnitude of the differences in the means (mean difference=.52, 95% *CI*: -.61 to 1.64) was very small (eta squared=0.01).

Moving on to **projects**, there was no significant difference in scores for males (*M*=48.64, *SD*= 5.14) and females (*M*=48.06, *SD*= 5.65; *t* [149] =.63, *p*=.53, two-tailed). The magnitude of the differences in the means (mean difference=.57, 95% *CI*: -1.23 to 2.38) was very small (eta squared=0.00). Analysis of **data investigation** as a form of formal assessment reveals that there is also no significant difference in scores for males (*M*=89.31, *SD*=5.67) and females (*M*=86.89, *SD*= 8.68; *t* [149] = 1.88, *p*=.62, two-tailed). The magnitude of the differences in the means (mean difference=2.42, 95% *CI*: -.12 to 4.95) was very small (eta squared=0.02).

With regard to **moderation of formal assessment**, analysis of data in this table indicates that there is no significant difference in scores for males (*M*=37.55, *SD*=3.30) and females (*M*=37.20; *SD*=3.16; t [149] =.65, *p*=.52, two-tailed). The magnitude of the differences in means (mean difference=.35, 95% *CI*:-72 to 1.41) was very small (eta squared=0.00). Regarding **recording and reporting of formal assessment**, analysis of data shows that there is no significant difference in scores for males (*M*=61.14, *SD*=2.92) and females (M= 60.27, *SD*=4.16; *t* [146.86] =1.47, *p*=.14, two-tailed). The magnitude of the differences in means (mean=.85, 95% *CI*:-.61 to 1.64) is very small (eta squared =0.01).

Independent-sample t-tests were conducted to compare young and old intermediate mathematics teachers on various forms of assessment. The following table presents data of the independent-sample t-tests which were conducted**.**

Table 4.16: Comparison of young and old intermediate mathematics teachers on various forms of assessment (n = 72 young teachers, 79 old teachers)

Variable		*M*	*SD*	*t*	*df*	*p*	*d*
Tests and Examination				-5.92	149	.00	0.19
	Young teachers	30.10	2.73				
	Old teachers	32.72	2.71				
Assignment				-2.04	149	.04	0.03
	Young teachers	29.58	3.30				
	Old teachers	30.70	3.40				
Project				-1.36	149	.18	0.01
	Young teachers	47.65	4.49				
	Old teachers	48.86	6.17				
Investigation				-2.47	149	.02	0.04
	Young teachers	86.22	5.63				
	Old teachers	89.28	9.04				
Moderation				-1.08	149	.28	0.01
	Young teachers	37.04	3.40				
	Old teachers	37.61	3.03				
Recording and Reporting				-.15	149	.89	0.00
	Young teachers	60.57	3.24				
	Old teachers	60.66	4.17				

Analysis of data in Table 4.16 reveals that with reference to **tests and examinations**, there is a statistically significant difference in the mean scores for young teachers (*M*=30.10, *AD*= 2.73) and old teachers (*M*= 32.72, *SD*=2.71; *t* [149] =-5.92, p=.00, two-tailed). The magnitude of the differences in means (mean difference=-2.62, 95% *CI*:-3.50 to -1.75) was large (eta squared=0.19). Again, with regard to **assignments**, there was a significant difference in scores for young teachers (*M*=29.58, *SD*= 3.30) and old teachers (*M*=30.70, *SD*=3.40; *t* [149] =-2.04, *p*= .04, two-tailed). The magnitude of the differences in means (mean difference=-1.11, 95% *CI*: -3.50 to -1.75) was small (eta squared =0.03).

Concerning **projects** as a formal assessment, there was no significant difference in scores for young teachers (*M*=47.65, *SD*=4.49) and old teachers (*M*=48.86, *SD*=6.17; *t*= [149] =-1.36, *p*=.18, two-tailed). The magnitude of the differences in the means (mean=-1.21, 95% *CI*: -2.96 to .54) was small (eta squared= 0.01). Relating to **investigation** as a formal assessment, statistics reveal that there was a significant difference in scores for young teachers (*M*=86.22, *SD*=5.63) and old teachers (*M*= 89.28, *SD*= 9.04; *t*= [149] =-2.47, *p*=.02, two-tailed). The magnitude of the differences in the means (mean=-3.06, 95% *CI*: -5.51 to -.61) was moderately small (eta squared 0.04).

With regard to the **moderation of formal assessment**, there is no significant difference in the scores of young teachers (*M*=37.04, *SD*=3.40) and old teachers (*M*=37.61, *SD*=3.03; *t* [149] =-1.08, *p*=.28, two-tailed). The magnitude of the differences in the means (mean difference =-.57, 95% *CI*: -1.60 t0 .47) was very small (eta squared=0.01). Lastly, with regard to **recording and reporting of formal assessment**, again there is no significant difference in the scores of young teachers (*M*=60.57, *SD*= 3.24) and old teachers (*M*=60.66, *SD*= 4.17; *t*= [149] =-.15, *p*=.89, two-tailed). The magnitude of differences in the means (mean=-.089, 95% *CI*: -1.30 to 1.12) was very small (eta squared=0.00).

Independent-sample t-tests were conducted to compare intermediate mathematics teachers with 1 to 5 years and 6 to 28 years of teaching experience on various forms of assessment. The following table presents data of the independent-sample t-tests which were conducted.

Table 4.17: Comparison of intermediate mathematics teachers with 1 to 5 years of teaching experience and 6 to 28 years of teaching experience on various forms of assessment (n = 1 to 5 years of teaching experience 55, 6 to 28 years of teaching experience 96)

Variable	*M*	*SD*	*t*	*df*	*p*	*d*
Tests and Examination			-4.94	149	.00	0.14
1.5 years teaching experience	29.98	2.83				
6-28 years teaching experience	32.32	2.79				
			-1.81	149	.07	0.02
Assignment						
1-5 years teaching experience	29.51	3.28				
6-28 years teaching experience	30.54	3.41				
Project			-1.64	149	.10	0.02
1-5 years teaching experience	47.33	4.47				
6-28 years teaching experience	48.83	5.89				
Investigation			-2.08	149	.04	0.03
1-5 years teaching experience	86.11	5.82				
6-28 years teaching experience	88.80	8.52				
Moderation			-.40	149	.69	0.00
1-5 years teaching experience	37.20	3.26				
6-28 years teaching experience	37.42	3.19				
Recording and Reporting			-.40	149	.69	0.00
1-5 years teaching experience	60.45	3.40				
6-28 years teaching experience	60.71	3.94				

Analysis of data in Table 4.17 reveals that with regard to **tests and examinations**, there was significant difference in scores for teachers with 1 to 5 years of teaching experience (*M*=29.98, *SD*=2.28) and teachers with 6 to 28 year of teaching experience (*M*=32.32, *SD*= 2.79; *t*= [149]=-4.94, *p*=.00, two-tailed). The magnitude of the differences in the means (mean difference=-2.34, 95% *CI*: -3.28 to -1.40) was large (eta squared= 0.14).

On the other hand, with regard to **assignments** as a form of assessment, analysis of data shows that there were no significant differences in scores for teachers with 1 to 5 years of teaching experience (*M*=29.51, *SD*= 3.28) and teachers with 6 to 28 years of teaching experience (*M*=30.54, *SD*= 3.41; *t*=[149]=-1.81, *p*=.07, two-tailed). The magnitude of the differences in the means (mean difference=-1.03, 95% CI:-2.16 to .092) was very small (eta squared= 0.02).

With regard to **projects** as a form of assessment, there was no statistically significant difference in the mean scores for teachers with 1 to 5 years of teaching experience (*M*=47.33, *SD*= 4.47) and teachers with 6 to 28 years of teaching experience (*M*= 48.83, *SD*=5.89; *t*= [149] =-1.64, *p*=.10, two-tailed). The magnitude of the differences in the means (mean difference =-151, 95% *CI*: -3.32 to .30) was very small (eta squared= 0.02). Concerning **investigation** as a form of assessment, there was a significant difference in mean scores for teachers with 1 to 5 years of teaching experience (*M*=86.11, *SD*=5.82) and teachers with 6 to 28 years of teaching experience (*M*= 88.80, *SD*= 8.52; *t* = [149] = -2.08, *p*=.04, two-tailed). The magnitude of the differences in the means (mean difference=-2.70, 95% *CI*: -5.25 to -.14) was however small (eta squared=0.03).

Analysis of data in this table also shows that with regard to **moderation of formal assessment**, there was no significant difference in scores for teachers with 1 to 5 years of teaching experience (*M*=37.20, *SD*= 3.26) and teachers with 6 to 28 years of teaching experience (*M*= 37.42, *SD*= 3.19; *t* = [149] =-.40, *p*=.69, two-tailed). The magnitude of the differences in the means (mean difference=-.22, 95% *CI*: -1.30 to .86) was very small (eta squared = 0.00). Furthermore, analysis of data reveals that with regard to **recording and reporting of formal assessment**, there is also no significant difference in scores for teachers with 1 to 5 years of teaching experience (*M*= 60.45, *SD*= 3.40) and teachers with 6 to 28 years of teaching experience (*M*=60.71, *SD*= 3.94; *t*= [149]=-.40, *p*= .69, two-tailed). The magnitude of the differences in the means (mean difference=-.25, 95% *CI*:-1.51 to .87) was very small (eta squared= 0.00).

Independent-sample t-tests were conducted to compare teachers with or without professional teaching qualification in the intermediate phase on various forms of assessment. The following table presents data of the independent-sample t-tests which were conducted.

Table 4.18: Comparison of teachers with or without professional teaching qualification in the intermediate phase on various forms of assessment (n = 69 with a professional qualification in the intermediate phase, 82 without a professional qualification in the intermediate phase)

Variable	*M*	*SD*	*t*	*df*	*p*	*d*
Tests and Examination			4.33	149	.00	0.11
Yes	32.57	2.79				
No	30.55	2.90				
Assignment			1.53	149	.13	0.02
Yes	30.62					
No	29.78					
Project			.94	149	.35	0.01
Yes	48.74	6.36				
No	47.90	4.55				
Investigation			1.93	149	.06	0.02
Yes	89.13	9.57				
No	86.72	5.59				
Moderation			1.67	149	.10	0.02
Yes	37.81	2.40				
No	36.94	3.73				
Recording and Reporting			.33	149	.74	0.00
Yes	60.72	3.92				
No	60.52	3.61				

Analysis of data in Tables 4.18 shows that with regard to **tests and examination**, there was a significant difference in scores for teachers with a professional teaching qualification (*M*= 32.57, *SD*=2.79) and teachers without a professional teaching qualification in the intermediate phase (*M*=30.55, *SD*=2.90; *t*= [149] =4.33, *p*=.00, two-tailed). The magnitude of the differences in the means (mean difference=2.02, 95% *CI*: 1.10 to 2.94) was large (eta squared=0.11). Concerning **assignments** as a form of formal assessment, there was no significant difference in scores for teachers with a professional teaching qualification (*M*=30.62, *SD*=3.51) and without a professional teaching qualification in the intermediate phase (*M*=29.78, *SD*= 3, 26; *t*= [149] =1.53, *p*=.13, two-tailed). The magnitude of the differences in the means (mean difference=.84, 95% *CI*: -.25 to 1.93) was small (eta squared=0.02).

With regard to **projects** as a form of formal assessment, there was no significant difference in scores for teachers with a professional teaching qualification (*M*=48.74, *SD*= 6.36) and teachers without a professional teaching qualification in the intermediate phase (*M*= 47.90, *SD*=4.55; *t*= [149] =.94, *p*=.35, two-tailed). The magnitude of differences in the means (mean difference=.84, 95% *CI*: -.92 to 2.60) was very small (eta squared=0.01). With reference to the **investigation** as a form of formal assessment, there was no significant difference in scores for teachers with a professional teaching qualification (*M*=89.13, *SD*= 9.75) and without a professional teaching qualification in the intermediate phase (*M*=86.72, *SD*= 5.59; *t* = [149] =1.93, *p*=.06, two-tailed). The magnitude of the differences in the means (mean difference=2.41, 95% *CI*: -.06 to 4.89) was very small (eta squared=0.02).

Concerning **moderation of formal assessment**, there was no significant difference in scores for teachers with a professional teaching qualification (*M*=37.81, *SD*= 2.40) and teachers without a professional teaching qualification in the intermediate phase (*M*=36.94, *SD*= 3.73; *t*= [149] =1.67, *p*=.10, two-tailed). The magnitude of the differences in the means (mean difference=.87, 95% *CI*: -.16 to 1.90) was small (eta squared=0.02). Again, in regard to **recording and reporting of formal assessment**, there was no significant difference in scores for teachers with a professional teaching qualification *(M*=60.72, *SD*= 3.92) and teachers without a professional teaching qualification in the intermediate phase (*M*= 60.52, *SD*= 3.61; *t*= [149] =.33, *p*=.74, two-tailed). The magnitude of the differences in the means (mean difference=.20, 95% *CI*: -1.01 to 1.41) was very small (eta squared=0.00).

Independent-sample t-tests were conducted to compare intermediate mathematics teachers who teach an average of 25 to 40 learners and 41 to 55 learners on various forms of assessment. The following table presents data of the independent-samples tests which were conducted**.**

Table 4.19: Comparison of intermediate mathematics teachers who teach an average of 25 to 40 learners and 41 to 55 learners on various forms of assessment (n = 25-40 learners 60, 41-55 learners 91)

Variable	*M*	*SD*	*t*	*df*	*p*	*d*
Tests and Examination			2.17	149	.03	0.03
25-40 learners	32.12	2.99				
41-55 learners	31.04	2.97				
Assignment			.25	149	.81	0.00
25-40 learners	30.25	3.63				
41-55 learners	30.11	3.24				
Project			1.72	149	.09	0.02
25-40 learners	49.22	4.07				
41-55 learners	47.67	6.14				
Investigation			1.53	149	.13	0.02
25-40 learners	89.00	6.45				
41-55 learners	87.04	8.42				
Moderation			.35	149	.73	0.00
25-40 learners	37.45	2.68				
41-55 learners	37.26	3.53				
Recording and Reporting			.94	149	.35	0.01
25-40 learners	60.97	3.42				
41-55 learners	60.38	3.94				

Data analysis in Table 4.19 indicates that with reference to **tests and examinations**, there was a significant difference in scores for teachers who teach an average of 25 to 40 learners (*M*=33.12. *SD*=2.99) and those who teach an average of 41 to 55 learners (*M*= 31.04, SD= 2.97; *t* [149] =2.17, *p*=.03, two-tailed). The magnitude of the differences in the means (mean difference=1.07, 95% *CI*: .09 to 2.05) was moderately small (eta squared=0.03). Concerning **assignments** as a form of formal assessment, analysis of data discloses that no significant difference in scores for teachers who teach an average of 25 to 40 learners (*M*=30.25, *SD*= 3.63) and those who teach an average of 41 to 55 learners (*M*=30.11, *SD*=3.24; *t* [149] =.25, *p*=.81, two-tailed). The magnitude of the differences in the means (mean difference=.14, 95% *CI*: -97 to 1.26) was very small (eta squared= 0.00).

With regard to **projects** as a form of formal assessment, there was no significant difference in scores for teachers who teach an average of 25 to 40 learners (*M*=49.22, *SD*= 4.07) and those who teach an average of 41 to 55 learners (*M*=47.67, *SD*=6.14; *t* [149] = 1.72, *p*=.09, two-tailed). The magnitude of the differences in the means (mean difference=1.55, 95% *CI*:-.23 to 3.33) was moderately small (eta squared=0.02). With reference to **investigation** as a form of formal assessment, there was also no significant difference in scores for teachers who teach an average of 25 to 40 learners (*M*=89.00, *SD*=6.45) and those who teach an average of 41 to 55 learners (*M*=87.04, *SD*= 8.42; *t* [149] =1.53, *p*=.13, two-tailed). The magnitude of the differences in the means (mean difference=1.96, 95% *CI*:-.57 to 4.49) was very small (eta squared=0.02).

Data analysis further reveals that pertaining to **moderation of formal assessment**, there was no significant difference in scores for teachers who teach an average of 25 to 40 learners (*M*=37.45, *SD*=2.68) and those who teach an average of 41 to 55 learners (*M*=37.26, *SD*= 3.53; *t* [149] =.35, *p*=.73, two-tailed). The magnitude of the differences in the means (mean difference=.19, 95% *CI*:-.87 to 1.24) was very small (eta squared=0.00). Concerning **recording and reporting of formal assessment**, there was also no significant difference in scores for teachers who teach an average of 25 to 40 learners (*M*=60.97, *SD*=3.42) and those who teach an average of 41 to 55 learners (*M*=60.38, *SD*=3.94; *t* [149] =.94, *p*= .35, two-tailed). The magnitude of the differences in the means (mean difference=.58, 95% *CI*: -.65 to 1.81) was very small (eta squared=0.01).

A one-way between-groups analysis of variance was also conducted to compare the variance between mathematics teachers who teach Grade 4, Grade 5 and Grade 6 with the variability within each of the grades on formal assessment. ANOVA was done to test the following hypotheses:

H_0: There is no statistically significant difference among mathematics teachers who teach different intermediate phase grades on formal assessment scores.

H_1: There is a statistically significant difference among mathematics teachers who teach different intermediate phase grades on formal assessment scores.

Table 4.20a: Means and standard deviations comparing three intermediate phase grades on formal assessment (n = 52 Grade 4; 49 Grade 5 & 50 Grade 6)

	n	*M*	*SD*
Grade 4	52	196.25	16.49
Grade 5	49	196.10	14.69
Grade 6	50	200.90	12.47

Table 4.20b: One-way analysis of variance summary table comparing three intermediate phase grades on formal assessment (n = 52 Grade 4; 49 Grade 5 & 50 Grade 6)

Source	***df***	***SS***	***MS***	***F***	***p***	***Eta squared***
Forms of Formal Assessment						
Between groups	2	746.19	373.09	1.73	.18	0.02
Within groups	148	31838.74	215.13			
Total	150	32584.93				

Data analysis in Tables 4.20a and b show that there was no statistically significant difference at the p < .05 level in the formal assessment scores comparing three intermediate phase grades: F (2,148) =1.73, p=.18. The effect size, calculated using eta squared, was approximately 0.02 which was a small to medium effect. Post-hoc comparison using the Tukey HSD test indicated that the mean score for Grade 4 (M= 196.25, SD=16.49), Grade 5 (M=196.10, SD=14.69) and Grade 6 (M=200.90, SD=12.47) did not differ significantly.

One-way between-groups analyses of variance were also conducted to compare the variance between mathematics teachers who teach Grade 4, Grade 5 and Grade 6 with the variability within each of the grades on various forms of formal assessment.

Table 4.21a: Means and standard deviations comparing three intermediate phase grades on tests and examination, assignment, project, investigation, moderation and recording and reporting (n = 52 Grade 4; 49 Grade 5 & 50 Grade 6)

Grade		Tests and examination		Assignment		Project		Investigation		Moderation		Recording and Reporting	
		1		2		3		4		5		6	
	n	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Grade 4	52	31.35	2.98	30.65	3.02	47.79	5.92	86.46	10.43	37.12	2.68	60.44	3.85
Grade 5	49	31.06	3.11	29.45	3.71	48.16	5.57	87.43	6.28	37.18	3.07	60.90	3.29
Grade 6	50	32.00	2.94	30.36	3.38	48.92	4.84	89.62	5.09	37.72	3.82	60.52	4.09

Table 4.21b: One-way analysis of variance summary table comparing three intermediate phase grades on tests and examination, assignment, project, investigation, moderation and recording and reporting (n = 52 Grade 4; 49 Grade 5 & 50 Grade 6)

Source	*df*	*SS*	*MS*	*F*	*p*	*Eta squared*
Test and examination 1						
Between groups	2	23.03	11.52	1.27	.28	0.02
Within groups	148	134.59	9.06			
Total	150	1363.62				
Assignment 2						
Between groups	2	39.45	19.73	1.73	.18	0.02
Within groups	148	1685.41	11.39			
Total	150	1724.86				

Table 4.21c: One-Way analysis of variance summary table comparing three intermediate phase grades on tests and examination, assignment, project, investigation, moderation and recording and reporting (n = 52 Grade 4; 49 Grade 5 & 50 Grade 6)

Source	*df*	*SS*	*MS*	*F*	*p*	*Eta squared*
Project 3						
Between groups	2	33.71	16.85	.56	.57	0.01
Within groups	148	4421.05	29.87			
Total	150	4454.76				
Investigation 4						
Between groups	2	265.47	132.74	2.26	.11	0.03
Within groups	148	8710.70	58.86			
Total	150	8976.17				
Moderation 5						
Between groups	2	11.04	5.52	.53	.59	0.01
Within groups	148	1534.74	10.37			
Total	150	1545.78				
Recording and reporting 6						
Between groups	2	5.93	2.96	.21	.81	0.00
Within groups	148	2093.80	14.15			
Total	150	2099.72				

Analysis of Data in Tables 4.21a, b and c show that with regard to tests and examinations, there was no statistically significant difference at the p<.05 level in the scores comparing three intermediate phase grades: *F* (2,148) =1.27, *p*=.28. The effect size, calculated using eta squared, was approximately 0.02, which was a small to medium effect. Post-hoc comparisons using Tukey HSD test indicated that the mean scores for Grade 4 (*M*=31.35, *SD*=2.98), Grade 5(*M*=31.06, *SD*=3.11) and Grade 6(*M*= 32.00, *SD*=2.94) did not differ significantly.

Concerning assignment as a form of formal assessment, analysis of data also reveals that there was no statistically significant difference at the *p*<.05 level in the scores comparing three intermediate phase grades: *F* (2,148) =1.73, *p*=.18. The effect size, calculated using eta squared, was approximately 0.02, which was a small to medium effect. Post-hoc comparisons using Tukey HSD test indicated that the mean scores for Grade 4(*M*=30.65, *SD*=3.02), Grade 5(*M*=29.45, *SD*=3.71) and Grade 6 (*M*=30.36, *SD*=3.38) did not differ significantly.

With regard to projects as a form of formal assessment, there was no statistically significant difference at the *p*<.05 level in the scores comparing three intermediate phase grades: F (2,148) =.56, p=.57. The effect size, calculated using eta squared, was approximately 0.01, which was a small effect. Post-hoc comparisons using the Tukey HSD test indicated that the mean scores for Grade 4 (*M*=47.79, *SD*=5.92) Grade 5 (*M*=48.16, *SD*=5.57) and Grade 6(*M*=48.92, *SD*=4.84) did not differ significantly.

With reference to the investigation as a form of formal assessment, there was no statistically significant difference at the *p*<.05 level in the scores comparing three intermediate phase grades: *F* (2,148) =2.26, *p*=.11. The effect size, calculated using eta squared, was approximately 0.03, which was a small to medium effect. Post-hoc comparisons using Tukey HSD test indicated that the mean scores for Grade 4 (*M*=86.46, *SD*=10.43), Grade 5(*M*=87.43, *SD*=6.28) and Grade 6 (*M*=89.62, S=5.09) did not differ significantly.

Analysis of data also shows that with reference to moderation of formal assessment, there was no statistically significant difference at the *p*<.05 level in the scores comparing three intermediate phase grades: *F* (2,148) =.53, *p*=.59. The effect size, calculated using eta squared, was approximately 0.01, which was a small effect. Post-hoc comparisons using the Tukey HSD test indicated that the mean scores for Grade 4 (*M*=37.12, *SD*=2.68), Grade 5 (*M*=37.18, *SD*=3.07) and Grade 6 (*M*=37.72, *SD*=3.82) did not differ significantly.

Concerning recording and reporting of formal assessment, there was also no statistically significant difference at the *p*<.05 level in the scores comparing three intermediate phase grades: *F* (2,148) =.21, *p*=.81. The effect size, calculated using eta squared, was approximately 0.00, which was a small effect. Post-hoc comparisons using Tukey HSD test indicated that the mean scores for Grade 4 (*M*=60.44, *SD*=3.85), Grade 5(M=60.90, *SD*=3.29) and Grade 6(*M*=60.52, *SD*=4.09) did not differ significantly.

A one-way between-groups analysis of variance was also conducted to compare the variance between mathematics teachers who teach at different school quintiles with the variability within each of the school quintiles on formal assessment. ANOVA was done to test the following hypotheses:

H_0: There is no statistically significant difference among intermediate mathematics teachers who teach at different school quintiles on formal assessment scores

H_1: There is a statistically significant difference among intermediate mathematics teachers who teach at different school quintiles on formal assessment scores

Table 4.22a: Means and standard deviations comparing five school quintiles on formal assessment (n = 23 Quintile 1; 53 Quintile 2; 38 Quintile 3; 9 Quintile 4 & 28 Quintile 5)

	n	*M*	*SD*
Quintile 1	23	197.13	22.50
Quintile 2	53	196.17	13.40
Quintile 3	38	194.87	13.95
Quintile 4	9	205.56	11.60
Quintile 5	28	202.61	8.96

Table 4.22b: One-Way Analysis of Variance Summary Table Comparing Five School Quintiles on Formal Assessment (n = 23 Quintile 1; 53 Quintile 2; 38 Quintile 3; 9 Quintile 4 & 28 Quintile 5)

Source	***df***	***SS***	***MS***	***F***	***p***	***Eta squared***
Formal Assessment						
Between groups	4		1665.60	1.97	.10	0.05
Within groups	146		30919.32			
Total	150		32584.93			

Analysis of data in Tables 4.22a and b shows that there was no statistically significant difference at the p < .05 level in the formal assessment scores for the five school quintiles in the intermediate phase grades: F (4,146) =1.97, p=.10. The effect size, calculated using eta squared, was 0.05 which was a small to medium effect. Post-hoc comparison using the Tukey HSD test indicated that the mean score for quintile 1 (M=197.13, SD=22.50), quintile 2 (M=196.17, SD=13.40), quintile 3 (M=194.87, SD=13.95), quintile 4 (M=205.56, SD=11.60) and quintile 5 (M=202.61, SD=8.96) did not differ significantly. Therefore, the null hypothesis is accepted whereas the alternative hypothesis is rejected.

One-way between-groups analyses of variance were also conducted to compare the variance between mathematics teachers who teach at different school quintiles with the variability within each of the school quintiles on various forms of formal assessment**.**

Table 4.23a: Means and standard deviations comparing five school quintiles on tests and examination, assignment, project, investigation, moderation and recording and reporting (n = 23 Quintile 1; 53 Quintile 2; 38 Quintile 3; 9 Quintile 4 & 28 Quintile 5)

School quintile	**Tests and examination 1**			**Assignment 2**		**Project 3**		**Investigation 4**		**Moderation 5**		**Recording and Reporting 6**	
	n	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Quintile1	23	32.17	2.90	30.30	3.55	47.87	8.30	86.78	14.38	34.48	4.44	58.96	4.46
Quintile2	53	30.66	2.93	30.45	3.53	47.94	4.74	87.11	6.32	37.25	3.49	60.60	3.53
Quintile3	38	31.29	3.16	29.05	3.10	47.39	5.64	87.13	6.11	38.37	2.17	60.63	4.17
Quintile4	9	33.89	2.32	29.89	4.43	51.44	8.84	90.33	4.15	36.56	2.96	60.44	3.91
Quintile5	28	31.89	2.81	31.11	2.78	49.46	3.37	90.14	4.52	37.07	2.49	62.04	2.17

Table 4.23b: One-way analysis of variance summary table comparing five school quintiles on tests and examination, assignment, project, investigation, moderation and recording and reporting (n = 23 Quintile 1; 53 Quintile 2; 38 Quintile 3; 9 Quintile 4 & 28 Quintile 5)

Source	*df*	*SS*	*MS*	*F*	*p*	*Eta squared*
Test and examination 1						
Between groups	4	105.04	26.26	3.05	.02	0.08
Within groups	146	1258.57	8.62			
Total	150	1363.62				
Assignment 2						
Between groups	4	77.40	19.35	1.72	.15	0.04
Within groups	146	1647.46	11.28			
Total	150	1724.86				
Project 3				1.44	.22	0.04
Between groups	4	169.05	42.26			
Within groups	146	4285.70	29.35			
Total	150	4454.76				
Investigation 4						
Between groups	4	277.17	69.29	1.16	.33	0.03
Within groups	146	8699.00	59.58			
Total	150	8976.17				
Moderation 5						
Between groups	4	65.30	16.33	1.61	.18	0.04
Within groups	146	1480.47	10.14			
Total	150	1545.78				
Recording and reporting 6						
Between groups	4	120.06	30.01	2.21	.07	0.06
Within groups	146	1979.66	13.56			
Total	150	2099.72				

Analysis of data in Tables 4.23a and b show that with regard to tests and examinations, there was a statistically significant difference at the $p < .05$ level in the scores for five school quintiles in the intermediate phase grades: F (4,146) =3.05, p=.02. The effect size, calculated using eta squared, was approximately 0.08 which was a moderate to large effect. Post-hoc comparison using the Tukey HSD test indicated that the mean score for quintile 2 (M=30.66, SD=2.93), was significantly different from quintile 4 (M=33.89, SD=2.32). The mean difference was 3.23. This reveals that quintile 4 schools are giving more tests and examinations than quintile 2 schools. Quintile 1 (M=32.17, SD=2.90), quintile 3 (M=31.29, SD=3.16) and quintile 5 (M=31.89, SD=2.81) did not differ significantly from either quintile 2 or 4.

With regard to assignment as a form of formal assessment, there was no statistically significant difference at the $p < .05$ level for the five school quintiles in the intermediate phase grades: F (4,146)1.72, p=.15. The effect size, calculated using eta squared, was approximately 0.04 which was a small to medium effect. Post-hoc comparison using the Tukey HSD test indicated that the mean score for quintile 1 (M=30.30, SD=3.55), quintile 2 (M=30.45, SD=3.53), quintile 3 (M=29.05, SD=3.10), quintile 4 (M=29.89, SD=4.43) and quintile 5 (M=31.11, SD=2.78) did not differ significantly.

With regard to project as a form of formal assessment, there was no statistically significant difference at the $p < .05$ level for five school quintiles in the intermediate phase grades: F (4,146)1.44, p=.22. The effect size, calculated using eta squared, was approximately 0.04 which was a small to medium effect. Post-hoc comparison using the Tukey HSD test indicated that the mean score for quintile 1 (M=47.87, SD=8.30), quintile 2 (M=47.94, SD=4.74), quintile 3 (M=47.39, SD=5.64), quintile 4 (M=51.44, SD=8.84) and quintile 5 (M=49.46, SD=3.37) did not differ significantly.

With reference to the investigation as a form of formal assessment, there was no statistically significant difference at the $p < .05$ level for five school quintiles in the intermediate phase grades: F (4,146)1.16, p=.33. The effect size, calculated using eta squared, was approximately 0.03 which was a small to medium effect. Post-hoc comparison using the Tukey HSD test indicated that the mean score for quintile 1 (M=86.78, SD=14.38), quintile 2 (M=87.11, SD=6.32), quintile 3 (M=87.13, *SD*=6.11), quintile 4 (*M*=90.33, *SD*=4.15) and quintile 5 (*M*=90.14, *SD*=4.52) did not differ significantly.

Analysis of data further shows that with reference to moderation of formal assessment, there was also no statistically significant difference at the $p < .05$ level for five school quintiles in the intermediate phase grades: *F* (4,146)1.61, *p*=.18. The effect size, calculated using eta squared, was approximately 0.04 which was a small to medium effect. Post-hoc comparison using the Tukey HSD test indicated that the mean score for quintile 1 (*M*=34.48, *SD*=4.44), quintile 2 (*M*=37.25, *SD*=3.49), quintile 3 (*M*=38.37, *SD*=2.17), quintile 4 (*M*=36.56, *SD*=2.96) and quintile 5 (*M*=37.07, *SD*=2.49) did not differ significantly.

Lastly, analysis of data shows that with reference to recording and reporting of formal assessment there was a statistically significant difference at the $p < .05$ level for five school quintiles in the intermediate phase grades: *F* (4,146) =2.21, *p*=.07. The effect size, calculated using eta squared, was approximately 0.06 which had a moderate effect. Post-hoc comparison using the Tukey HSD test indicated that the mean score for quintile 1(*M*=58.96, *SD=4.46*), was significantly different from quintile 5(*M*=62.04, *SD*=2.17). The mean difference was 3.08. This reveals that quintile 5 schools are recording and reporting more than quintile 1 schools. Quintile 2(*M*=60.60, *SD*=3.53), quintile 3(*M*=60.63, *SD*=4.17) and quintile 4(*M*=60.44, *SD*=3.91) did not differ significantly from either group 1 or 5. The subsequent section presents and analyses the checklist data.

4.3 PRESENTATION AND ANALYSIS OF CHECKLIST DATA

In the preceding section, the researcher presented and analysed inferential statistics as quantitative data. This section provides a presentation and analysis of checklist data. Killen (2015) mentions that checklists are useful for assessment in situations where a very specific set of objective judgements needs to be made about learner performance, in this case, in the implementation of formal assessments in intermediate phase mathematics teaching and learning. The checklist utilised in this study was constructed from the information provided in the *Curriculum and Assessment Policy Statement Grades 4-6 mathematics (DBE 2011: 294-296).*

Document analysis was conducted from the formal assessment records of nine intermediate phase mathematics teachers in the Lejweleputswa district. This was done to determine the actual implementation of formal assessment because data which were gathered through the questionnaire provided only the perceived implementation of formal assessment in Grades 4 to 6 mathematics. All the checklist statistics data which are presented and analysed in this section are found in Appendix K. The following is the personal data of the teachers whose formal assessment records were examined.

4.3.1 Biographical details of the respondents

The following table represents the biographical data of the teachers whose formal assessment records were analysed.

Table 4.24: Biographical details of the teachers whose formal assessment records were analysed **N=9**

Personal Data	% Respondents According to Category		% Total
A1. Gender	Male	4 (44.4%)	
	Female	5 (55.6%)	100
	4	3 (33.3%)	
A2. Grade	5	3 (33.3%)	100
	6	3 (33.3%)	
	1	2 (22.2%)	
A3. School Quintile	2	1 (11.2%)	100
	3	3 (33.3%)	
	5	3 (33.3%)	

Analysis of data in Table 4.24 indicates that three (44.4%) formal assessment records of male teachers were analysed whilst five (55.6%) formal assessment records of female teachers were examined. In terms of representation according to the gender of the teachers who agreed that their formal assessment records be analysed, there was no significant difference. Further analysis of data in the table reveals that formal assessment records of all the three grades in the intermediate phase were analysed. However, representation according to schools' quintile was not evenly spread. Analysis of data in the table discloses that 22.2% of the analysed formal assessment records were from quintile 1 schools, 11.1% were from quintile 2 schools, 33.3% were from quintile 3 schools and the remaining 33.3% were from quintile 5 schools. The researcher did not analyse documents from quintile 4 schools because all teachers from this quintile who were approached were not willing for their formal assessment records to be analysed. They volunteered to participate only in the interviews. The results are sufficient enough, as 80% of the schools in 5 quintiles in the Lejweleputswa district were represented which gives a clear indication of how formal assessments are implemented. The ensuing table presents and gives an analysis of data obtained for the minimum requirements for formal assessment in intermediate phase mathematics as stipulated in the CAPS document.

4.3.2 The minimum requirements for formal assessment in intermediate phase mathematics

Table 4.25: Minimum requirements for formal assessment: N=9

	Forms of Assessment		Mean	Median	Standard Deviation
School-based Assessment (SBA) 75%	B1	Tests	2.11	2.00	0.33
	B2	Midyear Examination	2.00	2.00	0.00
	B3	Assignment	1.67	2.00	0.50
	B4	Investigation	1.11	1.00	0.33
	B5	Project	1.44	1.00	0.53
	B6	**Total**	1.11	1.00	0.33
End of the year Examination 25%	B7	End of the year Examination	2.00	2.00	0.00

Analysis of data in Table 4.25 reveals that teachers fully administer examinations (*M*=2.00, *MD*=2.00, *SD*=0.00). Statistics show that the data is symmetrical since the skewness measure is zero. Furthermore, all formal assessment records that were analysed indicated that teachers fully administered examinations as stipulated in the CAPS document. This is because the standard deviation is zero which implies that there is no deviation from the mean. The mean value of 2 indicates that the implementation of examination has been achieved as per the rubric of the checklist.

Another revelation is that tests are wholly administered (*M*=2.11, *MD*=2.00, *SD*=0.33). Statistics show that data is positively skewed since the mean is higher than the median. Resultantly, the mean value indicates that the implementation of the test is fully achieved according to the CAPS requirements. With reference to assignments (*M*=1.67, *MD*=2.00, *SD*=0.50), statistics show that this form of assessment is moderately achieved as it is not fully done according to the CAPS requirements. Data is negatively skewed since the mean is smaller than the median. Investigation as a form of formal assessment is not done accurately as per the CAPS requirements (*M*=1.11, *MD*=1.00, *SD*=0.33). The mean value of 1.11 indicates that the implementation of investigation is not achieved as per the rubric of the checklist. This implies that some of the teachers whose records were analysed were not giving their learners investigative tasks. This implies that teachers are not promoting critical and creative thinking in their learners as suggested in CAPS. Statistics show that data is positively skewed since the mean is higher than the median.

Additionally, statistics show that the project as a form of assessment is not achieved at all (*M*=1.44, *MD*=1.00, *SD*=0.53). The mean of 1.44 is an explanatory of underachievement as per the rubric of the checklist. This implies that teachers are not providing learners with opportunities through which they can express their competencies of solving complex issues and in daily occurrences. By virtue of assignment, investigation and project not being achieved, the total tasks per year is resultantly not achieved (*M*=1.11, *MD*=1.00, *SD*=0.33). The mean value reveals that the total number of tasks per year was not met. Statistics show that data is positively skewed since the mean is higher than the median. The subsequent table serves to present and analyse cognitive levels and abilities tested in learners.

4.3.3 Cognitive levels and abilities tested in learners

Table 4.26 indicates levels and description of skills which should be demonstrated by Grades 4 to 6 learners in mathematics. Analysis of data in Table 4.26 below shows that there is the greatest achievement in the testing of cognitive skills such as straight recall (*M*=2.11, *MD*=2.00, *SD*=0.33). The mean value of 2.11 is a clear indication of achievement as per the checklist rubric. Statistics show that data for this item is positively skewed since the mean is higher than the median. Furthermore, testing of cognitive skills such as performing well-known procedures, simple applications and calculations, unseen-non routine procedures and breaking down problems into constituent parts are fully mastered as stipulated in the CAPS document (*M*=2.00, *MD*=2.00, *SD*=0.00). This implies that these skills are taught effectively, which in turn makes the broad aims of the subject achievable (DBE, 2011: 295). The standard deviation is zero which implies that there is no deviation from the mean. The mean value of 2 indicates that the testing of cognitive levels and abilities of learners has been achieved as per the rubric of the checklist. Statistics stipulate that the data for these skills is symmetrical since their skewness measure is zero. The following table presents and analyses data on testing of cognitive levels. With regard to the testing of cognitive skills such as estimation and appropriate rounding off and use of mathematical facts, the statistical results are similar which indicate that they were moderately achieved (*M*=1.89, *MD*=2.00, *SD*=0.33). Their standard deviations are not very far from the mean. The implication, therefore, is that knowledge as a cognitive level skill is tested as stipulated in the CAPS document, hence making the aims and objectives of the subject achievable.

Table 4.26: Testing of cognitive levels with description of skills N=9

Checklist items		Mean	Median	Standard Deviation
C1	Estimation and appropriate rounding off of numbers.	1.89	2.00	0.33
C2	Straight recall.	2.11	2.00	0.33
C3	Identification and direct use of correct formula.	1.78	2.00	0.33
C4	Use of mathematical facts.	1.89	2.00	0.33
C5	Appropriate use of mathematical vocabulary.	1.33	1.00	0.50
C6	Perform well known procedures.	2.00	2.00	0.00
C7	Simple applications and calculations, which might involve many steps.	2.00	2.00	0.00
C8	Derivation from given information may be involved.	1.44	1.00	0.52
C9	Identification and use after changing the subject of correct formula, generally similar to those encountered in class.	1.67	2.00	0.50
C10	Problems involving complex calculations and /or higher order reasoning.	1.11	1.00	0.33
C11	Investigations to describe rules and relationships; there is often not an obvious route to the solution.	1.11	1.00	0.33
C12	Problems not based on real world context could involve making significant connections between different representations.	1.33	1.00	0.50
C13	Conceptual understanding.	1.89	2.00	0.33
C14	Unseen, non-routine problems (which are not necessarily difficult).	2.00	2.00	0.00
C15	Higher order understanding and processes are often involved.	1.67	2.00	0.50
C16	Might require the ability to break the problem down into its constituent parts.	2.00	2.00	0.00

However, with reference to the testing of cognitive skills such as problem solving and investigations to describe rules and relationships, their statistical results are similar which indicates that there is high underachievement (*M*=1.11, *MD*=1.00, *SD*=0.33). The means of 1.11 for these skills reveal that their testing is not being done according to the CAPS requirements as per checklist rubric. This implies that teachers are not exposing learners to complex procedures which are designed to improve their higher-order reasoning. Moreover, the learners do not have opportunities to solve unseen non-routine procedures; as a result, this impedes their conceptual understanding of the subject. Data for these statistics is positively skewed since the means are higher than their medians.

Moreover, data shows that testing of the appropriate use of mathematical vocabulary is not achieved (*M*=1.33, *MD*=1.00, *SD*=0.50). The mean of 1.33 punctuates that the testing of this skill does not meet the CAPS requirements as per the checklist rubric. This denotes that teachers are not developing the correct use of the language of mathematics as stated under the specific skills which must be developed in mathematics (DBE, 2011:8). This, in turn, affects the achievability of aims and objectives of the subject. Ultimately, data shows that derivation from given information as a cognitive skill is not tested (*M*=1.44, *MD*=1.00, *SD*=0.52). The mean of 1.44 indicates that this skill is not tested according to the CAPS requirements as per the checklist rubric. This implies that teachers are not exposing learners to different formulas applicable in mathematics as stated under routine procedures as a cognitive skill to be taught. This means that learners cannot identify and use other mathematical formulas they may encounter, other than those used or taught in their classrooms. The following table presents and analyses data on the most tested cognitive levels in formal assessments.

Table 4.27: The most tested cognitive levels in formal assessments N=9

Cognitive Levels		Mean	Median	Standard Deviation
D1	Knowledge	1.80	1.80	0.24
D2	Routine procedures	1.78	1.75	0.63
D3	Complex procedures	1.36	1.25	0.22
D4	Problem-solving	1.89	2.00	0.17

Analysis of data in Table 4.27 shows that the most cognitive level that is developed and tested in learners is problem-solving although it is moderately tested (*M*=1.89, *MD*=2.00, *SD*=0.17). Data is negatively skewed because the mean is lower than the median. The mean of 1.89 confirms a moderate achievement according to CAPS requirements as per checklist rubric. This finding means that learners can moderately solve non-routine problems which are not necessarily difficult, which might lead to their understanding of word sums. The standard deviation is nearer to the mean indicating that the documents analysed revealed similar information.

The second developed and tested cognitive level is knowledge which is also moderately implemented in formal assessment (*M*=1.80, *MD*=1.80, *SD*=0.24). The mean of 1.80 indicates that this cognitive level is moderately achieved according to the stipulated requirements in the CAPS and as per checklist rubric. This suggests that learners moderately round off and recall some of the mathematical facts. Statistics indicate that data is normally distributed since the mean is equal to the median. The third cognitive level which is promoted and tested in the learners is routine procedures. This cognitive level is also moderately tested (*M*=1.78*, MD*= 1.75, *SD*=0.63). The implication of this finding is that learners are taught well-known procedures and other simpler calculations as stipulated in the CAPS document. Statistics indicate that data is positively skewed since the mean is higher than the median. However, data reveals that development and testing of complex procedures in learners is not being done (*M*=1.36, *MD*=1.25, *SD*= 0.17). This mean indicates that teachers are neglecting the development of learners in this cognitive level. Therefore, teachers are not developing the abilities of learners in handling complex mathematical procedures as per the requirements of CAPS. This implies that learners lack the ability to break down mathematical problems into different factors or constituent parts.

To wrap it up, document analysis shows that minimum requirements for formal assessments in intermediate phase mathematics are not being met as stipulated in the CAPS document. The following section presents and analyses data gathered from interviews.

4.4 PRESENTATION AND ANALYSIS OF INTERVIEW DATA

In the previous sections, the questionnaire and checklist data were analysed. The descriptive and inferential data analyses done in the preceding sections prompted the need for qualitative data to establish why some teachers were not meeting the minimum requirements for formal assessment in intermediate phase mathematics as espoused in the CAPS. The researcher interviewed intermediate phase mathematics teachers to generate this data. All interview data which are presented and analysed in this section are found in Appendix L. In this section, data collected from the nine teachers will be presented and analysed. It is of much significance to discuss the data collection instruments and the procedure followed; the construction of the interview schedule, credentials of the participants and finally the data analysis techniques employed in this study.

4.4.1 Data collection instruments and procedure

Semi-structured interviews were conducted in order to answer the following research questions:

- How are formal assessments used as a foundation for teaching and learning enhancement?
- What challenges do teachers and learners experience in the implementation of formal assessments?
- How could challenges teachers and learners experience in the implementation of formal assessments be alleviated?
- To what extent do differences in biographical variables (gender, age, teaching experience, professional qualification, class size and school quintile) and intermediate phase mathematics teachers' responses relate to their implementation of formal assessments?

Nine intermediate phase mathematics teachers were sampled from different selected schools. Data was recorded using a cellular phone by the researcher. Interviews were conducted during the day, after normal teaching time.

4.4.2 Construction of the interview schedule

One interview schedule for intermediate phase mathematics teachers was constructed. The components of the schedule were built on the implications of the descriptive and inferential data analysis. Their outcomes revealed that teachers were not adhering to the minimum requirements when implementing formal assessments. Hence the researcher saw the need to ascertain from intermediate phase mathematics teachers why such flaws were present.

4.4.3 Credentials of the interview participants

This section discusses the credentials of participants in this research. A nonprobability sampling technique, namely the purposeful sampling technique, was employed in this research to select nine teachers in different primary schools in the Lejweleputswa district. This type of sample is chosen on the basis of an idea of the population and the aim of the research (Lumadi, 2015). Additionally, Maree and Pietersen (2016) confirm that purposive sampling is applied with a definite intent in the researcher’s thoughts; in the present case, with a specific purpose to have an idea of the implementation of formal assessments; hence, intermediate phase mathematics teachers were ideal for the sample. The study had teachers from all the five (5) quintiles as specified in the South African School Act (SASA) Section 35(1). The teaching experience of the participants ranged from 1 year to 28 years of experience. The youngest teacher was 20 years old whereas the eldest was 55 years old. The participants were ideal for the research as they have sound knowledge of the subject under research.

4.4.4.1 Intermediate phase mathematics teachers

Intermediate phase mathematics teachers were interviewed because they were responsible for curriculum delivery of teaching and learning in mathematics. The assumption was that they were well versed in the subject since they were employed by the Free State Department of Education.

4.4.5 Data analysis techniques

After the interviews, data was processed following the steps outlined below.

Step 1: Transcription of the orally recorded interviews onto manuscript

Transcription describes the procedure of modifying audiotape recordings into textual data (Creswell, 2012). The responses of the participants were transcribed by the researcher so as to be familiar with it.

Step 2: Assigning variable codes to transcripts

Coding is a procedure of scrutinising transcribed data and thereafter splitting it into understandable interpretive items (Nieuwenhuis, 2016). Furthermore, the coding process enables the research to recover and gather all the text material that they have linked to some themes expected to emerge (Nieuwenhuis, 2016). Following this idea, the transcribed data about the implementation of formal assessments were segmented into variable codes.

Step 3: Analysing causes and effects of participants' inputs

Data analysis for this research was done manually. The scrutiny of qualitative data is a process whereby the researcher interprets the information (raw data) and splits it into relevant units (Creswell, 2012). This is what the researcher did for this study. Data was analysed manually because the researcher was analysing a small database and could easily keep track of files and wanted to be close to the data and have an immediate feel for it, as suggested by Creswell (2012).

The subsequent paragraph presents and analyses qualitative data on the implementation of formal assessments in intermediate phase mathematics teaching and learning.

4.4.6 Presentation and analysis of intermediate phase mathematics teachers' responses

Semi-structured interviews were carried out with teachers to seek clarity on the findings of the execution of formal assessments in intermediate phase mathematics teaching and learning. The ensuing section presents and analyses themes and sub-themes that emerged from the participants' responses.

Table 4.28a: Main themes and sub-themes that emerged from the one-on-one semi-structured interviews with teachers

Theme 1	**The forms of assessment implemented in mathematics teaching and learning**
	Sub-theme 1.1: Teachers' knowledge of the various forms of formal assessments implemented in intermediate phase mathematics teaching and learning.
Theme 2	**Challenges experienced by teachers in the implementation of formal assessments**
	Sub-theme 2.1: Lack of teaching and learning resources
	Sub-theme 2.2: Assessment brings too much workload on teachers.
	Sub-theme 2.3: Large class sizes
	Sub-theme 2.4: Lack of parental involvement
Theme 3	**Challenges experienced by learners when they are engaged in formal assessments**
	Sub-theme 3.1: Language barrier
	Sub-theme 3.2: Learners' beliefs and attitudes towards mathematics as a subject
	Sub-theme 3.3: Contextual factors
Theme 4	**Supporting and guiding learners after they have received formal tasks so as to give them quality feedback**
	Sub-theme 4.1**:** Item and error analysis
	Sub-theme 4.2**:** Intervention strategies

Table 4.28b: Main themes and sub-themes that emerged from the one-on-one semi-structured interviews with teachers

Theme 5	**Complex procedures and problem-solving skills are not tested**
	Sub-theme 5.1: Lack of subject knowledge
	Sub-theme 5.2: The six cognitive levels of Bloom's taxonomy not being followed in the setting of formal tests Sub-theme 5.3: Lack of proper moderation of formal assessments, both internally and externally
Theme 6	**Lack of support from the Free State Department of Education**
	Sub-theme 1: Inadequate visits and support for teachers by the mathematics subject advisors
	Sub-theme 2: Inadequate workshops

This section aims at ascertaining whether or not the six identified themes have an effect on the implementation of formal assessments in intermediate phase mathematics teaching in the Lejweleputswa schools. The teachers interviewed are identified as T1, T2, T3, T4, T5, T6, T7, T8 and T9. T1 represents teacher one and so forth. The first theme to be discussed is the forms of assessment used as tools in intermediate phase mathematics teaching.

4.4.6.1 Theme 1: The forms of assessment implemented in mathematics teaching and learning

Analysis of interview data has revealed that intermediate phase mathematics teachers are knowledgeable with forms of formal assessments used. The subsequent paragraphs present the inputs of teachers in the form of sub-themes, starting off with the discussion of teachers' knowledge of the various forms of assessments used in intermediate phase mathematics teaching and learning.

Sub-theme 1: Teachers' knowledge of the various forms of formal assessments implemented in intermediate phase mathematics teaching and learning

Almost all the teachers interviewed seemed to be knowledgeable about the forms of assessment used in intermediate phase mathematics teaching and learning as stipulated in the CAPS policy document. However, T3's response indicated that he lacked the knowledge of the SBA requirements. This was depicted in his response when asked about the various forms:

"The forms of assessment? Mm… I use the textbook and the teacher's guide, or if I see that the form of assessment is going to be very challenging for learners, I go out and search for an adequate form of assessment." (T3).

T3's view clearly indicates that he does not have the knowledge of the SBA requirements according to the CAPS policy. The next theme to be discussed is on the challenges experienced by teachers in the implementation of formal assessments.

4.4.6.2 Theme 2: Challenges experienced by teachers in the implementation of formal assessments

Teachers are challenged as they implement formal assessments. This is demonstrated by the outcomes of the interviews as presented in the following paragraphs in the form of sub-themes, starting off with lack of teaching and learning resources as a contributory factor.

Sub-theme 2.1: Lack of teaching and learning resources

Teachers had great concern on the inadequacy of teaching and learning resources. They indicated that this affects their proper implementation of assessments too. Their verbatim responses towards this concern are as follows, T1 has said:

"We don't have enough books here; we sometimes receive the Rainbow books very late maybe towards the end of term 1. We don't even have materials to construct objects in projects and investigations. It is really a challenge; it affects proper planning." (T1).

T8 shared the same sentiment when he added that:

"Allocation of resources are a challenge, we have problems with copiers, calculators. We really have problems with stationery; it disturbs our planning a lot." (T8).

The next section discusses a sub-theme of excessive workload brought by the assessment on the part of teachers.

Sub-theme 2.2: Assessment brings too much workload on the teachers

Most of the teachers pointed out that the implementation of assessments burdens them with a heavy workload. There is no time allocated on the timetables that are specifically for assessment. For instance, T3 said:

"Emphasis is on neatly designed assignments which takes most of our teaching time. I am not computer literate and the school knew about this when they hired me. Our tasks are returned back during the moderation process by our HODs just because they do not have for example, headers or footers, this derails my work." (T3).

T6 echoes the opinion that assessment has too much paperwork when pointing out that:

"*Our HODs do not take into consideration some of the periods are taken for assessments, those done in class. They don't understand when we are behind with curriculum coverage that we sometimes assess during the normal teaching time. It is a lot of work to assess learners individually for a project too or an investigation."* (T6).

Having discussed too much workload brought by the implementation of assessments, the next sub-theme to be discussed is the impact of large class sizes in relation to the implementation of formal assessments.

Sub-theme 2.3: Large class sizes

Class size was identified as one of the challenges which have impacted negatively on the teachers in the implementation of assessments. Most of the teachers stated that their classes were too big and overcrowded, which is against the ideal teacher-learner ratio of 1:35 as stated by the DoBE. According to T4:

"*I can't assist my learners individually, sometimes the period is over before group feedback is done because there are also too many groups in one class. Learners are overcrowded, we were promised by the department in 2012 when we had CAPS training that this will be solved, instead, they keep on enrolling learners without building more classrooms and employing other teachers."* (T4).

In agreement to T4, T2 confirmed overcrowding issue when stating that:
"I have 51 learners in my class, meaning I have to mark 51 projects or investigations. I end up grouping them even though the rubric states they must be individually assessed." (T2).

On the contrary, T6's class is found to be suitable for assessments; hence there is no problem of overcrowding at all. 10 minutes are allocated every day to check how far the learners are with the project and T6 assists them where ever necessary:
"Projects or assignments are not submitted the day they are given out. I give my learners time to go and collect data like now they are busy with data handling in grade 6. We work stage by stage until the project is finished according to the due date stated. I have 23 learners in my class, the number is quite easy to handle." (T6).

The researcher has however noted that class sizes are a challenge to quintile 1, 2 and 3 schools where the learner-teacher ratio is not practical. Quintile 4 and 5 schools' classes are not overcrowded; hence teachers are not challenged in this aspect. The next sub-theme to be discussed is on lack of parental involvement in their children's work.

Sub-theme 2.4: Lack of parental involvement

Teachers raised a concern that the majority of parents lack involvement in their children's homework. Some of the learners did not get any form of assistance from home pertaining to their school work. Assignments to be done at home were either lost or returned incomplete. For example, T1 said:
"Lack of support from home, Eh, I even know of learners who can tell you I am very tired I have been watching a movie last night with a parent, yet home works are not done. Parents must know that schoolwork comes first and support us, especially when we send projects home." (T1).

Interestingly, T6 also confirmed that the majority of parents were not committed in their children's homework when he said:
"Some parents don't even sign the marked tests we send home, just to acknowledge they received the work of their children. Worse… when it comes to assisting them in

assignments, it is a nightmare, I just let my learners collect information or materials to be used then they work in class under my supervision.” (T6).

The next theme to be discussed is on the challenges experienced by learners themselves when they engage in formal assessments.

4.4.6.3 Theme 3: Challenges experienced by learners when they are engaged in formal assessments

During interviews held with intermediate phase mathematics teachers, there was a revelation that learners were challenged as they engaged in formal assessments. The ensuing paragraphs present inputs in the form of sub-themes, starting with the language barrier as a challenge to the learners.

Sub-theme 3.1: Language barrier

The interviews held with the teachers revealed that the Language of Learning and Teaching (LoLT), thus the English language, made it difficult for learners to understand assessment instructions. This poses a challenge for learners to achieve in mathematics as they do not understand word problems either. This was confirmed by T7 in a statement below:
“The major challenge is on language understanding and also what I have noticed is that most of us who are teaching mathematics, tend now to divert the use of English trying to let learners understand, but not knowing that we are spoiling learners because the assessment will be purely in English, now when assessed it becomes difficult.” (T7).

In accordance with T7’s statement, T5 added that:
“Learners misinterpret questions; you will find that learners have a poor understanding of the English language. One can explain during an assignment or project but a subject teacher cannot assist learners in tests and examinations and they struggle a lot during examinations.” (T5).

The subsequent paragraph discusses learners’ perceptions concerning the subject, mathematics.

Sub-theme 3.2: Learners' beliefs and attitudes towards mathematics as a subject

Negative attitudes towards mathematics and the fear of mathematics were identified as a challenge to the learners during the interviews held with mathematics teachers. This is evident in T4's statement:

"This happens several times, they fear mathematics, they have psychological fear, activities they do very well under informal conditions are badly done when given as formal tasks." (T4).

This concern was also confirmed by T2, who alluded that:

"Learners generally believe that mathematics is difficult. We have to demystify that, show learners that it is possible. We have to tell them it can be done, we have to make noise about how easy maths can be, make it very interesting through games etc." (T2).

Sub-theme 3.3: Contextual factors

Teachers highlighted that contextual factors were a challenge to teaching and learning, hence having a negative impact on assessment. Issues like learners being exposed to communities with bad habits, poverty, poor parental education and inadequate access to health care services were pulled into focus as having a major effect on teaching and learning. This is demonstrated by T6's response:

"Socioeconomic factors, child-headed families, no one to monitor them at home; all these contribute to hardships in learners. There is totally no follow up at home. Assignments projects are done at home end up being done here, at school, by us again and it means there is no true reflection of what the learner achieves." (T6).

This was also supported by T4, who remarked that:

"Some learners are absent during assessment time, this might be due to ill-health, which is mostly from lack of care from parents, or lack of getting immediate attention when sicknesses are at a lower stage." (T4).

The next theme discusses how teachers support and guide learners after they receive their marked formal tasks.

4.4.6.4 Theme 4: Supporting and guiding learners after they have received formal tasks so as to give them quality feedback

Most of the teachers mentioned doing item and error analysis, then creating intervention strategies for the failing learners and recording the marks on the South African School and Administration Management System (SA-SAMS) so that all the stakeholders were informed of the assessment results. Item and error analysis is the first sub-theme to be discussed below.

Sub-theme 4.1: Item and error analysis

Item and error analysis was mention by most of the teachers as a tool which guides them on quality feedback to their learners. It helps them identify which concepts were achieved or not and what the causes were; they then create proper strategies thereafter. T1 elaborated on this as demonstrated in the following statement:
"For me to give proper feedback, I complete the item and error analysis, for a test, I use the rubric for assignments and projects. The item and error analysis identifies what was achieved, not achieved and why." (T1).

T3 confirmed what T1 has said by stating that:
"It is a requirement from the department that we do error analysis, yes it assists a lot, you identify mistakes to see where learners went wrong." (T3).

Similarly, this is what T8 added on the use of item and error analysis:
"A teacher can only see the problem after monitoring the work that is marking. I ask my learners what was the problem, right there, they will tell me what the problem was; I can detect what I did not explain much. I don't depend on identifying them as wrong through the analysis; I detect my mistakes from what they are saying." (T8)

Inversely, T7 raised a concern that the template for item and error analysis is too complicated to complete and it is time-consuming. This is what he said:
"*I really don't see the reason why I should complete the item and error analysis form, it is complicated, it takes a lot of my teaching time, I can tell as I mark what my*

learners are struggling with and this will be reflected as corrections. If one goes through their corrections, difficult concepts will be seen." (T7).

Having discussed the item and error analysis as a sub-theme, the next paragraph discusses the intervention strategies which can be implemented so as to give quality feedback to the learners as identified by the teachers.

Sub-theme 4.2: Intervention strategies

Teachers emphasised the need for intervention strategies as the best follow up and supportive measure for guiding learners after receiving their marked tasks. They stated it must be done soon after the item and error analysis was completed. This point was expanded by T1 who said:

"When I have marked task, it depends on the type of assessment which was given. I will go back and look at what they have done well or not in terms of the topic and concept, then I take it from there, through teaching the concept again and testing for the second." (T1).

T3 brought forward the issue of motivating learners and going the extra mile as a teacher to try and support the learners who did not achieve the expected standard in that particular assessment:

"You know, you need to have that motivation, tell them it is possible, this is what you got, but it is not the end, show them enthusiasm, be prepared to go an extra mile and it must be visible to them that you are going an extra mile, appraise them for every achievement, have extra material, give extra time to the failing learners." (T3)

When asked about the issue of just pasting a memorandum, which is usually done by teachers as corrections, this is how T5 responded:

"I think pasting of the memo, without evidence of working through the questions with learners is done by those teachers who want to emphasis to the supervisors that they are up to date with their work, everything is done. It's time really we become true to ourselves, like …I am a little bit slow like we had sports now, we did not teach today, but teachers are scared to mention that, they want to fit in the timescale. Teachers must not be slaves of the pacesetter. Explain exactly where you are,

corrections must be done without any hurry, repeat the concept if not yet understood by the learners." (T5).

The following paragraphs present and discuss the theme on the lack of testing complex and problem-solving skills.

4.4.6.5 Theme 5: Complex procedures and problem-solving skills are not tested

It was established through document analysis that complex procedures and problem-solving skills were not tested. The following paragraphs present teachers' responses in terms of sub-themes which emerged from the interview sessions. Lack of proper teacher qualification in mathematics will be discussed first.

Sub-theme 5.1: Lack of subject knowledge

Some teachers indicated that they were not receiving proper training to teach mathematics, they were qualified teachers of course but for different subject areas. For example, T9 stated that:

"Problem-solving skills were presented in one workshop in the form of games and …what is this, learning to play in mathematics. I did not understand clearly, I am not trained to teach mathematics, so I don't have enough skills to make the subject simpler to learners through games." (T9).

T7 said:

"Because of high failure rate of learners and learners demotivated in the subject and us teachers having to account, I think that is the reason teachers do not include complex or high order questions in tests, we, however, try to use them in projects, where learners have a chance to ask for clarity purposes." (T7).

Contrary to T9 and T7's views, T2 pointed out that teachers must not compromise the policy requirements, they must test all the skills as stipulated in the CAPS document:

"Teachers must teach from simple to complex, in that way, complex skills can be learnt as one moves on with the learners. We cannot divert from the policy, it comes

back when learners write common papers, from the department which incused those complex procedures and we then experience a high failure rate." (T2).

The ensuing paragraphs present and discuss the lack of six cognitive levels in the setting of formal tests.

Sub-theme 5.2: The six cognitive levels of Bloom's taxonomy not being followed in the setting of formal tests

According to T2 regarding the six cognitive levels of Bloom's taxonomy:

"*This one really is a challenge to most teachers, yes they learnt about it during their training and maybe they did not understand the practical part of it. On the other side, the textbooks that we are using do not clearly stipulate the levels, it becomes a mammoth task now for the teacher to try and select which question goes with which level, maybe because of lack of time or lack of knowledge."* (T2).

T4 and T8 had the following contradictory comments:

"I think these teachers do not engage with the CAPS document. The policy guides on how to select questions, they have to follow the policy." (T4).

"The reason for this is not following curriculum, mmh, not curriculum, but the policy, if you go at the back of the policy, you see the guidelines and even the past exam papers stipulate that. I would say these teachers are not following the policy or they don't understand the policy itself." (T8).

The next sub-theme to be discussed is on moderation of formal assessments.

Sub-theme 5.3: Lack of proper moderation of formal assessments, both internally and externally

An interview with the teachers on moderation revealed that this part of assessment implementation was not being done properly. Issues such as lack of proper moderation tools, moderators not being trained for the subject and lack of external moderation were highlighted. However, T2 was for the idea that moderation could be achieved at the school level if teachers practised moderating each other and took note of what was being done correctly and incorrectly. This is what T2 suggested:

“Let us have the culture of monitoring each other formally or informally, highlight what is not being correctly done, share the good practices of moderation here at the school level.” (T2*).*

Opposingly, T4 felt moderation was poorly performed by the HODs. This is what T4 brought forward:

Moderation is done by subject heads that are not trained for mathematics. Like as it is, I am an HOD for intermediate phase mathematics but I am trained for FET mathematics, so I don’t think I can perfectly moderate for this phase.” (T4).

Correspondingly, T3 raised the following factor:

“There are no proper moderation tools from the subject advisors, what exactly is supposed to be identified as correct or wrong, the tool we are using now for moderation is for all the subjects in the school, how can it be the same? I guess we are not doing it right when I was at another district; there was a different tool for each subject.” (T3).

There was a revelation that there was no external moderation done by the subject advisors for formal assessments. For example, T2 said:

“My tasks have never been moderated by my subject advisor, if I remember very well, only the tests for March, the quarterly test came from the department for grade 6, maybe that one was moderated by them. I set my own tasks, moderated here at the school level, that’s it.” (T2).

The next theme to be discussed is on inadequate lack of support from the Free State Department of Education.

4.4.6.6 Theme 6: Lack of support from the Free State Department of Education

Most of the teachers feel that they do not receive adequate support from the DoE, in terms of being developed professionally. Their concern is based on inadequate visits for support by the mathematics subject advisors and inadequate workshops. The first sub-theme to be discussed is on subject advisors’ visits.

Sub-theme 6.1: Inadequate visits and support for teachers by the mathematics subject advisors

Some teachers raised a concern that their subject advisors were not supporting them in terms of school visits, so as to establish what challenges they encountered as they taught, leading to formal assessments and examinations. For example, T5 said:

"I only saw my subject advisor for the final moderation in 2018 November, a bad report was given, yet I wasn't supported the whole year. My investigation was highly scrutinised, yet it wasn't moderated, externally before being given to learners." (T5).

Pursuing this further, T1 stated that:
"I had no visit since 2017, I, however, attended a start-up workshop in February this year, 2019, we were promised to be clustered according to grades and a lead teacher to be identified, nothing so far has happened." (T1).

Interestingly, T6 mentioned the issue with surprise visits as stated below:
"Sometimes they just come unannounced, how then can we prepare for our challenges, if they cannot give us a date for the visit? We could seat as a department at school, write down and present our challenges to them." (T6).

On the contrary, T4 is satisfied with the support from subject advisors:
"They visited, we had start-up workshops, indexes and other file material were issued out. If one calls, they come for support. Teachers must know their lead teachers, every circuit has a lead teacher to assist as one waits for the subject advisor, according to me and the support is adequate enough." (T4).

The subsequent paragraphs present and discuss the issue of inadequate workshops.

Sub-theme 6.2: Inadequate workshops

The revelation of the interviews is that workshops are held but the time allocated for them is not adequate enough to address teachers' challenges and develop them professionally. For example, T9 said:

"We have been fighting, workshops start at 2 o'clock and one can't address a challenge in 2 hours. And we finish before 4 most of the times, slide presentations are done, we don't get them sometimes, they promise to email them to the school of which we rarely get them. If these workshops can be done during school holidays maybe so that we have enough time." (T9).

T7 raised the following concern:
"Sometimes some schools are not invited for workshops, you just hear other neighbouring schools went for workshops, I don't know how it's done sometimes." (T7).

T1 also said:
"We really need to be developed as teachers, new teachers join the field every year and yet they will only attend a workshop the following year, or luckily, one gear workshop to begin the year." (T1).

4.5 CONCLUSION

This chapter presented and analysed both quantitative and qualitative data on the implementation of formal assessments. Descriptive and inferential statistics were utilised to present and analyse quantitative data. This incorporated biographical data of teachers which included gender, age, teaching experience, professional teaching qualifications and the number of learners in class and school quintiles. Independent sample t-tests were conducted for descriptive statistics. ANOVA was used to test the hypotheses. This was followed by a checklist which was used for document analysis. Qualitative data was presented on the implementation of formal assessments so as to clarify the findings of the other two research instruments.

Reference can be made to the themes that emerged, such as the forms of assessment implemented in mathematics teaching and learning, challenges experienced by teachers in the implementation of formal assessments and challenges experienced by learners when they are engaged in formal assessments. Further reference can be made to themes such as supporting and guiding learners after they have received formal tasks so as to give them quality feedback and complex procedures and problem-solving skills not being not tested and lack of support from the FSDoE on the part of developing teachers professionally. The subsequent and final chapter discusses the findings, recommendations and draws the conclusion to this study.

CHAPTER 5: SUMMARISED FINDINGS, IMPLICATIONS, RECOMMENDATIONS AND CONCLUSION

5.1 INTRODUCTION

The intent of this chapter is to present the summarised findings of the literature review, as well as the quantitative and qualitative data on the implementation of formal assessments in intermediate phase mathematics teaching and learning. Furthermore, the conclusions obtained from the findings and the implications they bear will also be presented. The chapter will provide a description of the problems experienced by the researcher whilst conducting the research and finally, the researcher will state recommendations for further research. The following section gives an analysis of the summarised results of the literature review and what they imply.

5.2 SUMMARISED FINDINGS AND IMPLICATIONS OF LITERATURE REVIEW

The literature on the implementation of formal assessments was reviewed in Chapter Two; the intention being to present a theoretical framework and contextual analysis of the CAPS document. In Chapter Four, the researcher tried to ascertain the extent to which differences among biographical variables such as gender, teaching experience, professional teaching qualifications and school quintiles impact on the implementation of formal assessments. The checklist was utilised to establish the actual implementation of formals assessments and lastly, interviews were conducted to clarify the findings of the questionnaire and the checklist. This section presents a summary and findings of the literature review, which responded to the main research question:

What is the nature of formal assessments in intermediate phase mathematics teaching in South African schools?

5.2.1 The nature of formal assessments in intermediate phase mathematics in South African schools

The implementation of formal assessment in intermediate phase mathematics teaching and learning is stipulated in the CAPS document (DBE, 2011a). Literature indicates that intermediate phase mathematics formal assessments comprise of tests, examinations, projects assignments and investigations (cf. 2.4.2). The questionnaire utilised in this study is designed in a manner that shows the perceived status of the nature of the implementation of formal assessments according to intermediate phase mathematics CAPS. Incorporated in the questionnaire are items which require teachers to rate themselves on the above-stated components of formal assessments (Appendix F). The checklist employed in this study shows the actual implementation of formal assessments according to the records analysed. This analysis is done according to the achieved requirements for formal assessments and adequacy testing of cognitive levels and skills to be demonstrated (Appendix G). The subsequent paragraph discusses the implications of constructivism theories employed in this study.

5.2.2 Implications of cognitive and social constructivism theories on formal assessments

A review of the theoretical framework in Chapter Two exposed that the implementation of formal assessments is based on constructivist theories (cf.2.3). The constructivism theory states that knowledge is acquired, whereas understanding is bolstered through the effective construction of mental frameworks (Killen, 2015). In this study, two constructivism theories were employed to form the conceptual framework of the study; these are cognitive and social constructivism. The cognitive constructivism and its implications are discussed in the subsequent paragraph.

5.2.2.1 Summarised findings and implications of cognitive constructivism

The cognitive theory makes great use of the work of Piaget (1964). The main emphasis is based on the notion that children can formulate their own perceptions of the world as they connect with different settings which, in turn, prompt assimilation and accommodation (Berk, 2012). The theory has weighty implications for education, such as active engagement and exploration, unevenness of cognitive development and quality of thinking (cf.2.2.1.3). The subsequent paragraph discusses the findings based on active engagement and exploration as an education implication. These findings are derived from the descriptive statistics, checklist data and the thematic analysis.

Startlingly, it has been proven that learners are not actively engaged in the implementation of some of the assessment requirements in intermediate phase mathematics teaching and learning. A quantitative analysis of the checklist (cf. Table 4.25) for formal assessments given to the learners in 2018 shows that investigations and projects are not implemented as forms of assessments in mathematics, rather, learners were given a test instead of a project or investigation (cf. Table 4.26). Resultantly, learners lack critical and creative thinking which must be triggered by active engagement and exploration. This finding also emerged from the qualitative data responses in the semi-structured interviews conducted with mathematics teachers. Upon enquiry about complex procedures and problem-solving skills not being tested, thus interview question 10, the participant confirmed that the skill was not tested because of the lack of knowledge in the subject, on the part of the teachers (cf.4.4.6.5 sub-theme 5.1). This is adverse to the DBE (2011) which states that as a skill, learners should learn to investigate, analyse and represent information (cf.2.3.4.2). The following paragraph presents the findings of how teachers deal with the unevenness of cognitive development as they implement assessments.

Quantitative analysis revealed that unevenness of cognitive development is partially considered when teachers are setting formal tasks (cf. Table 4.3, questionnaire item C5.). Conversely, thematic analysis reveals that some teachers do not consider unevenness of cognitive development of learners as they set formal assessments. This can be achievable through the application of Bloom's taxonomy as assessments are set to cater to all the cognitive levels (cf. Table 4.3, questionnaire item C5). This was confirmed by one of the participants, responding to interview question 8, who mentioned that some of the teachers are not well versed with the application of cognitive levels and it becomes difficult for them to set the tasks (cf. 4.4.6.5 sub-theme 5.2). Consequently, learners' thinking competencies can be lessened if not directed to comprehend on Bloom's level of thinking (Jacobs, 2016). The emphasis of the level of understanding is underpinned by one of mathematics' specific aims, thus to establish a profound understanding of concepts so as to have a logic of mathematics as a subject (DBE, 2011a.). Nevertheless, this aim is not achieved in this study. The following paragraph presents summarised findings and implications of social constructivism.

5.2.2.2 Summarised findings and implications of social constructivism

Social constructivism clarifies worthwhile learning as one which takes place when people are exceptionally instructed on how to utilise their cultural psychological tools and have exposure on how to utilise them in turn so as to establish a universal awareness of phenomenon (Snowman *et al,* 2011). Vygotsky (1978) provides some important aspects of social constructivism theory; these are the role of social context, language and mediation (cf.2.2.2). The subsequent paragraphs summarise the findings and implications of the role of social context as an important facet of social constructivism. These findings are derived from the descriptive statistics, checklist data and the thematic analysis.

The quantitative findings revealed that whilst the role of social context is crucial in the cognitive development of a learner, in this instance mediation as a significant aspect of social context in the implementation of formal assessments, teachers are not applying it (cf. 2.2.2.3). Responses to questionnaire items I3, I4 and I5 which were meant to ascertain the level of teachers' ability to mark formal assessments, give individualised attention to learners and providing quality feedback to the learners show that there was a great dissimilarity among respondents, the *SDs* for these items were far from their means (cf. Table 4.9a). Analysis of data in Table 4.9a has revealed that the following challenges moderately affect intermediate phase teachers when they are engaged in formal assessment: class size (*M*=4.2), lack of individualised attention after marking tasks (*M*=4.21), attending to individualised learner needs (*M*=4.17) and provision of quality feedback (*M*= 4.44). This is a clear indication that teachers are challenged in playing their significant role of being potential mediators (cf. 2.2.2.4), hence it is a barrier in the proper teaching and learning of intermediate phase mathematics.

The review of information in Table 4.9b has revealed that intermediate phase mathematics teachers experience the following challenges with regard to formal assessment: learners are unable to solve word problems (*M*=3.23), learners are unable to read and write fluently in English (*M*=3.24) and the language of teaching and learning does not promote learner understanding of questions (*M*=3.66). To endorse this quantitative finding, reference can be made to the participants' responses to interview questions 2 and 7. These questions were meant to demonstrate the challenges teachers encounter as they execute formal assessment and how teachers support and guide learners after they have received their marked assessments. Consequent to enquiry, two of the participants (T2 & T4) mentioned that it was impossible to assist learners individually because of the class sizes (cf.4.4.6.2. sub-theme 2.3). Both the quantitative and qualitative findings evidently demonstrate that there is the inadequacy of social interaction between the teachers and their learners. This opposes the aspect of social context which states that learners develop new knowledge and meaning between the known and unknown through social interactions with knowledgeable peers or teachers (cf.2.2.1). Furthermore, the implication is that teachers are not playing their role of being mediators in the ZPD to guide learners (cf. 2.2.2.3). The subsequent paragraphs summarise the findings and implications of the role of language as a notable aspect of social constructivism.

Language is clarified as a solution to conversations which serve to connect the teacher and learners. Furthermore, reference is made that the teacher's proficiency in conveying messages clearly will lead to learners' accelerated mastery of language (Killen, 2015). This includes both spoken and written language (cf. 2.2.2.2).

Inversely, the quantitative analysis discloses that the use of English language as a LoLT brings about a lot of challenges. Responses to questionnaire items I25, I27 and I28 indicate that the LoLT makes it difficult for learners to understand questions, learners have difficulties in solving word problems due to language barriers and learners' performance is not up to standard because they cannot read and write in English (cf. Table 4.9b). Additionally, the checklist data confirms the issue of language challenges which affects testing of cognitive skills. Teachers are not making use of appropriate mathematical language when testing learners for formal assessments (cf. item C5 Table 4.26a).

The above is bolstered by the qualitative findings which emerged from interview question 3 on the challenges teachers experience when implementing formal assessments. In response to the question, the participants confirmed that LoLT posed a challenge in their implementation of formal assessments since it hindered learners' level of understanding, resultantly leading to poor performance (cf. 4.4.6.3 sub-theme 3.1). Literature confirms LoLT as a challenging issue in the teaching and learning of mathematics, hence being a barrier in the effective implementation of formal assessments (cf. 2.5.6). The next section will discuss the summarised findings on the utilisation of formal assessments as a foundation of teaching and learning. Consequently, this ensuing section provides answers on the following research question:

How are formal assessments used as a foundation for teaching and learning enhancement?

5.3 SUMMARISED FINDINGS AND IMPLICATIONS ON THE USE OF FORMAL ASSESSMENTS AS A FOUNDATION FOR TEACHING AND LEARNING ENHANCEMENT

This section presents the findings and implications of formal assessments as a foundation for teaching and learning in accordance with the literature, the questionnaire, the checklist employed in this study and responses from the participants' interviews. Killen (2015) suggests that teachers must follow the Quality Teaching Model (QTM) to bolster the quality of teaching and learning. This model categorises teaching practices into three elements, namely the intellectual quality, significant knowledge and the learning environment. The intellectual quality recommends that the significant role of the teacher is to assist learners with an understanding of new concepts in the subject area through the use of pedagogical methods. This idea is supported by one of the specific aims of mathematics, which is to reinforce the intensive assimilation of the concept so as to fully understand mathematics as a subject (cf.2.3.4.1). Significant knowledge comprises concepts, principles and fundamental ideas that are foundations of the subject taught. Furthermore, significant knowledge incorporates relationships that prevail between the fundamental ideas and other subjects (Killen, 2015). This element is supported by the DBE (2011a) as one of the specific aims, thus to develop acquisition of distinct knowledge and capabilities essential to learn relevant the subject (cf. 2.3.41). Similarly, this was also encouraged by Anthony and Walshaw (2009) as a principle of producing worthwhile mathematical tasks (cf.2.3.5.1). The learning environment must be conducive for learners to work collaboratively, also develop interesting learning experiences which are challenging though (Killen, 2015). This idea is underpinned by one of the specific aims of mathematics thus to broaden the motive for the love and curiosity for mathematics (cf. 2.3.4.1). Borich (2014) also supports cooperative learning (cf.2.4.5.2).

The questionnaire shows the perceived status of teaching and learning enhancement in mathematics. This is sought under the marking, recording and moderation of formal tasks and the setting of tests, examinations, projects, assignments and investigations (Appendix F). The actual enhancement of mathematics teaching and learning is revealed by the document analysis through the checklist results. Furthermore, the clarity of findings is furnished by the semi-structured interview responses.

Despite the recommendations from literature, questionnaire items and the checklist requirements on how teaching and learning can be enhanced, the implementation of formal assessments in not done properly. Teachers have challenges on the knowledge of the subject, meaning they cannot effectively impart the knowledge to the learners on the implementation of formal assessments. Resultantly, proper investigation and problem-solving skills are not tested. Table 4.26 has revealed that the following challenges, namely problem-solving (M=1.11) and investigation (M=1.11) highly affect teachers as they engage in formal assessment: This is confirmed with qualitative findings where participants mentioned lack of knowledge as an effect in the implementation of formal assessments (cf. 4.4.6.5 sub-theme 5.1). The ensuing section provides answers to the following research question:

What challenges do teachers and learners experience in the implementation of formal assessments?

5.4 SUMMARISED FINDINGS AND IMPLICATIONS ON THE CHALLENGES TEACHERS AND LEARNERS EXPERIENCE IN THE IMPLEMENTATION OF FORMAL ASSESSMENTS

This section demonstrates the findings and implications of the challenges teachers and learners experience in the implementation of formal assessments. Information is derived from literature, the questionnaire, the checklist and the semi-structured interview responses. Killen (2015) suggests that to teach effectively, teachers need to be knowledgeable with the subject and pedagogical content awareness. The knowledge of the subject will enable teachers to effectively communicate and engage with learners. Language has an essential part in the accomplishment of knowledge (Vygotsky, 1987). The role of language has been discussed earlier in this study (cf. 2.2.2.2). Du Plessis (2014) suggests that teachers need professional development to address their pedagogical challenges (cf. 2.5). Indisputably, literature reveals that teachers face various challenges in the implementation of formal assessments. These challenges include viewing assessments as an administrative burden on the teacher's part, lack of knowledge of formal assessments, teachers' poor content and pedagogical knowledge, lack of ongoing professional development, difficulties in understanding policies and the difficulties posed by the LoLT (cf. 2.5.1 to 2.5.6). The quantitative findings also reveal that both the teachers and learners are challenged in the implementation of formal assessments (cf**.** Tables 4.9 a & 4.9 b).

The checklist also reveals that there is a lack of appropriate mathematical language in testing cognitive levels (cf. Table 4.26: C4). This implies that learners lack knowledge of mathematics which comprises 25% of the cognitive levels as specified in the checklist (Appendix G) and the development of the correct use of mathematical language (cf. 2.3.4.2). Additionally, interview results confirm that learners and teachers have difficulties in executing assessment tasks effectively (cf. 4.4.6.5 sub-theme 5.1). The following section presents the implications of the implementation of formal assessments according to biographical variables. The section answers the following research question:

To what extent do differences in biographical variables (gender, age, teaching experience, professional teaching qualification, class size and school quintile) and mathematics intermediate phase teachers' responses relate to their implementation of formal assessments?

5.5 SUMMARISED FINDINGS AND IMPLICATIONS ON THE IMPLEMENTATION OF FORMAL ASSESSMENTS ACCORDING TO BIOGRAPHICAL VARIABLES

The implementation of formal assessments in intermediate phase mathematics was compared according to biographical variables such as gender, age, teaching experience, professional teaching qualifications, class size and school quintile. The comparison was derived from the results of the independent-sample t-tests and the ANOVA which was performed to test different hypotheses. The t-test was used to determine the implementation of formal assessments according to gender, age, teaching experience, professional teaching qualifications and class size.

5.5.1 The implementation of formal assessments according to gender, age, teaching experience, professional teaching qualifications and class size

This section presents the findings and implications of independent-sample t-tests. Altogether, there were five hypotheses analysed on the following variables, namely gender, age, teaching experience, professional qualifications and class sizes. The first one to be discussed is the comparison of male and female mathematics teachers in their implementation of formal assessments.

5.5.1.1 The implementation of formal assessments according to gender

An independent-sample t-test was conducted to compare the implementation of formal assessments between males and females. The following hypotheses were tested to compare the implementation of formal assessments according to gender:

H_0: There is no statistically significant difference between male and female intermediate mathematics teachers on formal assessment scores.

H_1: There is a statistically significant difference between male and female intermediate mathematics teachers on formal assessment scores.

Analysis of data shows that there is no statistical difference between the male and female assessment scores, *p*=.16. Both genders implement assessments comparably (cf. 4.2.2.1 & Table 4.10). Therefore, the null hypothesis is accepted whereas the alternative hypothesis is rejected. This implies that gender (on the part of teachers) does not affect curriculum delivery in the intermediate phase. There is no need for the DBE to change staffing strategies based on gender. The next paragraph discusses the comparison of young and old intermediate phase teachers on formal assessments implementation.

5.5.1.2 The implementation of formal assessments according to the teachers' age

An independent-sample t-test was conducted to compare the implementation of formal assessment scores for young and old teachers. The following hypotheses were tested to compare the implementation of formal assessments according to the teachers' ages:

H_0: There is no statistically significant difference between young and old intermediate mathematics teachers on formal assessment scores.

H_1: There is a statistically significant difference between young and old intermediate mathematics teachers on formal assessment scores.

The results show that there is a statistically significant difference between the means of old and young teacher's assessment scores, *p*=.00. The magnitude of the difference in the mean scores is moderately large because the effect size was 0.07. Additionally, confidence intervals do not include 0 (zero) which is a confirmation that there is a statistically significant difference (cf. 4.2.2.2 & Table 4.11). Therefore, the null hypothesis is rejected; whilst the alternative hypothesis is accepted.

The major reason for the difference can be assigned to the higher number of teaching experiences the old teachers have compared to the young teachers. A suggestion can be put forward that when the placement of teachers is done, there must be experienced teachers per grade who can assist the HoDs with the development of novice teachers. The ensuing paragraph discusses the comparison of intermediate phase mathematics teachers in the implementation of assessments in terms of years of teaching experience.

5.5.1.3 The implementation of formal assessments according to teaching experience

An independent-sample t-test was conducted to compare the implementation of formal assessments of teachers with 1 to 5 years of teaching experience with those with 6 to 28 years of teaching experience. The following hypotheses were tested to compare the implementation of formal assessments according to teaching experience:

H_0: There is no statistically significant difference among intermediate mathematics teachers with teaching experiences of 1-5 years and 6-28 years on formal assessment scores.

H_1: There is a statistically significant difference among intermediate mathematics teachers with teaching experiences of 1-5 years and 6-28 years on formal assessment scores.

The results show that there is a statistically significant difference in the mean scores of teaching experience, *p*=.00. The magnitude of the difference was moderately large because the effect size was 0.06. Furthermore, the confidence intervals confirm the statistical difference since the intervals do not include a 0 (zero) between them (cf. 4.2.2.3 & Table 4.12). Therefore, the null hypothesis is rejected, whereas the alternative hypothesis is accepted. The logic behind the difference can be assigned to the reason that the more years teachers have in the field, the more experience they have in the implementation of formal assessments. This can be confirmed by the fact that CAPS was introduced in 2011, thus eight years ago. This implies that all the teachers who have less than eight years of teaching experience did not receive the CAPS training. In agreement with the above, Kanjee (2013) states that the NPA as stipulated in the CAPS is difficult for teachers to understand (cf. 2.5.5). This is validated by the quantitative findings whereby most of the respondents indicated that they view the NPA as confusing and complex (cf. 4.2.1.2 Table 4.9b, questionnaire item I23). The ensuing paragraph discusses the comparison of teachers with or without professional teaching in the intermediate phase.

5.5.1.4 The implementation of formal assessments according to teaching qualifications

An independent-sample t-test was conducted to compare the implementation of formal assessments value scores for teachers with or without professional teaching qualification in the intermediate phase. The following hypotheses were tested to compare the implementation of formal assessments according to teaching qualifications:

H_0: There is no statistically significant difference among mathematics teachers with or without professional teaching qualification in the intermediate phase on formal assessment scores.
H_1: There is a statistically significant difference among mathematics teachers with or without professional teaching qualification in the intermediate phase on formal assessment scores.

Data show that there is a statistically significant difference between the means of teachers with and teachers without qualification in the intermediate phase in their assessment scores, p=.01. The magnitude of the difference was moderately small because the effect size was .04. Additionally, the confidence interval does not include 0 (zero) which is a confirmation that there is a statistically significant difference (cf. 4.2.2.4 & Table 4.13). Therefore, the null hypothesis is rejected, whereas the alternative hypothesis is accepted. The reasons behind the differences are assigned to the inadequacy of subject competency on the part of teachers without professional qualifications in intermediate phase mathematics teaching and learning. Apparently, these teachers lack proper methodology on the subject area, hence difficulties in the implementation of assessments. This is attested by the thematic discussion outcomes of this research, whereupon enquiry the participants indicated that as ascribable to insufficient knowledge and grounding in mathematics, it was difficult to implement assessments (cf. 4.4.6.5 sub-theme 5.1). Additionally, it was highlighted in Chapter Two that lack of knowledge and skills affect the implementation of assessments (cf. 2.5.2 & 2.5.3). This is consistent with references made by Killen (2015) that to be an efficient teacher, one needs profound knowledge of the particular subject being taught. The subsequent paragraph discusses the comparison of teachers who teach an average of 25 to 40 learners and 41 to 55 learners with regard to assessment implementation.

5.5.1.5 The implementation of formal assessments according to the class size

An independent-sample t-test was conducted to compare the assessment scores for teachers who teach an average of 25 to 40 learners and 41 to 55 learners. The following hypotheses were tested to compare the implementation of formal assessments according to the class size:

H_0: There is no statistically significant difference among intermediate mathematics teachers who teach an average of 25-40 learners and an average of 41-55 learners on formal assessment scores.

H_1: There is a statistically significant difference among intermediate mathematics teachers who teach an average of 25-40 learners and an average of 41-55 learners on formal assessment scores.

The revelation is that there is a statistically significant difference in mean scores, *p*=. 05. The magnitude of the difference was small because the effect size was .02. Moreover, the confidence interval does not include 0 (zero) which is a confirmation that there is a statistically significant difference (cf. 4.2.2.5 & Table 4.14). Therefore, the null hypothesis is rejected, whereas the alternative hypothesis is accepted.

Teachers with a lower number of learners are not burdened with the implementation of formal assessments by virtue of having less learners in the class. This is validated by the descriptive statistics of this study. Most of the teachers confirmed that their class sizes are not suitable for formal assessments (cf. Table 4.9, questionnaire item I2). Furthermore, this is reinforced by the qualitative findings whereupon enquiry about the challenges teachers experience as they implement formal assessments (cf. 4.4.6.2 sub-theme 2.3, interview question 3), revealed large class sizes as a major challenge in the implementation of formal assessments. Therefore, the inference reached is that the larger the number of learners in the class, the more difficult it is to implement formal assessments and vice versa.

Furthermore, a comparison was made based on various forms of assessments implemented in intermediate phase mathematics teaching and learning, namely tests and examinations, assignment, project, investigation, moderation and recording and reporting. These are briefly highlighted below.

With regards to comparison based on gender, there was no statistically significant difference in all the various forms of assessment (cf. Table 4.15). This is shown by the following *p* values: Tests and examinations, *p*=.90, assignments=.37, project, *p*=.53, investigation, *p*=.62, moderation, *p*=.52 and lastly recording and reporting, *p*=.14. The ensuing paragraph discusses a comparison based on teachers' ages.

In relation to comparison based on age, the following variables had significant differences in the implementation of formal assessments: tests and examinations, *p*=.00. The magnitude of the difference was large because the effect size was 0.19 (cf. Table 4.16a). With regard to assignment, *p*=.04, however, the magnitude of the difference was moderately small because the effect size was 0.03. Lastly, concerning investigation, *p*=.02, with a magnitude difference of 0.04 which had a moderately large effect. Furthermore, the confidence intervals confirm the statistical difference since the intervals do not include a 0 (zero) in-between them (cf. 4.2.2.3 & Table 4.16). However, concerning projects, moderation and recording and reporting, the results show that there was no statistical significance in comparison based on teachers' ages. This is revealed by the following *p* values: projects, *p*=.18, moderation, *p*=.28 and recording and reporting, *p*=.89 (cf. 4.2.2.3 & Table 4.16b). The subsequent paragraph discusses the comparison of the implementation of formal assessments based on teaching experience.

Concerning tests and examinations and investigations, there was a significant difference in comparison made on the basis of teaching experiences. With regard to tests and examination, *p*=.00, the magnitude of the difference was large because the effect size was 0.14. Regarding investigation, p=.04 with however small effect size of 0.03. Furthermore, the confidence intervals confirm the statistical differences since the intervals do not include a 0 (zero) between them (cf. 4.2.2.3 & Tables 4.17). However, with other variables, there was no difference in how the experienced and inexperienced teachers implemented assessments. This is shown by the following *p* values: assignment, *p*=.07, project, *p*=.10, moderation, *p*=.69 and also recording and reporting, *p*=.69 (cf. 4.2.2.3 & Table 4.17). The ensuing paragraph discusses the comparison of the implementation of formal assessments based on teachers' qualifications.

With regards to comparison based on teachers' qualifications, the results show that tests and examinations was the only variable with a significant difference with *p*=0.00. The magnitude of the difference in means was large because the effect size was 0.11 (cf. 4.2.2.3 & Table 4.18). However, with other variables, there was no difference in how teachers implemented assessments. This is shown by the following *p* values: assignment, *p*=.13, project, *p*=.35, investigation, *p*=.06, moderation, *p*=.16 and recording and reporting, *p*=.74 (cf. 4.2.2.3 & Table 4.18). The following paragraph discusses the comparison of the implementation of formal assessments based on class sizes.

In relation to comparison based on class sizes, results indicate that tests and examinations were the only variable with a significant difference, with *p*=.03. The magnitude of the difference in means was moderately small because the effect size was 0.03 (cf. 4.2.2.3 & Table 4.19). However, with other variables, there was no difference in how teachers implemented assessments based on class sizes. This is shown by the following *p* values: assignment, *p*=.81, project, *p*=.09, investigation, *p*=.13, moderation, *p*=.73 and recording and reporting, *p*=.35 (cf. 4.2.2.3 & Table 4.19). The subsequent paragraphs discuss the implementation of formal assessments according to the different grades and school quintiles. ANOVA was used to compare the implementation of formal assessments in different grade and school quintiles.

5.5.2 The implementation of formal assessments according to different grades and school quintiles

This section presents the findings and implications of the ANOVA results. There were two hypotheses analysed, namely three intermediate phase grades on various forms of assessment and differences according to the school quintiles. First, ANOVA was done to test the following hypotheses:

H_0: There is no statistically significant difference among mathematics teachers who teach different intermediate phase grades on formal assessment scores.

H_1: There is a statistically significant difference among mathematics teachers who teach different intermediate phase grades on formal assessment scores.

The first finding to be discussed is a comparison of the three intermediate phase grades on formal assessment.

5.5.2.1 The implementation of formal assessments according to three intermediate phase grades

A one-way between-groups analysis of variance was conducted to compare the variance between three intermediate phase grades in the implementation of formal assessments. Data were separated into three categories, thus Grades 4 to grade 6.

The hypotheses mentioned in Section 5.5.2 are based on the information in Table 4.20a & Table 4.20b. Results reveal that in all variables, there was no difference in how teachers implemented assessments based on different intermediate phase grades. This is shown by the following *p* values: tests and examinations *p*=.28, assignment, *p*=.18, project, *p*=.57, investigation, *p*=.11, moderation, *p*=.59 and recording and reporting, *p*=.81 (cf. 4.2.2.3 & Tables 4.21b & 4.21c). As shown, there is no statistical difference between the three intermediate phase grades in the implementation of formal assessments. All three grades implement assessments comparably. This implies that grade (on the part of teachers) does not affect curriculum delivery in the intermediate phase. Therefore, the recommendations and elements of future research which will be given at the end of this study are applicable throughout the entire intermediate phase. The next paragraph discusses the comparison of formal assessment implementation according to school quintiles.

5.5.2.2 The implementation of formal assessments according to school quintiles

A second ANOVA was also done to test the following hypotheses:

H_0: There is no statistically significant difference among intermediate mathematics teachers who teach at different school quintiles on formal assessment scores
H_1: There is a statistically significant difference among intermediate mathematics teachers who teach at different school quintiles on formal assessment scores.

A one-way between-groups analysis of variance was conducted to compare the variance between five school quintiles in the implementation of formal assessments. Data were split into five categories, thus quintile 1 to quintile 5. Data analysis shows that there was a statistically significant difference in the tests and examination scores of quintiles 2 and 4 schools: *p*=.02. The magnitude of the differences had a moderate to large effect size of .008. Post-hoc comparison using the Tukey HSD test indicated the mean scores for quintile 2 (*M*=30.66) and quintile 4 (*M*= 33.89). The mean difference is 3.23. The implication is that quintile 4 schools are giving more tests and examinations than quintile 2 schools (cf. 2.2.2 & Tables 4.23a & b). The reason for the differences can be attributed to class sizes as discussed earlier in this chapter (cf. 4.23 Table 4.19). Also, data analysis shows that there was a statistically significant difference in recording and reporting scores for quintile 1 and 5 schools, *p*=.07. The magnitude of the differences had a moderate effect size of .006. Post-hoc comparison using the Tukey HSD test indicated the mean scores for quintile 1 (*M*=58.96), quintile 5 (*M*= 62.04). The mean difference is 3.08. The revelation is that quintile 5 schools are recording and reporting more than quintile 1 schools. This could be attributed to smaller class sizes and less workload which is an advantage to quintile 5 schools (cf.4.4.6.2 sub-theme 2.3). However, with other variables, there was no difference in how teachers implemented assessments based on the school quintiles. This is shown by the following *p* values: assignment, *p*=.15, project, *p*=.22, investigation, *p*=.33 and moderation, *p*=.18 (cf. 4.2.2.3 & Tables 4.23a, b &c).

The preceding section discussed the findings of both quantitative and qualitative data. In conclusion, the findings of this study indicated that the implementation of formal assessments in intermediate phase mathematics teaching and learning in the

Lejweleputswa district is insufficient. Resultantly, the subsequent paragraphs present some recommendations which can be considered in the alleviation of the aforementioned challenges.

5.6 RECOMMENDATIONS

The recommendations involve various stakeholders in the teaching and learning of mathematics in the intermediate phase, namely the policymakers, the Free State Department of Education, Teacher Training Institutions, mathematics subject advisors and the mathematics teachers themselves. The following paragraph presents the recommendations to the policymakers.

5.6.1 Involvement of teachers in curriculum design

Regarding the development and planning of the CAPS document, teachers in South Africa are not involved in this part; their duty is to implement the designed curriculum. Adversely, the results of this research indicate that teachers have challenges in the mastery of the CAPS policy designed for them; this has been discussed in chapter Four (cf. 4.4.6.4) and chapter Five (cf. sub-theme 5.1). This calls for curriculum developers to consult teachers, who are curriculum implementers, about the challenges they encounter with CAPS in the implementation of formal assessments and make reforms accordingly. Curriculum developers may unintentionally incorporate controversial information; this does not, however, call for negative criticism but the development of reforms. Hence, it is recommended that curriculum designers also count on the conclusions and decisions based on what researchers suggest for the betterment of quality teaching and learning. The subsequent paragraph discusses the recommendations to the Free State Department of Education.

5.6.2 Placement of teachers according to subjects and phases they are qualified for

To teach effectively, teachers need to be competent in the subject area and be well versed with relevant content. Conflictingly, findings of this study reveal that a number of teachers employed in the intermediate phase to teach mathematics do not possess the proper qualifications to do so, instead, they are qualified to teach other phases or other subject areas; hence they are challenged in the implementation of assessments because they lack the knowledge base for the subject. This issue has been discussed earlier in this chapter (cf. 5.3.1.4). Additionally, large class sizes pose a challenge to the teachers as they implement formal assessments, they cannot give learners individualised attention. Recommendations are therefore submitted to the DOE to accede to the stipulated teacher to learner ratio of 1:35. Furthermore, the DOE has to timeously provide schools with enough Teaching-Learning Materials (TLMS).

5.6.3 Presentation of a module on the implementation of formal assessments in teacher training institutions

Findings of this research reveal that most of the teachers are not able to set the tests in alignment with Bloom's taxonomy as recommended by CAPS. This calls for teacher training institutions to fully present and teach student teachers how to apply the taxonomy. Furthermore, teacher training institutions should practically train mathematics student teachers to implement formal assessments effectively.

5.6.4 Development of teachers by mathematics subject advisors on assessments

Teachers are expected to continuously develop, to keep abreast with current knowledge for the subjects they are teaching. However, findings of this study indicate that teachers lack ongoing professional development (cf. 2.5.4). Furthermore, subject advisors do not moderate formal assessments set by teachers at the school level. This is revealed by the quantitative findings which indicated that there are no external moderations for the tasks by the subject advisors (cf. Table 4.7 item G3). Furthermore, the qualitative findings from participants confirm that there are no task moderations by the subject advisors (cf. 4.4.6.5 sub-theme 5.3). The researcher recommends that subject advisors must hold various workshops so as to support teachers in the knowledge of formal assessments and be available for support in schools when needed. Van der Nest, Long and Engelbrecht (2018) affirm that professional development which incorporates assessment as learning is essential to support teachers' assessment practices in the classrooms.

5.6.5 Lifelong learning by intermediate phase mathematics teachers

Teachers are the implementers of the curriculum as discussed earlier in this chapter (cf. 5.4.1). This suggests that they must have sound knowledge of the subject as a whole. Underwhelming, some of the teachers in the research are not trained to teach intermediate phase mathematics and are not making efforts to be part of the PLCs either. The researcher recommends that teachers must fulfil their role of being 'life-long learners'. They must make efforts to acquaint themselves with new developments in mathematics teaching and learning. They must invite subject advisors to their schools if they need support. In this way, they can improve their professional development. The ensuing paragraph discusses the problems experienced by the researcher whilst conducting the study.

5.7 PROBLEMS EXPERIENCED IN THIS RESEARCH

As per requirements, the researcher applied to the Free State Department of Education for authorisation to carry out research in public schools. The department took very long to grant approval. The application was submitted on the 14th of February 2019 and the approval was only received on the 10th of June 2019, four days before schools closed for the second term. This delayed the process of data collection on the part of the researcher.

Some of the teachers were reluctant to have their documents analysed and to participate in the interview sessions. This also delayed the textual data collection and interviews as the researcher had to look for other participants.

Furthermore, intermediate phase mathematics subject advisors were not available for interviews, yet the researcher needed their responses to clarify the quantitative findings and the teachers' responses to the interviews. The subsequent paragraph presents the recommendations for future research suggested by the researcher.

5.8 FUTURE RESEARCH

The literature revealed that there is not much research done in the implementation of assessments in intermediate phase mathematics teaching and learning. As a result, it calls for further research. Furthermore, there have not been any adjustments in the CAPS policy since its implementation in 2011, regardless of some researchers submitting recommendations for adjustments. The researcher suggests that the following areas in mathematics teaching and learning should be conducted in future:

- strategies for actively involving mathematics learners in the learning procedure;
- experimentation and discovering of rules in mathematics;
- the development of learner cognitive levels through formal mathematics tasks;
- the testing of complex mathematical procedures to improve learners' investigation skills; and
- the development of problem-solving skills to improve learners' high order thinking skills in mathematics.

Policy designers are therefore requested to address any shortcomings highlighted by the researcher to produce an improved curriculum.

5.9 CONCLUSION

In this chapter, the researcher presented the summarised outcomes and implications of the literature review and from both the descriptive and inferential statistics on the implementation of formal assessments. Furthermore, the researcher presented the recommendations which might enhance the implementation of assessments in future.

This research project explored the implementation of formal assessments in intermediate phase mathematics as the foundation of teaching and learning in the Lejweleputswa district. The findings revealed that generally, the implementation of formal assessments is inadequately done. The reason behind the inadequacy is the lack of alignment of mathematics teaching and learning according to CAPS. Another contributory factor is the failure of teachers to follow the nature of formal assessments in intermediate phase mathematics as stipulated in the CAPS policy.

Furthermore, the challenges encountered by both the teachers and learners contribute to the insufficiency of assessment implementation. However, the researcher believes these challenges can still be alleviated so as to improve quality education for all.

REFERENCES

Abrie M.; Blom N. & Fraser B. 2016. Theoretical Foundations. In Jacobs M.; Vakalisa N.C.G & Gawe N. (Eds.). *Teaching-Learning Dynamics.* Cape Town: Pearson Education.

Akbari R. & Alivar N. K. 2010. L2 Teacher Characteristics as Predictors of Students' Mathematical Thought Processes. *Educational Studies in Mathematics,* 41: 109-142.

Anthony G. & Walshaw M. 2009. Characteristics of Effective Teaching of Mathematics: A view from the West. *Journal or Mathematics Education*, 2(2): 147-164.

Arends R. I. 2011. *Learning to Teach.* (9^{th} ed). Boston, MA: McGraw Hill.

Babbie E.R. 2013. *The Practice of Social Research*. Cape Town: Oxford University Press.

Baird J. 2009. Macro and Micro Influences on Assessment Practices. Assessment in Education: Principles, Policy and Practice. *International Journal of Education,* 16(2): 127-129.

Baird J.; Hopfenbeck T.N.; Newton P.; Stobart G. & Steen-Utheim A.T. 2014. *State of the Field Review: Assessment and Learning.* Norwegian Knowledge Centre for Education. Oxford: Oxford University Centre for Educational Assessment.

Bakkabulindi F. 2015. Positivism and Interpretivism: Distinguishing characteristics, Criteria and Methodology. In Okeke C. & Van Wyk M. (Eds.). *Educational Research: An African Approach.* Cape Town: Oxford University Press.

Bakkabulindi F. 2015. Quantitative Data Analysis: Inferential Statistics. In Okeke C. & Van Wyk M. (Eds.). *Educational Research: An African Approach.* Cape Town: Oxford University Press.

Bateson G. 1972. *Steps to Ecology of Mind*. New York: Ballantine Books.

Berk K.L. 2012. *Child Development*. (9th ed). New York: Pearson.

Blackstone A. 2012. *Principles of Sociological Inquiry: Qualitative and Quantitative Methods. Saylor Foundation.* Retrieved June 25, 2019, from: https://saylordotorg.github.io/text_principles-of-sociological-inquiry-qualitative-and-quantitative-methods/s05-03-inductive-or-deductive-two-dif.html.

Boaler J. 2015. Fluency *Without Fear: Research Evidence on the Best Ways to Learn Math Facts.* Retrieved December 4, 2019, from https://www.semanticscholar.org /paper/Fluency-Without-Fear%3A-Research-Evidence-on-the-Best-Boaler-Confer/75a7 c496afdf9c75136287428ee0d5d231a08e9a.

Borich G.D. & Tombari M.L. 1997. *Educational Psychology: A Contemporary Approach.* New York: Longman.

Borich G.D. 2014. *Effective Teaching Methods: Research-Based Practice.* Boston: Pearson.

Botes H. & Mji A. 2010. Language Diversity in the Mathematics Classroom: Does a Learner Companion Make a Difference? *South African Journal of Education,* 30:123-128.

Bouwer C. 2016. Identification and Assessment of Barriers to Learning. In Landsberg E.; Kruger D. & Swart E. (Eds.). *Addressing Barriers to Learning: A South African Perspective.* Pretoria: Van Schaik.

Bowen G.A. 2009. *Document Analysis as a Qualitative Research Method.* Retrieved April 8, from http://www.academia.edu/8434566/.

Bowie L. Gleeson-Baird R.; Jones R.; Morgan H.;Morrison K. & Smallbones M. 2012. *Platinum Mathematics: Grade 6 Teacher's Guide.* Cape Town: Maskiew Miller Longman.

Brodie K. 2013. The Power of Professional Learning Communities: *Education as Change,* 17(1), 5-8.

Brookhart S.M. & Nitko A.J. 2014. *Educational Assessment of Learners 7th ed.* Pittsburgh: Pearson.

Brookhart S.M. 2011. Educational Assessment Knowledge and Skills for Teachers. *Educational Measurement: Issues and Practice*, 30(1):3-12.

Brookhart S.M.; Moss C.M. & Lang B.A. 2010. Teacher Inquiry into Formative Assessment Practices: Assessments in Education: Principles, Policy and Practice. *International Journal of Education,* 17(1): 41-58.

Brown G.T.L.; Kennedy K.J.; Fok P.K. & Chan J.K.S. 2009. Assessments for Learners Improvement: Understanding Teachers' Concepts and Practices of Assessments: Assessments in Education: *Principles, Policy and Practice*, 16(3): 347- 363.

Butt G. 2010. *Making Assessment Matter.* London: Continuum.

Cambourne B. 1998. *The Whole Story: Natural learning and the Acquisition of Literacy in the Classroom.* New York: Ashton Scholastic.

Carnoy M.; Chisholm L.; Addy N.; Arends F.; Baloyi H.; Irving M.; Raab E.; Reeves C., Sapire I. & Sorto A. 2011. *The Process of Learning in South Africa: The Quality of Mathematics Teaching in North West Province.* Technical Report. Pretoria: Human Sciences Research Council.

Castle K. 2012. *Early Childhood Teacher Research: From Question to Results.* Milton Park: Routledge.

Cathcart S.G., Pothier M. Y.,Vance H.J. & Bezuk S.N. 2011. *Learning Mathematics in Elementary and Middle Schools: A Learner-Centred Approach*. Alberta: Pearson.

Chisholm L.; Hoadley M.; Prinsloo C; Mosia D. & Rule S. 2009. *Teacher Workload in South Africa.* Pretoria: Human Science Research Development (HSRD).

Churches, R. & Dommett, E. 2016. *Teacher-led Research: Designing and Implementing Randomised Controlled Trials and Other Forms of Experimental Research*. Carmarthen: Crown House.

Coffey J.E.; Hammer D.; Levin D.M & Grant T. 2011. The Missing Disciplinary Substance of Formative Assessment. *Journal of Research in Science Teaching,* 48(10): 1109-1136.

Coombs B. 1995. *Successful Teaching: A Practical Handbook.* Oxford: Heineman.

Crespo S. & Riegelman N. 2015. Introduction to Part III. In Suurtamm C & Roth McDuffie A (Eds.). *Annual Perspective in Mathematics Education: Assessment to Enhance Teaching and Learning*. 119-121. Reston, VA: National Council of Teachers of Mathematics.

Creswell J. W & Creswell J.D. 2018. *Research Design: Qualitative, Quantitative & Mixed-methods Approaches.* Los Angeles: Sage.

Creswell J.W. & Plano Clark V.L. 2011. *Designing and Conducting Mixed-methods Research (*2nd ed.). Thousand Oaks. CA: Sage.

Creswell J.W. 2012. *Educational Research: Planning, Conducting and Evaluating Quantitative and Qualitative Research.* Boston: Pearson.

Creswell J.W. 2015. *Educational Research: Planning, Conducting and Evaluating Quantitative and Qualitative Approaches to Research,* 5th ed. Upper Saddle River, NJ: Merrill/Pearson Education.

Creswell J.W.2013. *Qualitative Inquiry and Research Design: Choosing Among Five Traditions,* 3rd ed. Thousand Oaks, CA: Sage.

Dakwa F. 2015. The Interview Method. In Okeke C & Van Wyk M. (Eds.). *Educational Research: An African Approach:* Cape Town: Oxford University Press.

DeLuca C.; Luu K.; Sun Y. & Klinger D. 2012. Assessment for Learning in the Classroom: Barriers to Implementation and Possibilities for Teacher Professional Learning. *Assessment Matters*, 4, 5-29.

Delvin A. S. 2018. *The Research Experience: Planning, Conducting and Reporting Research.* Los Angeles: Sage.

Dempsey K.; Beesley A.D.; Clark T.F. & Tweed A. 2015. Authentic Student Work Samples Support Formative Assessment in Middle School. In Suurtamm & Roth-McDuffie (Eds.). *Annual Perspectives in Mathematics Education: Assessment to Enhance Teaching and Learning*. Reston: National Council of Teachers of Mathematics (NCTM).

Denzin N.K & Lincoln Y.S. 2013. *Strategies of Qualitative Inquiry*. London: Sage.

Department of Basic Education. 2011. *Curriculum and Assessment Policy Statement, Grades 4-6 Mathematics*. Pretoria: Government Printers.

Department of Basic Education. 2011a. *Curriculum and Assessment Policy Statement (CAPS).* Pretoria: Government Printers.

Department of Basic Education. 2010. *Guidelines for Incisive Teaching and learning.* Pretoria: Government Printers.

Department of Basic Education. 2011b. *School-based Assessments (SBA) Requirements.* Pretoria: Government Printers.

Department of Basic Education. 2012. *School-based Assessments (SBA) Requirements.* Pretoria: Government Printers.

Department of Basic Education. 2016. *National Assessment Circular 3 of 2016*. Pretoria: Department of Basic Education. Government Printers.

Department of Education. 1997. *Curriculum 2005: Lifelong Learning for the 21st Century*. Pretoria: Government Printers.

Department of Education. 2010. *Guidelines for Inclusive Learning Programmes.* Pretoria: Government Printers.

Dettmer P., Knackendoffel A. & Thurston L.P. 2013. *Collaboration, Consultation and Teamwork for Learners with Special Needs.* 7th ed. Boston: Pearson Education.

Donald D.; Lazarus S.& Moolla N. 2014. *Educational Psychology in Social Context: Eco Systematic Applications in South Africa.* Cape Town: ABC Press.

Du Plessis E. 2013. Do Teachers Receive Proper In-Service Training to Implement Changing Policies: Perspective from the South African Case? *Education in One World,* (11):53-58.

Duarte G. & Miller E. 2015. Survey Research Methods. In Okeke C. & Van Wyk M. (Eds.). *Educational Research: An African Approach.* Cape Town: Oxford University Press.

Dyer K. 2014. *Measuring What Matters: Teach. Learn. Grow. The Education Blog*. *Formative Assessment, Classroom Tips.* Retrieved April 8, 2018, from https://www.nwea.org/blog/author/kdyer/page/13/

Eggen P. & Kauchak D. 2010. *Educational Psychology: Windows on Classrooms.* Upper Saddle River, NJ: Prentice Hall.

Eggen P. & Kauchak D. 2012. *Learning and Teaching. Research-Based Methods.* Boston: Pearson.

Eggen P.D & Kauchak D.P. 2016. *Educational Psychology: Windows on Classrooms.* Boston: Pearson.

Elliot A.C & Woodward W. A. 2016. *IBM SPSS by Example: A Practical Guide to Statistical Data Analysis.* Los Angeles: Sage.

Elrod M & Strayer J.F. 2015. Using an Observational Rubric to Facilitate Change in Undergraduate Classroom Norms. In Suuurtamm C. & Roth McDuffie A. (Eds.). *Annual Perspectives in Mathematics Education: Assessment to Enhance Teaching and Learning*, 87-96. Reston, VA: National Council of Teachers of Mathematics (NCMT).

Field A. 2013. *Discovering Statistics Using IBM SPSS Statistics. 4t ed.* Thousand Oaks.,CA: Sage.

Fink A. 2014. *Conducting Research Literature Reviews: From the Internet to the Paper*. Thousand Oaks, CA: Sage.

Flick W. 2018. *An Introduction to Qualitative Research (6th Ed.).* Los Angeles: Sage.

Friend M. & Bursuck W.D. 2006. *Including Students with Special Needs. A Practical Guide for Classroom teachers*. New York: Allyn & Bacon.

Ganga E. & Maphalala M. 2015. The Questionnaire Approach. In Okeke C. & Van Wyk M. (Eds.). *Educational Research: An African Approach.* Cape Town: Oxford University Press.

Gasa V. & Marofa P. 2015. Using Secondary Sources of Data. In Okeke C. & van Wyk M. (Eds.). *Educational Research: An African Approach.* Cape Town: Oxford University Press.

Gay L.R; Mills G.E & Airasian P.W. 2011. *Educational Research: Competencies for Analysis and Applications.* Boston: Pearson.

Geist E. 2010. The Anti-Anxiety Curriculum: Combating Math Anxiety in the Classroom. *Journal of Instructional Psychology,* 37 (1): 24-31.

Gibbs G.R. 2018. *Analysing Qualitative Data*. Los Angeles: Sage.

Gilles R.M. 2014. The Role of Assessment in Informing Interventions for Learners with Special Education Needs. *International Journal of Disability, Development and Education,* 61(1):1-5.

Giorgi A. 2009. *The Descriptive Phenomenological Method in Psychology: A Modified Husserlian Approach.* Pittsburg, PA: Duquesne University Press.

Gipps CV. 2012. *Beyond Testing: Towards a Theory of Educational Assessment.* London: Routledge.

Glesne C. 2011. *Becoming Qualitative Researchers: An introduction.* Boston, MA: Pearson.

Gotch C.M. & French B.F. 2014. A Systematic Review of Assessment Literacy Measures. *Educational Measurement: Issues and Practice*, 33 (2): 14-18.

Gonzales R. & Aliponga J. 2012. Classroom Assessment Preferences of Japanese Language Teachers in the Philippines and English Language Teachers in Japan. *MEXTESOL Journal,* 36 (1), 1-19.

Grbich C. 2013. *Qualitative data Analysis: An Introduction:* Los Angeles: Sage.

Gumbo M. 2015. The Pilot Study. In Okeke C. & Van Wyk M. (Eds.). *Educational Research: An African Approach.* Cape Town: Oxford University Press.

Halliday J. 2010. Educational Assessment. *The SAGE Handbook of Philosophy of Education*: Thousand Oaks: Sage Publications.

Harding J. 2019. *Qualitative Data Analysis: From Start to Finish.* Los Angeles: Sage.

Hart C. 2018. *Doing a Literature Review: Releasing the Research Imagination*: London: Sage.

Hattie J. 2009. *Visible Learning: A Synthesis of Meta-Analysis Relating to Achievement.* London: Routledge.

Hennink M.; Hutter I. & Bailey A. 2011. *Qualitative Research Methods.* London: Sage.

Hesse-Biber S.N. & Leavy P. 2011. *The Practice of Qualitative Research.* Thousand Oaks, CA: Sage.

Hsiung C. M. 2013. The Effectiveness of Cooperative Learning. *The Research Journal for Engineering Education*, 101(1): 119-137.

Imenda S.N. 2014. Is There a Conceptual Difference between Theoretical and Conceptual Frameworks? *Journal of Social Science,* 38(2): 185-195.

Ivankova N.V.; Creswell J.W & Plano Clark V.L. 2016. Foundations and Approaches to Mixed-methods Research. In Maree K. (Ed.). *First Steps in Research:* Pretoria: Van Schaik.

Jacoby J.C; Heugh S.; Bax C & Brandford-White C. 2014. Enhancing Learning Through Formative Assessment. *Innovations in Education and Teaching International,* 51(1): 72-83.

Jacobs. M. 2016. Aims and Objectives. In Jacobs M., Vakalisa N.C.G. & Gawe N. (Eds.). *Teaching-Learning Dynamics.* Cape Town: Pearson Education.

Johnson D.W; Johnson R.T & Roseth C. 2010. Cooperative Learning in Middle: Schools: Interrelationship of Relationships and Achievement. *Middle Grades Research Journal,* 5(1): 1-8.

Jooste C.; Press K.; Slamang M. & Smuts C. 2012. *Study & Master. Mathematics Learner's Book Grade 6.* Cape Town: Oxford University Press.

Kanjee A. & Sayed Y. 2013. Assessment Policy in Post-Apartheid South Africa: Challenges for Improving Education Quality and Learning. *Assessment in Education: Principles, Policy & Practice,* 20(4): 442-469.

Kanjee A. 2015. Enhancing Teacher Assessment Practices in South African Schools: Evaluation of the Assessment Resource Banks. *South African Journal of Education,* 13(1): 73-89.

Kanjee A. 2017. *National Learner Support Community of Practice. "Pull up your socks": Developing effective assessment systems that improve learning in South Africa.* Retrieved April 6, 2018, from 2017http://www.bridge.org.za/knowledgehub/meeting-highlights-maths-science-national-cop-february-2017/.

Kapambwe W. 2010. The Implementation of School-Continuous Assessment (CA) in Zambia. *Educational Research and Reviews*, 5(3), 99-107.

Killen R. 2015*. Teaching Strategies for Quality Teaching and Learning*. Cape Town. Juta and Company.

Kim R.Y.; Kim K.Y.; Lee M.H.; Jeon J.H. & Park J.W. 2012. The Challenges and Issues Regarding Extended Constructed- Response Questions: Korean Teacher's Perspective. In Proceedings of the 12th International Congress on Mathematical Education: *Topic Study Group,* 33: 6631-6640, Seoul, Korea.

Kune C., Lombard A. & Moodley T. 2013. A learning Pathway for Whole Numbers that Informs Mathematics Teaching in the Early Years. *South African Journal of Childhood Education*, 3(3):79-95.

Kuze M. W. & Shumba A. 2011. An investigation into Formative Assessment Practices of Teachers in selected schools in Fort Beaufort in South Africa. *South African Journal of Education,* 29(2):159 -170.

Ladewig W.; Potgieter R. & Pretorius J. 2012. *Oxford Successful Mathematics Teacher's Guide Grade 6.* Cape Town: Oxford University Press.

Lantolf J.P. 2008. *Sociocultural Theory and the Teaching of Second Languages:* London: Equinox Publishing.

Lave J. & Wenger E. 1991. *Situated Learning: Legitimate Peripheral Participation.* Cambridge: Cambridge University Press.

LeCompte M. & Schensul J. 2010. *Designing and Conducting Ethnographic Research.* Walnut Creek, CA: Rowman Altamira.

Leedy P. D & Ormrod J.E. 2013. *Practical Research: Planning and Design.* Boston: Pearson.

Leedy P. D. & Ormord J.E. 2016. *Practical Research: Planning and Design.* New Jersey: Pearson.

Leedy P.D. & Ormrod J.E. 2010. *Practical Research: Planning and Design*. New Jersey: Pearson.

Lemmer E. & Van Wyk N. 2010. *Themes in South African Education*. Upper Saddle River. N.J: Pearson.

Lemmer E.M. 2013. The Parent-teacher Relationship as Partnership: A Conceptual Analysis. *South African Journal of Education.* 49(2) 25-54.

Li W.; Liping P. & Khan Q. 2018. Research Methods in Education. Los Angeles: Sage.

Lombard K. & Themane M. 2015. Contextualising Teaching Practice as a Component of Teacher Education. In Taole M.J. (Ed.). *Teaching Practice, Perspectives and Frameworks.* Van Schaik: Pretoria.

Long C. & Dunne T. 2014. Approaches to Teaching Primary Level Mathematics. *South African Journal of Childhood Education,* 4(2):134-153.

Loughran J. 1999. *Researching Teaching.* Hong Kong: Falmer Press-Graphicraft Ltd.

Lumadi M. W. 2015. The Logic of Sampling. In Okeke C. & Van Wyk M. (Eds.). *Educational Research: An African Approach.* Cape Town: Oxford University Press.

Ma J. 2016. Making Sense of Research Methodology. In Palaiologue I; Needham D & Male T. (Eds.). *Doing Research in Education: Theory and Practice.* Los Angeles: Sage.

Machaba M. M. & Mokhele M. L. 2013. Approaches to Teaching Mathematical Computations: What Foundation Phase Teachers do! *Mediterranean Journal of Social Sciences,* 5(3): 388-394.

Maree K. & Pietersen J. 2016. Sampling. In Maree K. (Ed.). *First Steps in Research.* Pretoria: Van Schaik.

Maree K. & Pietersen J. 2016. The Quantitative Research Process. In Maree K. (Ed.). *First Steps in Research.* Pretoria: Van Schaik.

Maree K. 2014. *First steps in Research.* Pretoria: Van Schaik.

Mays T., Grosser M. & de Jagger L. 2016. *Getting Practical: A Guide to Teaching and Learning.* Cape Town: Oxford Press

McCarthy J. & Oliphant R. 2013. *Mathematics Outcomes in South African Schools. What are the facts? What should be done?* Retrieved April 8, 2018, from http://www.cde.org.za/wp-content/uploads/2013/10/MATHEMATICS% 20OUTCOMES %20IN%20SOUTH%20AFRICAN%20SCHOOLS.pdf.

McMilaan J.H. & Schumacher S. 2010. *Research in Education: Evidence Based Inquiry.* New York: Addis Wesley Longman.

McMillan J. & Schumacher S. 2014. *Research in education: Evidence-Based Inquiry.* London: Pearson.

McMillan J. H. 2012. *Educational Research: Fundamentals for the Consumer.* Boston: Pearson Education.

McMillan J.H. & Schumacher S. 2010. *Research in Education: Evidence-Based Inquiry.* New York: Addis Wesley Longman.

McMillan J.H. 2011. *Classroom Assessment. Principles and Practices for Effective Instruction*. Boston: Allyn &Bacon.

McMillan J.H. 2012. *Educational Research. Fundamentals for the Consumer*. New York: Pearson.

Mercer C.D., Mercer A. R. & Pullen P.C. 2011. *Teaching Learners with Learning Problems.* 8th ed. Upper Saddle River: N.J: Pearson.

Merriam S.B. 2009. *Qualitative Research: A Guide to Design and Implementation.* San Franscisco, CA: Wiley & Sons.

Miles M. B.; Huberman A.M. & Saldana J. 2014. Qualitative Data Analysis: A Methods Sourcebook (3rd ed.). Thousand Oaks,CA: Sage.

Mitchell P. & Ziegler F. 2007. *Fundamentals of Development. The Psychology of Childhood.* New York: Psychology Press.

Morgan D. 2014. *Intergrating Qualitative and Quantitative Methods*. Los Angeles: Sage.

Morgan G.A.; Leech N. L.; Gloecker G.N & Barrett K. C. 2013. *IBM SPSS for Introductory Statistics: Use and Interpretation.* New York: Routledge.

Moses J.W. & Knutsen T.L. 2007. *Ways of knowing: Competing Methodologies in Social and political research.* London: Sage.

Motala S., Morrow S. & Sayed Y. 2014. Gauteng Department of Education: A Policy Review. In Prew M. and Maringe F eds. *Twenty Years of Education Transformation in Gauteng*: 1994-2014. Johannesburg: Gauteng Department of Education.

Moyo N.; Modiba M & Simwa K. 2015. Critical Research: Understanding Material Constraints and Engaging in Transformative Action Research. In Okeke C. & Van Wyk M. (Eds.). *Educational Research: An African Approach.* Cape Town: Oxford University Press.

Mutendwahothe W. L .2013. Challenges Besetting Teachers in classroom assessment: An Exploratory Perspective. Curriculum and Instruction, College of Education, University of South Africa (UNISA). *South African Journal of Education*, 34(3): 211-221.

Mutendwahothe W. L .2013. Challenges Besetting Teachers in Classroom Assessment: An Exploratory Perspective. *South African Journal of Education*, 34(3): 211-221.

Mwamwenda T.S.2004. *Educational Psychology: An African Perspective.* Durban: Butterworths.

Needham D. 2016. Constructing the Hypotheses/Creating the Research Question(s). In Palaiologou I & Male T. (Eds.). *Doing Research in Education: Theory and Practice.* Los Angeles: Sage.

Nieuwenhuis J. 2016. Qualitative Research Designs and Data Gathering Techniques. In Maree K. (Ed.). *First Steps in Research.* Pretoria: Van Schaik.

Nieuwoudt S. & Reyneke M. 2016. Assessment. In Jacobs M., Vakalisa N.C.G. & Gawe N. (Eds.). *Teaching-Learning Dynamics.* Cape Town: Pearson Education.

Ojose B. 2008. Applying Piaget's Theory of Cognitive Development to Mathematics Instruction. *The Mathematics Teacher*, 18(1): 26-30.

Okeke C. 2015. Achieving Qualitative Validity, Reliability and Generalisability. In Okeke C. & van Wyk M. (Eds.). *Educational Research: An African Approach.* Cape Town: Oxford University Press.

Ozola S. & Purvins M. 2013. Teaching/Learning Theories: How they are pPrceived in Contemporary Educational Landscape. *Education in One World,* 11: 133-138.

Pallant J. SPSS 2016. *Survival Manual: A Step by Step Guide to Data Analysis Using IBM SPSS*. Maidenhead: McGraw Hill Education.

Patton M.Q. 2014. *Qualitative Research and Evaluation Methods: Integrating Theory and Practice,* 4th ed. Thousand Oaks, CA: Sage.

Paulsen R. & Dednam A. 2016. Challenges in Mathematics: Mathematical Literacy and Numeracy. In Landsberg E.; Kruger D. & Swart E. (Eds.). *Addressing Barriers to Learning: A South African Perspective.* Pretoria: Van Schaik.

Perry L. 2013. Review of Formative Assessment Use and Training in Africa. *International Journal of School & Educational Psychology,* 1(2): 94-101.

Piaget J. 1953. *The Origin of Intelligence in the Child.* London: Routledge and Kegan Paul.

Piaget J. 1964. *The Early Growth of Logic in the Child*. London: Routledge and Kegan Paul.

Pietersen J. & Maree K. 2015. Statistical Analysis 1: Descriptive Statistics. In Maree K. (Ed.). *First Steps in Research.* Pretoria: Van Schaik.

Pietersen J. & Maree K. 2016. Statistical Analysis II: Inferential Statistics. In Maree K. (Ed.). *First Steps in Research.* Pretoria: Van Schaik.

Plowright D. 2011. *Using Mixed Methods: Frameworks for an Integrated Methodology.* Los Angeles: Sage*.*

Popham W.J. 2009. Assessment Literacy for Teachers: Faddish or Fundamental? *Theory into Practice,* 48(1):4-11.

Pournara C., Hogen J., Alder J. & Pillay V. 2015. Can Improving Teachers' Knowledge of Mathematics Lead to Gains in Learners' Attainment in Mathematics? *South African Journal of Education,* 35(3), 1-10.

Power-Collins R. 1994. Middle School Science: A problem-Solving Orientation. *The Clearing House, 68(1),* 5-6.

Putnam R.D. 2015. *Our Kids: The American Dreams in Crisis.* New York: Simon & Schuster.

Reddy C.; le Grange l.; Beets P. & Lundie S. 2015. *Quality Assessment in South African Schools*. Cape Town: Juta.

Reilly R.R & Lewis E.L. 1985. *Educational Psychology.* New York: Macmillan.

Renkl A. 2009. Why Constructivist should not talk about Constructivist Learning Environments: A commentary on Loyens and Gijbels. *Instructional Science,* 37: 495-498.

Reys R., Lindquist M., Lambdin D., Smith N.,Rogers A., Falle J., Frid S. & Bennett S. 2012. *Helping Children Learn Mathematics.* Melbourne: Wiley & Sons.

Richard A. & Thomas J. 2013. *Theory Building in Applied Disciplines.* San Franscisco, CA: Berret-Koehler.

Ridley D. 2012. *The Literature Review: A Step-by Step Guide for Students.* Los Angeles: Sage.

Rowland T. & Ruthven K. 2011. *Mathematical Knowledge in Teaching.* New York: Springer.

Ruiz-Primo M.A. (2011). Informal Formative Assessment: The Role of Instructional Dialogues in Assessing Learners' Learning. *Studies in Educational Evaluation*, 37(1), 15-24.

Rule P. & John V. 2011. *Your Guide to Case Study Research.* Pretoria: Van Schaik.
Salkind N.J 2018. *Exploring Research*. Harlow: Pearson Education Limited.

Salkind N.J. 2018. *Exploring Research.* Harlow: Pearson Education.

Savin-Baden M. & Major C.H. 2013. *Qualitative Research: The Essential Guide to Theory and Practice.* London: Routledge.

Sayed Y.; Kanjee A. & Rao N. 2014. Assessment and learning: Problems and Prospects. In Wagner D. A. (Ed.). *Learning and Education in Developing Countries: Research and Policy for the Post-2015 UN Development Goals.* New York: Palgrave Macmillan.

Sepeng P. 2014. Learners' Voices on the Issues of Language Use in Learning Mathematics. *International Journal of Education Science*, 6(2):207-215.

Sequeria A. H. 2017. *Introduction to Concepts of Teaching and Learning.* Retrieved April 8, 2018, from https://www.researchgate.net/publication/.

Shulman L. 1987. Knowledge and Teaching: Foundations of the New Reform. *Harvard Educational Review*, *57*, 1-22.

Smith J.A.; Flower P. & Larkin M. 2009. *Interpretive Phenomenological Analysis: Theory, Method and Research.* London: Sage.

Snowman J., McCrown R.& Biehler R. 2011. *Psychology Applied to Teaching.* (13th ed). Belmont, CA: Wadsworth.

Sotuku N. & Duku S. 2015. Ethics in Human Science Research. In Okeke C. & Van Wyk M. (Eds.). *Educational Research: An African Approach.* Cape Town: Oxford University Press.

Sousa D.A. 2010. *Mind, Brain and Education: Neuroscience Implications for the Classroom.* Bloomington, IN: Solution Tree Press.

Sparks S.D. 2011. Researchers Probe Causes of Math Anxiety. *Education Week,* 30(31). Retrieved December 4, 2019 from https://www.edw eek.org/ew/articles /2011/05/18/31math_ep.h30.html.

Spaull N. 2013*. South Africa's Education Crisis: The Quality of Education in South Africa 1994-2011.* Pretoria: Centre for Development and Enterprise.

Sprinthall N.A. & Collins W.A. 1995. *Adolescent Psychology: A Developmental View* (3rd ed). New York: McGraw-Hill.

Sternberg R.J.2002. Intelligence: The Triarchic Theory of Intelligence. In Guthier J.W. (Eds.). *Encylopedia of Education.* New York: McMillan.

Stols G.,Ferreira R., Pelser A., Olivier W., Van der Merwe A., De Villers C. & Venter S. 2015. Perceptions and Needs of South African Mathematics Concerning their Use of Technology for Instruction. *South African Journal of Education,* 35(4) 1-13.

Suurtamm C., Thompson D., Kim R., Moreno L., Sayac N., Schukajlow S., Silver E., Ufer S. & Vos P. 2016. *Assessment in Mathematics Education: Large Scale Assessment and Classroom Assessment.* Hamburg: Springer.

Taber K.S. 2010*. Constructivism and Pedagogy: What is Constructivist Pedagogy?* Retrieved December 5, 2019. https://www.bing.com/search?q =taber+k+s+2010.+constructivist+and+pedagogy+waht+is+constructivist+pedagogy&form=EDGEAR&qs = PF&cvid=58ff87f7f26e4049a2c5ba5b2ec19e18&cc=ZA&setlang=en-US&plvar=0&PC = ACT.

Taras M .2009. Summative Assessment: The Missing Link for Formative Assessment Learning: Assessing the Theory and Evidence. *Journal for Further and Higher Education,* 2(1): 27-69.

Taylor N. & Taylor S. 2012. Teacher Knowledge and Professional Habitus. In N Taylor, S Van der Berg & T. Mabogoane (Eds.). *What makes Schools Effective? Report of South Africa's National School Effective Study.* Cape Town: Pearson.

Taylor N. & Taylor S. 2013. *Teacher Knowledge and Professional Habitus*: *What Makes Schools Effective? Report of the National Schools Effectiveness Study.* Cape Town: Stellenbosch University.

Taylor S.J.; Bogdan R. & DeVault M.L. 2016*. Introduction to Qualitative Research Methods: A Guidebook and Resource.* New Jersey:John Wiley.

Tharp R. & Gallimore R. 1988. *Rousing Minds to Life: Schooling in Social Context.* New York: Cambridge University Press.
Tomlinson C. 2014. Educational Leadership: Using Assessments Thoughtfully: The Bridge between Today's Lessons and Tomorrow's. *Education Leadership*, 71(6): 10-14.

Tshabangu I. 2015. Interpretive Research: Construction of Meanings. In Okeke C. & Van Wyk M. (Eds.). *Educational Research: An African Approach.* Cape Town: Oxford University Press.

Vakalisa N.C.G. 2016. Participative Teaching. In Jacobs M.; Vakalisa N.C.G & Gawe N. (Eds.). *Teaching-Learning Dynamics.* Cape Town: Pearson Education.

Valazza G. 2011. Professional Development: Teacher Development and Confidence. Retrived February 2, 2020, from www.onestopenglish.com/methodology/methodology/professional-development/professional-development-teacher-development-and-confidence/146473.article.

Van Damme D. 2015. International Learner Mobility Driven by Imbalances in the Global Higher Education System? *OCED international journal of adult competencies,* 3(4):1-35.

Van Dat T. 2013. Theoretical Perspectives Underlying the Application of Cooperative Learning in Classrooms. *International Journal of Higher Education*, 2(4): 101-115.

Van der Nest A., Long C. & Engelbrecht J. 2018. The Impact of Formative Activities on the Development of Teacher Agency in Mathematics Teachers. *South African Journal of Education,* 38(1), 1-10.

Van der Nest A., Long C. & Engelbrecht J. 2018. The Impact of Formative Activities on the Development of Teacher Agency in Mathematics Teachers. *South African Journal of Education,* 38(1), 1-10.

Van Wyk M. & Taole M. 2015. Research Design. In Okeke C. & Van Wyk M. (Eds.). *Educational Research: An African Approach.* Cape Town: Oxford University Press.

Van Wyk M. 2015. Afrocentricity as a Research Philosophy. In Okeke C. & Van Wyk M. (Eds.). *Educational Research: An African Approach.* Cape Town: Oxford University Press.

Van Wyk M. 2015. Writing for Publication: Sharpening your Academic Writing Skills. In Okeke C. & Van Wyk M. (Eds.). *Educational Research: An African Approach.* Cape Town: Oxford University Press.

Vandeyer S. & Killen R. 2009. Teaching and Teacher Education: Primary and Secondary Teachers' Conceptions of Assessment: A Qualitative Study. *Journal of Education*, 27(2): 472-482.

Vergnaud G. 2009. The Theory of Conceptual Field. *Human Development,* 52: 83-94.

Vogel. H. M. 2011. *Introduction to Inclusive Education: Learner Support.* Pretoria: Unisa.

Vygotsky L. 1978. *Mind in Society: The Development of Higher Mental Processes.* Cambridge, Mass: Harvard University Press.

Webb L. & Webb P. 2013. Teaching Strategies in Language-Diverse Mathematics Classes: A case Study. *Educational Research for Social Change,* 2(2): 31-42.

Wheldon J. & Ahlberg M.K. 2012. *Visualising Social Science Research. Maps, Methods & Meaning.* Los Angeles: SAGE.

William D. 2011. What is Assessment for Learning? *Studies in Educational Evaluation,* 37(1):3-14.

Wolhuter C. 2015. Steps in the Research Process. In Okeke C. & Van Wyk M. (Eds.). *Educational Research: An African Approach.* Cape Town: Oxford University Press.

Woolfolk. A. 2010. *Educational Psychology.* Upper Saddle River, N.J.: Pearson.

Wyatt-Smith C.; Klenowski V.& Colbert P. 2014. *Designing Assessment for Quality Learning.* New York: Springer.

Wyk V. & Wolhuter C. 2016. *Learn to Teach: A Handbook for Teaching Practice. 2.* Cape Town: Oxford University Press.

Wylie C. & Lyon C. 2012. Formative Assessment Supporting Students' Learning. *Educational Testing Service R&D Connection, 19, 1-12.*

Yawe B. & Mubazi J. 2015. Quantitative Data Analysis: Descriprive Statistics. In Okeke C. & Van Wyk M. (Eds.). *Educational Research: An African Approach.* Cape Town: Oxford University Press.

Zull J.E. 2002. *The Art of Changing the Brain: Enriching Teaching by Exploring the Biology of Learning.* Sterling, VA: Stylus Publishing.

APPENDICES

Appendix A: FRIC Approval Letter

Appendix B: Ethics Clearance Certificate

Appendix C: A Letter of Approval to Conduct Research

Appendix D: Letter to the Principal Seeking Permission to Conduct Research in the School

Appendix E: A Covering Letter to the Teachers Requesting them to participate in the Research

Appendix F: A Questionnaire Directed to the Teachers to Elicit Information on the Implementation of Formal Assessments

Appendix G: Checklist for 2018 Formal Assessments

Appendix H: Semi-structured Interview Questions

Appendix I: Questionnaire Descriptive Statistics Outputs

Appendix J: Inferential Statistics Outputs

Appendix K: Checklist Outputs

Appendix L: Interview Transcripts

APPENDIX A: FRIC APPROVAL LETTER

Central University of Technology, Free State

FACULTY OF HUMANITIES

FACULTY RESEARCH AND INNOVATION COMMITTEE (FRIC)

To: The Research Project Promoter

Dr. Kalobo, L
Dr. Rambuda, A.M

OUTCOMES OF FRIC APPLICATIONS (REF: FRIC 18/7)

Your application for approval of a research project (LS262a) form was presented at the FRIC Meeting which was held on 09 November 2018.

5.4.10 Sibanda, S – M. Ed (Dr. Kalobo, L; Dr. Rambuda, A.M) D.FRIC.18.7.15

RESOLUTION: FRIC 08/18/7
The FRIC approved the application.

Mhlolo

Prof. M. Mhlolo
Assistant Dean: Research, Innovation, & Engagement:
Faculty of Humanities

FRIC: Humanities • Private Bag X20539 • Bloemfontein • SOUTH AFRICA • 9300 •
Tel: +27 051 507 4027 • **Fax:** +27 051 507 3751 • **E-mail:** mmhlolo@cut.ac.za • **Website:** www.cut.ac.za

APPENDIX B: ETHICS CLEARANCE CERTIFICATE

Central University of Technology, Free State

FACULTY RESEARCH AND INNOVATION COMMITTEE – Faculty of Humanities RESEARCH ETHICS APPROVAL LETTER

Date: 22 February 2019

This is to confirm that ethical clearance has been provided by the Faculty Research and Innovation Committee in view of the CUT Research Ethics and Integrity Framework, 2016 with reference number **[D FRIC 08/18/7]**

Applicant's Name	Mrs S Sibanda
Student Number	217008495
Supervisor's Name for Student Project	Dr L Kalobo Dr AM Rambuda
Level of Qualification for Student's Project	M Ed
Title of research project	**The implementation of formal assessments in the intermediate phase mathematics as a foundation for teaching and learning enhancement in the Lejweleputswa District**

The following special conditions were set:

x Adherence to all ethical measures as stipulated and approved in the LS262a form

We wish you success with your research project.

Regards

APPENDIX C: A LETTER OF APPROVAL TO CONDUCT RESEARCH

Enquiries: KK Motshumi
Ref: Research Permission: S Sibanda
Tel. 051 404 9283 / 9221 / 079 503 4943Email:

3 Phillips Town House

Dagbreek

Welkom. 9459

Dear Ms. Sibanda

APPROVAL TO CONDUCT RESEARCH IN THE FREE STATE DEPARTMENT OF EDUCATION

1. This letter serves as an acknowledgement of receipt of your request to conduct research in the Free State Department of Education.

   Research Topic: The Implementation of formal assessments in the intermediate phase mathematics as a foundation of teaching and learning in the Lejweleputswa district
   Schools: Allanridge, Aurora, Bedeli, Bofihla, Boikutlo, Boshof, Bothaville, Brandwag, Bronville, Dagbreek, Daluvuyo, Dihwa, Dr.M.G. Mngoma, Eben Donges, Hani Park, Harmony Mine, Hennenman, Hlaboloha, Icoseng, Ikemisetseng, Impucuk, Itumeleng Mabelle, Khotsong, Lakeview, Lemotso, Lenyora, Letlotlo Naledi, Malebaleba, Marobe, Matlaletsa, Mohobo, Mojaho Moremaphofu, Naudeville, Odensia, Reitzpark, Riebeeckstad, SA Mokhothu, Saaiplaas, St Helena, Thabong, Thembekile, Thusanong, Tikwe, Tshireletso, Virginia Mine, Virginia Volkskool and Welkom Prep. Primary.
2. **Target Population**: 200 questionnaires will be distributed to 48 different schools in the Lejweleputswa district, 4-5 questionnaires per school. Questionnaires will be administered from the 3rd - 6th June 2019. Semi-structured interviews will be conducted with 9 teachers, 3 from each grade, thus from grades 4, 5 and 6. The interview is scheduled to be conducted on the 10th to the 12th of June 2019. Only 3 schools will be selected for this interviews. The semi-structured interview to be conducted with subject advisors is expected to be approximately 20 minutes long. The interview is scheduled to be conducted as from the 25th to the 27th of June 2019.

3. **Period of research**: From date of signature until 30 September 2019. Please note the department does not allow any research to be conducted during the fourth term (quarter) of the academic year. Should you fall behind your schedule by three months to complete your research project in the approved period, you will need to apply for an extension.

4. The approval is subject to the following conditions:

   4.1 The collection of data should not interfere with the normal tuition time or teaching process.

   4.2 A bound copy of the research document or a CD, should be submitted to the Free State Department of Education, Room 319, 3rd Floor, Old CNA Building, Charlotte Maxeke Street, Bloemfontein.

   4.3 You will be expected, on completion of your research study to make a presentation to the relevant stakeholders in the Department.

   4.4 The ethics documents must be adhered to in the discourse of your study in our department.

   4.5 Please note that costs relating to all the conditions mentioned above are your own responsibility.

Yours sincerely

DR JEM SEKOLANYANE
CHIEF FINANCIAL OFFICER

DATE: 27/05/2019

RESEARCH APPLICATION S SIBANDA PERMISSION 21 MAY 2019Strategic Planning, Policy & Research Directorate Private Bag X20565, Bloemfontein, 9300 Room 318, Old CNA Building, 3rd Floor,

APPENDIX D: A COVERING LETTER TO THE PRINCIPAL SEEKING PERMISSION TO CONDUCT RESEARCH IN SCHOOLS

3 Phillips Town House
1 Gray Street
Welkom
9459
14 May 2019

Research on the Implementation of Formal Assessments in the Intermediate Phase Mathematics as foundation of teaching and learning enhancement in Lejweleputswa district.

Dear Principal

I am involved in a research that tries to investigate how **formal assessment tasks are implemented in the Intermediate Phase Mathematics as foundation of teaching and learning in Lejweleputswa district.**

The investigation into formal assessment implementation is chosen in order to provide information to education specialists who will be in a better position to understand the consequences and implications of creating assessment policies in a developing country such as South Africa. In examining the process, vital lessons can be learnt regarding the potential errors that can arise in the implementation of formal assessments. The research will evaluate how the CAPS curriculum affects the quality of formal assessment implementation and the nature of support needed for the teachers to effectively implement the formal assessments in Mathematics. The research findings might provide useful information to the Department of Basic Education to be used when reviewing formal assessment implementation in Mathematics.
The research gathers information on the implementation of formal assessments in grades 4, 5 and 6 mathematics. Information will be gathered from your teachers inform of the questionnaire which they will be requested to complete in a period of 2 hours approximately. The questionnaires will be administered to the teachers for completion and be collected back after 2 days. Questionnaires will be delivered by me to schools as from the 3rd to the 6th of June 2019.
I will also conduct semi-structured interviews with 9 teachers, 3 from each grade, thus from grade 4, 5 and 6. However, only 3 schools out of the 48 listed for the questionnaire will be selected for interviews and notified during the process of collecting the questionnaire. There will be only one interview session per individual which will take 20 minutes. Interviews are scheduled to be conducted as from the 10th to the 12th of June 2019.

Interviews will be followed by document analysis. Teacher's portfolios and other relevant documents of those teachers interviewed will be analysed. Also, formal assessment tasks of learners taught by those teachers interviewed will be analysed.

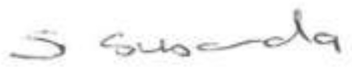
The selection of learners' task will be based on the level of performance for that particular task under analysis, thus one task per level obtained (from level 1 to level 7) will be analysed per class. Document analysis is scheduled to be done as from the 18th to 20th of June 2019.

All these activities; thus distribution of questionnaires, interviews and document analysis will be conducted after normal teaching time.

This research will provide ideas to solutions on effective formal assessment implementation. Therefore, in order for the researcher to understand how formal assessments are implemented in the intermediate phase mathematics in the Lejweleputswa district, information is needed from your teachers. The survey has been approved by the Free State Department of Education. I will be grateful for your teachers' responses and wish to guarantee that their responses will remain completely anonymous and confidential.

.

Yours sincerely



Ms S. Sibanda

Consent Form

I, the undersigned hereby allow my teachers to participate in the research on the Implementation of Formal Assessments in the Intermediate Phase Mathematics as foundation of teaching and learning enhancement in Lejweleputswa district.

____________________________ ____________

Signature of the Principal Date

APPENDIX E: A COVERING LETTER TO THE TEACHERS REQUESTING THEM TO PARTICIPATE IN THE RESEARCH

3 Phillips Town House
1Gray Street
Welkom
9459

14 May 2019

Research on the Implementation of Formal Assessments in the Intermediate Phase Mathematics as foundation of teaching and learning enhancement in Lejweleputswa district.

Dear Intermediate phase mathematics teacher

I am involved in a research that tries to investigate how **formal assessment tasks are implemented in the Intermediate Phase Mathematics as foundation of teaching and learning in Lejweleputswa district.**

The investigation into formal assessment implementation is chosen in order to provide information to education specialists who will be in a better position to understand the consequences and implications of creating assessment policies in a developing country such as South Africa. In examining the process, vital lessons can be learnt regarding the potential errors that can arise in the implementation of formal assessments. The research will evaluate how the CAPS curriculum affects the quality of formal assessment implementation and the nature of support needed for the teachers to effectively implement the formal assessments in Mathematics. The research findings might provide useful information to the Department of Basic Education to be used when reviewing formal assessment implementation in Mathematics.
The research gathers information on the implementation of formal assessments in grades 4, 5 and 6 mathematics. Information will be gathered from you inform of the questionnaire you will be requested to complete in a period of 2 hours approximately. The questionnaires will be administered to you for completion and be collected back after 2 days. Questionnaires will be delivered by me to schools as from the 3rd to 6th of June 2019.
I will also conduct semi-structured interviews with 9 teachers, 3 from each grade, thus from grade 4, 5 and 6. However, only 3 schools out of the 48 listed for the questionnaire will be selected for interviews and notified during the process of collecting the questionnaire. There will be only one interview session per individual which will take 20 minutes. Interviews are scheduled to be conducted as from the 10th to the 12th of June 2019.

Interviews will be followed by document analysis. Teacher's portfolios and other relevant documents of those teachers interviewed will be analysed. Also, formal assessment tasks of learners taught by those teachers interviewed will be analysed. The selection of learners' task will be based on the level of performance for that

particular task under analysis, thus one task per level obtained (from level 1 to level 7) will be analysed per class. Document analysis is scheduled to be done as from the 18th to the 20th of June 2019.

All these activities; thus distribution of questionnaires, interviews and document analysis will be conducted after normal teaching time.

This research will provide ideas to solutions on effective formal assessment implementation. Therefore, in order for the researcher to understand how formal assessments are implemented in the intermediate phase mathematics in the Lejweleputswa district, information is needed from you. The survey has been approved by the Free State Department of Education. I will be grateful for your responses and wish to guarantee that your responses will remain completely anonymous and confidential.

Yours sincerely

S Sibanda

Ms S. Sibanda

Consent Form

I, the undersigned hereby agree to participate in the research on the Implementation of Formal Assessments in the Intermediate Phase Mathematics as foundation of teaching and learning enhancement in Lejweleputswa district.

______________________________ ____________________

Signature of the Educator Date

APPENDIX F: THE QUESTIONNAIRE DIRECTED TO TEACHERS TO ELICIT INFORMATION ON THE IMPLEMENTATION OF FORMAL ASSESSMENTS

PART A: PERSONAL DATA

For office use		

A1. Indicate your gender.

Male	1
Female	2

A2. Indicate your age in the box provided below.

A3. Write the total years of your teaching experience below.

A4. Is your professional teaching qualification in the Intermediate Phase?

Yes	1
No	2

A5. What is the average number of leaners teach? Write the number in the box provided.

A6. Indicate the highest grade you teach mathematics in the intermediate phase.

Grade 4	1
Grade 5	2
Grade 6	3

For each statement below, please rate the extent to which you agree or disagree with it. Kindly answer by putting an (X) on a relevant answer that you wish to select.

USE THE SCALE BELOW

1	2	3	4	5	6	7
Not at all						**Always**

PART B: Marking, Recording and Moderation of Formal assessment Tasks according to the CAPS

	Statement								**Office use only**
B1.	I mark formal tasks for learners' promotion purposes.	1	2	3	4	5	6	7	
B2.	I record formal assessment marks for learners' promotion purposes.	1	2	3	4	5	6	7	
B3.	I submit formal assessment tasks for moderation for the purpose of quality assurance and maintaining appropriate standards.	1	2	3	4	5	6	7	
B4.	I use various forms of assessments like tests, examinations, projects and assignments as the recommended nature of formal assessments according to the CAPS document.	1	2	3	4	5	6	7	

B5.	The forms of assessment I use are appropriate to the ages and cognitive levels of learners.	1	2	3	4	5	6	7	
B6.	The tasks I design cover the content and achieve the broad aims of the subject.	1	2	3	4	5	6	7	
B7.	I use appropriate instruments such as rubrics and memoranda for marking tasks.	1	2	3	4	5	6	7	

PART C: Tests and examinations

	Statement								Office use only
C1.	I design tests and examinations to ensure that learners demonstrate their full potential in mathematics content.	1	2	3	4	5	6	7	
C2.	I spread questions to cater for different cognitive levels of learners.	1	2	3	4	5	6	7	
C3.	I assess tests and examinations using a memorandum.	1	2	3	4	5	6	7	
C4.	I set authentic tests that ask learners questions, which will enable them to display their skills in real life situations.	1	2	3	4	5	6	7	
C5.	I apply six cognitive levels of Bloom's taxonomy when setting tests and examinations.	1	2	3	4	5	6	7	

PART D: Assignments

									Office

	Statement								use only
D1.	I ensure that assignments are individualised tasks.	1	2	3	4	5	6	7	
D2.	I make use of a collection of past exam questions, which have the same concept to be covered for that assignment.	1	2	3	4	5	6	7	
D3.	I focus on the more demanding work for which resource material can be used.	1	2	3	4	5	6	7	
D4.	I give assignments immediately after the lessons or activities to which they relate.	1	2	3	4	5	6	7	
D5.	I display the assignment in the classrooms so that learners who have missed the information can always refer to the display.	1	2	3	4	5	6	7	

PART E: Projects

	Statement								Office use only
E1.	I use projects to asses a variety of skills and competencies.	1	2	3	4	5	6	7	
E2.	I ensure the integration of various activities like planning, research, data analysis and reporting when setting projects.	1	2	3	4	5	6	7	

E3.	I ensure that learners are able to demonstrate their understanding of different mathematical concepts through projects and apply them in real-life situations.	1	2	3	4	5	6	7	
E4.	I set projects, which are not above learners' cognitive levels.	1	2	3	4	5	6	7	
E5.	I clearly indicate the assessment criteria on the project specification.	1	2	3	4	5	6	7	
E6.	I focus on the mathematics involved and not on duplicated pictures and facts copied from reference material.	1	2	3	4	5	6	7	
E7.	The projects I give contain the collection and display of real data.	1	2	3	4	5	6	7	
E8.	I ensure that I teach skills like research and presentations before handing out projects for assessment.	1	2	3	4	5	6	7	

PART F: Investigation

	Statement								**Office use only**
F1.	I set investigation tasks, which promote critical thinking and creative thinking.	1	2	3	4	5	6	7	
F2.	I ask questions, which will help learners to discover rules and concepts.	1	2	3	4	5	6	7	

F3.	I ensure that the investigation question involves inductive reasoning.	1	2	3	4	5	6	7	
F4.	I ask questions, which will lead learners to identifying patterns or relationships.	1	2	3	4	5	6	7	
F5.	My investigation question(s) allow learners to draw conclusions and establish general trends.	1	2	3	4	5	6	7	
F6.	I allow my learners to be seek assistance when doing the initial investigation at home, however, the final write-up is done in class, under my supervision.	1	2	3	4	5	6	7	
F7.	I assess investigations with rubrics.	1	2	3	4	5	6	7	
F8.	I award marks for each skill tested in the task.	1	2	3	4	5	6	7	
F9.	I include organising and recording ideas and discoveries, e.g. diagrams and tables.	1	2	3	4	5	6	7	
F10.	I award marks for communicating investigation ideas with appropriate explanations.	1	2	3	4	5	6	7	
F11.	I award marks for the calculations, which show clear understanding of mathematical concepts.	1	2	3	4	5	6	7	
F12.	I award marks for generalising and drawing conclusions.	1	2	3	4	5	6	7	
F13.	The forms of investigation tasks I use are appropriate to the age and cognitive levels of learners.	1	2	3	4	5	6	7	
F14.	My investigation question(s) allow learners to inquire, as well as experiment.	1	2	3	4	5	6	7	

PART G: Moderation

	Statement								Office use only
G1.	I submit my assessment tasks for moderation to ensure that they are fair, valid and reliable.	1	2	3	4	5	6	7	
G2.	I submit my formal assessment tasks for moderation internally at school.	1	2	3	4	5	6	7	
G.3	I submit my formal assessment tasks for moderation externally to the subject advisors.	1	2	3	4	5	6	7	
G4.	I ensure that quality assessment is given and high but achievable standards maintained through the moderation process.	1	2	3	4	5	6	7	
G5.	My formal tasks meet the principles of high quality assessment through the moderation process.	1	2	3	4	5	6	7	

PART H: Recording and reporting of formal assessments

	Statement								Office use only
H1.	I document the level of a learner's performance in a specific assessment task through recording the marks.	1	2	3	4	5	6	7	
H2.	I track learners' development through recording in order to improve classroom teaching.	1	2	3	4	5	6	7	

H3.	I make use of records to indicate the learners' progress towards the achievement of the knowledge as prescribed in the CAPS document.	1	2	3	4	5	6	7	
H4.	I record learners' performance to provide evidence of their conceptual progression within a grade and their readiness to the next grade.	1	2	3	4	5	6	7	
H5.	I use checklists as ways of recording assessment.	1	2	3	4	5	6	7	
H6.	I use rating scales as ways of recording assessment.	1	2	3	4	5	6	7	
H7.	I use records of learner performance in formal assessments to verify the progress I make in the teaching and learning process.	1	2	3	4	5	6	7	
H8.	I communicate learner performance to learners, parents, school and other stakeholders through the reporting process.	1	2	3	4	5	6	7	

PART I: Challenges in mathematics assessments

	Statement								**Office use only**
I1.	Formal assessments allow me to have adequate teaching time.	1	2	3	4	5	6	7	
I2.	My class sizes are suitable for formal assessment tasks.	1	2	3	4	5	6	7	
I3.	I am able to mark formal assessment tasks and give my learners individualised attention.	1	2	3	4	5	6	7	

I4.	I find it easy to pay attention to the learners' individual needs.	1	2	3	4	5	6	7	
I5.	I find it easy to provide quality feedback when implementing formal assessments.	1	2	3	4	5	6	7	
I6.	I have adequate knowledge and skills for the implementation of formal assessments.	1	2	3	4	5	6	7	
I7.	I underwent training for the implementation of formal assessments.	1	2	3	4	5	6	7	
I8.	I know exactly what formal assessment is.	1	2	3	4	5	6	7	
I9.	I know exactly how to implement formal assessments.	1	2	3	4	5	6	7	
I10.	I have mathematical content knowledge to notice and analyse learners' mathematical thinking.	1	2	3	4	5	6	7	
I11.	I have adequate content knowledge on the implementation of formal assessments in mathematics.	1	2	3	4	5	6	7	
I12.	I have adequate pedagogical knowledge on the implementation of formal assessments in mathematics.	1	2	3	4	5	6	7	
I13.	I have proper qualifications in the subject.	1	2	3	4	5	6	7	
I14.	I have proper experience in the subject.	1	2	3	4	5	6	7	
I15.	I have prior knowledge of all my learners' cognitive levels before I asses them.	1	2	3	4	5	6	7	
I16.	I receive professional development, which	1	2	3	4	5	6	7	

	addresses areas of my pedagogical challenges.								
I17.	I am competent in developing and validating new assessments.	1	2	3	4	5	6	7	
I18.	I am competent in validating existing assessments.	1	2	3	4	5	6	7	
I19.	I am part of teacher networking, where we work together as teachers to share ideas on formal assessment tasks (Professional Learning Committee).	1	2	3	4	5	6	7	
I20.	I receive adequate support from the subject advisors.	1	2	3	4	5	6	7	
I21.	I understand the National Protocol on Assessment very well.	1	2	3	4	5	6	7	
I22.	I am able to adapt my assessment practices on the changing demands of the contents' school education system.	1	2	3	4	5	6	7	
I23.	I view the National Protocol on Assessment as confusing and complex.	1	2	3	4	5	6	7	
I24.	I view the National Protocol on Assessment as clear and simple.	1	2	3	4	5	6	7	
I25.	The language of teaching and learning makes it easy for my learners to understand the instruction for assessment questions.	1	2	3	4	5	6	7	
I26.	I am able to perform dual tasks, namely teaching both Mathematics and English at the same time.	1	2	3	4	5	6	7	
I27.	My learners are able to solve word problems due to language clarity and word structure.	1	2	3	4	5	6	7	

I28.	My learners are able to perform in Mathematics because they can read and write fluently in English.	1	2	3	4	5	6	7	

THANK YOU FOR YOUR COOPERATION

Consent Form

I, the undersigned hereby agree to participate in the research on the Implementation of Formal Assessments in the Intermediate Phase Mathematics as foundation of teaching and learning enhancement in Lejweleputswa district.

______________________________ ____________________

Signature of the Educator Date

APPENDIX G: CHECKLIST FOR 2018 FORMAL ASSESSMENTS

Checklist Number	

SECTION A: Biographical Data

A1. Indicate gender of the teacher.

Male	1
Female	2

A2. Grade: **4 5 6** ***(choose only one grade per checklist)***

1	2	3

A3. School quintile

1	2	3	4	5

SECTION B: Minimum Requirements for Formal Assessment: Intermediate Phase Mathematics

	Forms of assessment	Minimum requirements per term				Number of tasks per year	Weighting	Not Achieved 1	Achieved 2	Outstanding Achievement 3
		T 1	T 2	T3	T4					
SBA	B1.Tests	1	1	1		3	75%	1	2	3
	B2.Examinations					1		1	2	3
	B3.Assignment	1			1	2		1	2	3
	B4.Investigation				1	1		1	2	3
	B5.Project			1		1		1	2	3
End of the year Examination	B6.Total	2	2	2	2	8		1	2	3
	B7. Examination					1	25%	1	2	3

For office use only	
Key	
1	Not achieved
2	Achieved
3	Outstanding achievement

SECTION C: Tests Cognitive Levels

Cognitive levels	**Description of skills to be demonstrated**	**Not achieved**	**Achieved**	**Outstanding achievement**	**Comments**
Knowledge (=25%)	C1.Estimation and appropriate rounding off of numbers	1	2	3	
	C2. Straight recall	1	2	3	
	C3.Identification and direct use of correct formula	1	2	3	
	C4.Use of mathematical facts	1	2	3	
	C5. Appropriate use of mathematical vocabulary	1	2	3	
Routine procedures (=45%)	C6.Perform well-known procedures	1	2	3	
	C7. Simple applications and calculations, which might involve many steps	1	2	3	
	C8.Deriviation from given information may be involved	1	2	3	
	C9. identification and use after changing the subject) of correct formula generally similar to those encountered in class	1	2	3	
	C10.Problems involving complex calculations and/or higher order reasoning	1	2	3	

Complex procedures (=20%)	C11. Investigations to describe rules and relationships- there is often not an obvious route to the solution	1	2	3	
	C12.Problems not based on real world context-could involve making significant connections between different representations	1	2	3	
	C13.Conceptual understanding	1	2	3	
Problem solving (=10%)	C14.Unseen, non-routine problems (which are not necessarily difficult)	1	2	3	
	C15.Higher order understanding and processes are often involved	1	2	3	
	C16.Might require the ability to break the problem down into its constituent parts	1	2	3	

Consent Form

I, the undersigned hereby agree to participate in the research on the Implementation of Formal Assessments in the Intermediate Phase Mathematics as foundation of teaching and learning enhancement in Lejweleputswa district.

______________________________ ____________________

Signature of the Educator Date

APPENDIX H: SEMI-STRUCTURED INTERVIEW QUESTIONS

These questions seek to clarify the findings of quantitative research that was done with intermediate phase mathematics teachers

1. Which forms of formal assessments do you use as tools to achieve quality learning in the intermediate phase mathematics?
2. What suggestions do you have for these forms of formal assessments?
3. What challenges do you experience when you implement formal assessments in the intermediate phase mathematics?
4. How do you think these challenges could be alleviated?
5. What challenges are experienced by your learners when they are engaged in formal assessments?
6. How do you think these challenges could be alleviated?
7. How do you support and guide learners after they have received their marked formal assessment tasks?
8. Why is it a challenge for most of the intermediate phase mathematics teachers to apply the six cognitive levels of Bloom's taxonomy when setting tests?
9. How do you think these challenges can be alleviated?
10. Complex procedures and problem solving skills are not tested in the intermediate phase mathematics. How can this be improved so as to achieve quality learning in mathematics?

Thank you for your cooperation

APPENDICES I TO L INFORMATION CAN BE ACCESSED FROM THE COMPACT DISC (CD) ATTACHED ON THE LAST PAGE OF THIS DISSERTATION

APPENDIX I: QUESTIONNAIRE DESCRIPTIVE STATISTICS OUTPUTS

Recording and Moderation of Formal Assessment Tasks	Tests and Examinations
Marking, Recording & Moderation.xlsx	Tests & examinations.xlsx

Assignments	Projects
Assignments.xlsx	Projects.xlsx

Investigation	Moderation
Investigations.xlsx	Moderation.xlsx

Recording and Reporting of Formal Assessments	Challenges in Mathematics Assessments
Recording & Reporting.xlsx	Recording & Challenges.xlsx

APPENDIX J: INFERENTIAL STATISTICS OUTPUTS

I.1 T-Tests Output Data

Comparison of Male and Female Intermediate Mathematics Teachers on Formal Assessments	Comparison of Young and Old Mathematics Teachers on Formal Assessments
t-test Gender & Formal assessment, t	t-test Age & Formal assessments, table 2.

Comparison of teachers with 1 to 5 years of teaching Experience and 6 to 28 Years on Formal Assessments	Comparison of Teachers with or without Teaching Qualification in the Intermediate Phase on Formal Assessments
t-test Teaching experience & Formal a	t-test Qualification & Formal assessment, T

Comparison of Intermediate Mathematics Teachers who Teach an average of 24 to 40 Learners and 41 to 55 learners	Comparison of Male and Female Intermediate Mathematics teachers on various Forms of Assessment
t-test Average number of learners &	T-tests Gender, table 6.xlsx

Comparison of Young and Old Intermediate Mathematics Teachers on Various Forms of Assessment	Comparison of Intermediate Phase Mathematics teachers with 1 to 5 Years of teaching Experience and 6 to 28 Years of Experience
young and old, table 7.xlsx	T-tests Teaching Experience , table 8.:

Comparison of Teachers with or without Professional Teaching Qualification on Various Forms of Assessment	Comparison of Intermediate Mathematics teachers who Teach an Average of 25 t0 40 Learners and 41 to 55 Learners on Various Forms of Assessment
T-tests Professional teaching qualification	T-tests Number of learners per class, tal

I.2 ANOVA Outputs

Grade and Formal Assessment	
ANOVA Grade & Formal assessment.x	ANOVA Grade.xlsx

School Quintile and Formal Assessment	
ANOVA School quintile & Formal as	ANOVA Quintile.xlsx

APPENDIX K: CHECKLIST OUTPUTS

Biographical Details of Respondents
Checklist, Biographical Data.xlsx

Minimum requirements of Formal Assessments
Checklist, Minimum Requirements for For

Testing of Cognitive Levels with Description of Skills
Checklist, Cognitve levels.xlsx

The Most Tested Cognitive Levels in Formal Assessments
Checklist, Cognitve levels totals.xlsx

APPENDIX L: INTERVIEW TRANSCRIPTS

Interview transcripts for the nine teachers interviewed and themes generated
Interview Transcripts.docx