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The Implementation of Formal Assessments in Intermediate Phase Mathematics at Primary Schools in South Africa

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Abstract. The purpose of this research was to explore the implementation of formal assessments in intermediate phase mathematics at primary schools. The research was elicited by reports that assessment methods and procedures for tackling learners' needs had been observed to be insufficient in South African schools. The study is grounded in Piaget's cognitive constructivism and Vygotsky's social constructivism. The researchers conducted document analysis of teachers' portfolios which were purposefully selected. Nine teachers– three from each of Grades 4 to 6 were sampled. The portfolios were analysed to establish whether the implementation of the formal assessments was aligned with the Curriculum and Assessment Policy Statement requirements. A checklist was used to determine teachers' implementation of formal assessment. Measures of central tendency were used to analyse data. The results revealed that teachers were not developing the abilities of learners in handling complex mathematical procedures as per the requirements of the policy. This implies that learners lacked the ability to break down mathematical problems into different factors or constituent parts. Learners were given a test instead of a project or investigation. Hence teachers were not promoting cooperative learning which is advocated by the policy. Therefore, teachers should be assisted by knowledgeable colleagues and subject advisors in their adoption and use of assessment. There must be a close examination of the classroom observation tools that are currently being utilised. Classroom observation assists teachers to improve their assessment strategies. The Department of Basic Education should supply tablets to primary schools to promote social constructive

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interaction amongst teachers and learners to enhance effective teaching and learning.

Keywords: assessment; cooperative learning; formal assessment; intermediate phase; mathematics

1. Introduction

Chigonga (2020) asserts that assessment is the procedure employed to collect information with the intention to examine the learner's previous understanding of the content, identify the gaps and formulate instructional decisions thereafter. In the context of this study, the intention of assessment is to enhance mathematics teaching and learning. Assessment serves a dual purpose: first, as proof of learning to indicate what the learner has achieved; second, to assist the teacher to ascertain whether the learner is performing as specified in the curriculum. A difference is made between informal assessments, such as daily monitoring of the learner's progress, and a formal assessment, which is the systematic evaluation of learner's progress. In this study, the main emphasis is on formal assessment because Reddy et al. (2015) assert that South African mathematics teachers lack knowledge in formal assessment. To reinforce their significance in teaching and learning enhancement, formal assessments have been continuously implemented on-line during the COVID-19 pandemic in South Africa. Teachers need to collect and evaluate learners' understanding to come up with reasonable decisions on the way forward (Liberman et al., 2020). 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 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**.** Additionally, it is indicated that a greater number of teachers have inadequate proficiency in the implementation of formal assessments and that there is a lack of proper guidance and support regarding this aspect. There is thus an inadequacy of assessment knowledge and practice amongst teachers. Mathematics teaching and learning has been found to be highly insufficient in South Africa schools (Jojo, 2019). Papadikis et al. (2017) contend that the adoption of mathematics teaching theory such as Realistic Mathematics Education (RME) develops connection between mathematics and reality in kindergarten learners. Teachers and learners interact so that learners can construct reality and under complex mathematical problems. Papadikis et al. (2021) further suggest that teacher use of smart mobile devices such as tablets lead to effective teaching and meaningful learning in mathematics. Mathematics applications (apps) expose learners to real life problems which enable them to understand fundamental mathematical concepts. The comprehension of numbers is more evident in early childhood learners who use tablets (Papadikis et al., 2018). However, to check if there is meaningful mathematics learning, teachers must possess knowledge of formal assessment practices. As a result, a study on how teachers carry out assessments for teaching and learning enhancement is essential (Kanjee & Mthembu, 2015). Therefore, what is the nature of formal assessment in intermediate phase mathematics in schools? What are the most tested cognitive levels in formal assessments? Consequently, the objective of this study is to suggest strategies mathematics teachers could adopt to improve their teaching to implement effective formal assessment.

The South African Department of Basic Education (DBE) is relevant because one of the key imperatives of the Curriculum and Assessment Policy Statement (CAPS) is to implement a valuable and functional assessment program which give pertinent information to all role-players to enhance teaching and learning procedures (DBE, 2011). The preceding section provides the introduction to the research. The following sections are organised as follows: section 2 provides a literature review, section 3 presents the methodology, section 4 provides the results, section 5 provides discussion of the results, section 6 presents the conclusion and section 7 presents a list of references. The upcoming section discusses the literature review.

2. Literature review

This research is framed within constructivism theory 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 to the key to constructivism being 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). 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 cognitive constructivism (1953) and Vygotsky's social constructivism (1978). Cognitive constructivism theory calls for teachers to deviate from the common practice of direct teaching and be facilitators in teaching and learning. It is a view of learning suggesting that instead of imparting knowledge, that is formulated beforehand, learners must be given opportunities to make use of their own capabilities and skills to create their own understanding (Paulsen & Dednam, 2016). Social constructivism theory is a theory concerned mainly with the way cognitive development happens from 'the outside in'. Social constructivism theory emphasises the conception that cognitive development happens within social connections. Furthermore, reference is made to the theory that all better intellectual systems are a result of social interaction (Vygotsky, 1978). Vygotsky's theory proposes 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 must 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. This can be accomplished through learner use of tablets to develop their mathematical competence (Papadakis et al., 2016). At the same time, the teacher still has a significant role to decide to choose the most effective, well-informed potential mediator for the learners. This can also be attained through scaffolding and student-to-student discussions (Abrie et al., 2016). However, mathematics is usually viewed as challenging to teach, even under normal circumstances, and the situation is currently worsened by the COVID-19 pandemic (Fritz et al., 2019).

Literature selected for review was derived from the gap identified, guided by the research questions. In other words, the nature of formal assessments in the intermediate phase in South African schools was precisely used to guide the literature review.

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

Formal assessment consists of School Based Assessment (SBA) and end of year examinations (DBE, 2011). It is the duty of concerned teachers to monitor and control assessment tasks and record them for subsequent promotional purposes. Before being administered to learners, all formal assessment tasks must be moderated to ensure control of quality and retention of proper measures. Although the SBA element may have various formats, regarding mathematics, assignments, projects, investigations, tests, and examinations are suitable, as outlined in Table 1 below.

Table 1: 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**	75%
	Examinations		1			**1**	
	Assignments	1			1	**2**	
	Investigation				1	**1**	
	Project			1		**1**	
End of the year Examination	**Total**	**2**	**2**	**2**	**2**	**8**	
						1	25%

(DBE, 2011, p. 294).

As indicated in Table 1, 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 investigations. These forms of assessment did not change, even during the COVID-19 pandemic, and currently guide the program of assessment (DBE, 2021). The forms of assessment, according to requirements, are explained below.

2.1.1. 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, 2011). 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. 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 guarantees 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: 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).

The information in Table 2 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.

2.1.2. Assignment

An assignment is given to the learners as an individual task. This may be obtained from past examination papers; but whatever, it must centre on challenging content, as there is a variety of resources to refer to. It can be done at home, not under class supervision (DBE, 2011). 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 their 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.

2.1.3. Projects

A project is an activity which extends learning beyond the classroom and positions it in the real world (Coombs, 1995). Moreover, projects 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 the data, analyse it thereafter, and draw conclusions* (DBE, 2011, p.294). Gawe et al. (2016) point out that the project method is learner-centred learning and highly based on the constructivist principle. This 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, 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 paragraph below explains the investigation as a formal task.

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

2.1.5. 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).

2.1.6. 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 becoming an essential part of teachers' assessment practices for learners. This is so because working with rubrics both 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 3 below.

Table 3: 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]**

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, 2011: 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.

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 regard. Assessing learners has many facets. Additionally, the procedure of making sense of learners' mathematical reasoning and explanation of approaches is more convoluted than can be assumed and poses challenges to teaching and learning (Suurtamm et al., 2016).

3. Methodology

The study follows a quantitative approach, using a survey design. Quantitative research is an approach which utilises numerical data in a structured and empirical scheme. It makes use of a particular subgroup to derive its data; subsequently, findings are generalised to the sector 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). The survey design 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 researchers conducted the document analysis from the primary schools because they offer intermediate phase mathematics. A checklist (Appendix 1) was used to determine whether the requirements of formal assessment implementation were met by intermediate phase mathematics teachers.

3.1. Format of the checklist

Killen (2015) points out 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, pp. 294-296). 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 researchers. Gasa and Mafora (2015) emphasise that if the information is not openly accessible, written consent for the utilisation of the data ought to be obtained from the possessors. The researchers obtained permission through the consent form which was annexed to the letter addressed to the principals and intermediate phase teachers. Document analysis was explained to the participants before it was conducted. Purposive sampling, which is classified under a non-probability sampling method, was utilised for document analysis. Maree and Pietersen (2016) point out 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 of Grades 4 to 6. Their portfolios, which included learners' formal tasks for the year 2018, were analysed. The checklist's Cronbach's alpha coefficient was 0.83, which suggested a moderate reliability for the scale.

3.2. Biographical details of the respondents

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

Table 4: Biographical details of the teachers whose formal assessment records were analysed N=9

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

Analysis of the data in Table 4 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 the 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 the 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, as 80% of the schools in quintile 5 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, the data obtained for the minimum requirements for formal assessment in intermediate phase mathematics as stipulated in the CAPS document.

4. Results

4.1. The minimum requirements for formal assessment in intermediate phase mathematics

Table 5: 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 the data in Table 5 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 administer 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 examinations had been achieved as per the rubric of the checklist. Another revelation is that tests were wholly administered (*M*=2.11, *MD*=2.00, *SD*=0.33). Statistics show that the data is positively skewed, since the mean is higher than the median. Resultantly, the mean value indicates that the implementation of the test was 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. The 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 was not achieved as per the rubric of the checklist. This implies that some of the teachers whose records were analysed are 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 the 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 explanation 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 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 the data is positively skewed, since the mean is higher than the median. The following table serves to present and analyse cognitive levels and abilities tested in learners.

4.2. Cognitive levels and abilities tested in learners

Table 6 indicates levels and description of skills which should be demonstrated by Grades 4 to 6 learners in mathematics. Analysis of the data in Table 4.26 below shows that there is 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 the 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 the data on testing of cognitive levels. Regarding 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.

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 mean of 1.11 for these skills reveals 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. The data for these statistics is positively skewed, since the means are higher than their medians.

Table 6: 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

The 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 indicates 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, the 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 the data on the most tested cognitive levels in formal assessments.

Table 7: 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 the data in Table 7 shows that the cognitive level that is most developed and tested in learners is problem-solving, although it is moderately tested (*M*=1.89, *MD*=2.00, *SD*=0.17). The 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 most 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 the 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 the data is positively skewed, since the mean is higher than the median. However, the 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. In summary, document analysis shows that minimum requirements for formal assessments in intermediate phase mathematics are not being met as stipulated in the CAPS document.

5. Discussion

Startlingly, it has been proven that learners were 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 shows that investigations and projects are not implemented as forms of assessment in mathematics – rather, learners were given a test instead of a project or investigation. Resultantly, learners lack critical and creative thinking, which must be triggered by active engagement and exploration. This finding implies that teachers are not promoting cooperative learning, which is advocated by the CAPS. Cooperative learning is a set of instructional strategies in which 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 makes 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). Vygotsky (1978) 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 – collecting, organising, representing, analysing, interpreting, and reporting the data. They can also work together, regarding space and shape, to construct 3-D shapes using mathematics apps as suggested by Papadakis et al. (2018). Borich (2014) discusses some of the outcomes of co-operative learning, which are attitudes and values, pro-social behaviour, alternative perspectives and viewpoints, and higher thought and processes. 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. This plays a crucial role in shaping their values and attitudes, which, in turn, they 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. Classrooms are now a significant medium in which to reinforce pro-social behaviours, as a result of the high volume of working parents or guardians. Therefore, teachers must plan for and implement co-operative learning programmes 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 must create learning experiences which give learners opportunities for working cooperatively in interesting, challenging, and open-ended tasks such as projects and investigations (Killen, 2015). Cooperative learning furnishes the context in which several views and ideas can be exchanged (Borich, 2014). This is closely linked to participative learning, in which 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 which improve mathematics competence. Furthermore, cooperative learning is associated with outstanding academic achievement of learners. It improves learners' critical-thinking and problem-solving skills. 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 – higher-order thinking must be stimulated by complex thinking tasks. This, in turn, implies that teachers must engage learners in, for example, research and problem-solving skills, which encourage high-order thinking (Borich, 2014).

Acclaiming the idea of the aforementioned outcomes are the ideas of Gawe et al. (2016), who emphasise the benefits of co-operative learning. They mention learner achievement and social consequences as some of the noticeable benefits. Outstanding achievement has been reported in the classrooms 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), "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" (p. 267). Additionally, co-operative learning can contribute to integrating learners into networks of peer social relationships which, in turn, assist them with constructive conflict resolution leading to academic performance. Therefore, teachers must ensure that every learner has a chance to participate in a group (Gawe et al., 2016). Sustaining this idea is Vygotsyk's (1978) work, through mediation and the Zone of Proximal Development (ZPD), where cognitive mediation will take place. 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 – to establish a profound understanding of concepts to have a logic of mathematics as a subject (DBE, 2011). This aim is not achieved according to this study. Additionally, the checklist data confirm 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.

6. Conclusion

The research has contextual limitations because it was conducted in primary schools with different circumstances of working conditions; therefore, the results cannot be generalised because schools differ in contextual factors. The findings of the study confirm that formal assessments are inadequately implemented. Mathematics is usually viewed as a challenging subject to teach, even under normal circumstances, and the situation is currently worsened by the COVID-19 pandemic. Therefore, teachers should be assisted by knowledgeable colleagues and subject advisors in adopting and using assessment. Professional development must be a significant element 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. There must be a close examination of the classroom observation tools that are utilised to enable teachers to ascertain the capacity of the tool to give valid feedback on formal assessment tasks. Furthermore, classroom observation assists teachers to improve their assessment strategies when they are given feedback. Feedback from classroom observations supports teachers in identifying areas of formal assessments in which they need to improve to enhance the teaching and learning of mathematics. Teachers need to promote practical learning, which can be achieved using portfolios and oral presentations to evoke deeper understanding of mathematical concepts. Concept mapping, linking connections involving related mathematical ideas, must be utilised to achieve improvements in critical and creative thinking in investigations and problem-solving tasks. Moreover, teachers are encouraged to adapt the instructional method to promote the utilisation of assessment to ascertain learners' misconceptions. Subsequent teaching and learning alternatives must be drawn from these misconceptions and, consequently, accord learners who misinterpreted the concept(s) another chance of achievement (Chigonga, 2020). Although, South Africa is a developing country, with several socio-economic problems, the Department of Basic Education should supply tablets to schools to enhance the teaching and learning of mathematics. Research indicates that the use of tablets in mathematics teaching and learning improves competence in early childhood education.

7. References

Abrie, M., Blom, N., & Fraser, B. (2016). Theoretical foundations. In M. Jacobs, N. C. G. Vakalisa, & N. Gawe (Eds.), *Teaching-Learning Dynamics.* (pp. 37). Pearson Education.

Borich, G. D. (2014). *Effective teaching methods: Research-based practice.* Pearson.

Chigonga, B. (2020). Formative assessment in mathematics education in the twenty-first century, theorizing STEM education in the 21st century. *IntechOpen*, 1-10. http://dx.doi.org/10.5772/intechopen

Coombs, B. (1995). *Successful teaching: A practical handbook.* Heinemann.

Department of Basic Education, (2011). *Curriculum and assessment policy statement, grades 4-6 mathematics*. Government Printers. https://www.education.gov.za/Portals/0/CD/National%20Curriculum%20Statements%20and%20Vocational/CAPS%20IP%20%20MATHEMATICS%20GR%204-6%20web.pdf?ver=2015-01-27-161430-553

Department of Basic Education, (2021). *Intermediate phase annual teaching plans (ATPs), mathematics.* Government Printers. https://www.education.gov.za/Curriculum/IntermediatePhaseATPs2021.aspx

Donald, D., Lazarus, S., & Moolla, N. (2014). *Educational psychology in social context: Eco systematic applications in South Africa.* ABC Press.

Eggen, P. D, & Kauchak, D. P. (2016). *Educational psychology: Windows on classrooms.* Pearson.

Elrod, M., & Strayer, J. F. (2015). Using an observational rubric to facilitate change in undergraduate classroom norms. In C. Suurtamm & A. McDuffie (Eds.), *Annual Perspectives in Mathematics Education 2015: Assessment to Enhance Teaching and Learning* (pp. 87-96). National Council of Teachers of Mathematics.

Fritz, A., Haase, V. G., & Rasanen, P. (2019). *International handbook of mathematical learning difficulties: From the laboratory to the classroom*. https://doi.org/10.1007/978-3-319-97148-3

Gasa, V., & Marofa, P. (2015). Using secondary sources of data. In C. Okeke & M. van Wyk (Eds.), *Educational research: An African approach.* (pp. 355-370). Oxford University Press.

Gawe, N., Jacobs, M., & Vakalisa, N.C.G. (2016). Learner-centred methods. In M. Jacobs, N. C. G. Vakalisa & N. Gawe N. (Eds.), *Teaching-learning dynamics.* (pp. 250-281). Pearson Education.

Ivankova, N.V., Creswell, J.W., & Plano Clark, V.L. (2016). Foundations and approaches to mixed-methods research. In K. Maree (Ed.), *First steps in research.* (pp. 306-336). Van Schaik.

Jacobs, M. (2016). Aims and objectives. In M. Jacobs M., N. C. G. Vakalisa & N. Gawe (Eds.), *Teaching-learning dynamics.* (pp. 105-137). Pearson Education.

Jojo, Z. (2019). Mathematics education system in South Africa. IntechOpen, https//doi.org/10.5772/intechopen.85325

Kanjee, A., & Mthembu, J. (2015). Assessment literacy of foundation phase teachers: An exploratory study. *South African Journal of Childhood Education, 5*(1), 142-168. https://doi.org/10.4102/sajce.v5i1.354

Killen, R. (2015). *Teaching strategies for quality teaching and learning*. Juta.

Lombard, K., & Themane, M. (2015). Contextualising teaching practice as a component of teacher education. In M. J. Taole (Ed.), *Teaching practice, perspectives and frameworks.* (pp. 11-24). Van Schaik.

Liberman, J. Levinin, J., & Luna-Bazaldua, D. (2020). *Are students still learning during COVID-19? formative assessment can provide the Answer*. World Bank Blogs. https://blogs.worldbank.org/education/are-students-still-learning-during-covid-19 formative-assessment-can-provide-answer

Maree, K., & Pietersen, J. (2016). The quantitative research process. In K. Maree (Ed.), *First steps in research.* (pp. 162-172). Van Schaik.

Mays, T., Grosser, M., & de Jagger, L. (2016). *Getting practical: A guide to teaching and learning.* Oxford University Press.

Nieuwoudt, S., & Reyneke, M. (2016). Assessment. In M. Jacobs, N. C. G. Vakalisa & N. Gawe (Eds.), *Teaching-learning dynamics.* Pearson Education.

Papadakis, S., Kalogiannakis, M., & Zaranis, N. (2016). Comparing tablets and PCs in teaching mathematics: An attempt to improve mathematics competence in early childhood education. Preschool and Primary Education, 4(2), 241-253. https://doi.org/10.12681/ppej.8779

Papadakis, S., Kalogiannakis, M., & Zaranis, N. (2018). The effectiveness of computer and tablet assisted intervention in early childhood students' understanding of numbers. An empirical study conducted in Greece. *Education and Information Technologies, 23*(5), 1849–1871. https://www.learntechlib.org/p/191703/

Paulsen, R., & Dednam, A. (2016). Challenges in Mathematics: Mathematical Literacy and Numeracy. In E. Landsberg, D. Kruger & E. Swart (Eds.), *Addressing barriers to learning: A South African perspective.* (pp. 241-262). Van Schaik.

Piaget, J. (1953). *The origin of intelligence in the child.* Routledge and Kegan Paul.

Reddy, C., Le Grange, L, Beets, P., & Lundie, S. (2015). *Quality assessment in South African schools*. Juta.

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.* Springer.

Vakalisa, N. C. G. (2016). Participative teaching. In M. Jacobs, N. C. G. Vakalisa & N. Gawe (Eds.), *Teaching-learning dynamics.* (pp. 39-71). Pearson Education.

Vygotsky, L. (1978). *Mind in society: The development of higher mental processes.* Harvard University Press.

William, D. (2011). What is assessment for learning? *Studies in Educational Evaluation, 37*(1), 3-14. https://doi.org/10.1016/j.stueduc.2011.03.001

Appendix 1

Checklist for 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**	**T 3**	**T 4**					
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	
Complex procedures (=20%)	C10.Problems involving complex calculations and/or higher order reasoning	1	2	3	
	C11. Investigations to describe rules and relationships- there is	1	2	3	

	often not an obvious route to the solution				
	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