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INVESTIGATING CHALLENGES EXPERIENCED BY INTERMEDIATE PHASE MATHEMATICS TEACHERS IN THE IMPLEMENTATION OF FORMATIVE ASSESSMENTS

Senzeni Sibanda*)[1], Awelani Melvin Rambuda[2]
[1]Central University of Technology, Welkom, South Africa; ssibanda@cut.ac.za
[2]Central University of Technology, Welkom, South Africa; arambuda@cut.ac.za
*) Corresponding author: Senzeni Sibanda; E-mail addresses: Senzeni Sibanda; ssibanda@cut.ac.za

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Abstract. In this empirical paper, the authors discuss the challenges experienced by the intermediate phase teachers in the implementation of formative assessments in mathematics teaching and learning. Numerous reports regarding South African learners' poor performance in mathematics necessitated the research. Challenges associated with the language of learning and teaching are the primary contributors of this issue. The paper is grounded in the social constructivist theory which places emphasis on the notion that learning occurs when learners are provided with opportunities to apply the cultural psychological mechanisms they utilize, that include mathematical concepts, language, and diagrams and then taught the way to apply those mechanisms as to gain an in-depth comprehension of (some) phenomenon. In this quantitative paper, the questionnaire was administered to 151 respondents to elicit information on assessment challenges. The study found that the implementation of formative assessments poses a challenge to most of the in-service teachers. Considering these findings, the study recommends that subject advisors and policy makers provide ongoing professional development for teachers regarding the implementation of formative assessments. Additionally, teachers should employ the social constructivist approach while assessing learners, particularly for projects and investigations as forms of formative assessments.

INTRODUCTION

Despite several years of mathematics development programs, South African learners have not made enough progress. Poor performance as reported by the Southern African Consortium for Monitoring Education Quality (SACMEQ) and the Trends in International Mathematics and Science Study (TIMSS) confirm this matter (Department of Basic Education [DBE], 2019). It continues to be an established fact that most South African learners underperform in mathematics (Mabena et al., 2021). Although formative assessment is included in government policy documents, there is insufficient research-based data to support if teachers provide assessments in an adequate and appropriate manner. Further evidence suggests that while several studies have been conducted on the

approaches of assessment, minimal research has been done on the assessment literacy of South African teachers (Taylor, 2021).

The challenges encountered in implementing formative assessments in mathematics intermediate phase, thus grades four to six have been the focus of various research. Mahlambi et al. (2022) conducted a study on exploring the utilization of assessment for learning (AfL) in grade 6 mathematics to develop a classroom atmosphere that reacts to learners' acquisition of knowledge. Their study was triggered by the continuous poor performance of South African learners in mathematics, hence calls for a deeper investigation of the challenges surrounding AfL assessment methods in math classes. The authors contend that even though the use of AfL has been made compulsory and its benefits for teaching and learning have been proven, there are still challenges with implementing formative assessments. These challenges include teachers' lack of understanding of AfL practices and inadequate pedagogical knowledge in the subject.

The authors recommended that major endeavors be made by the Department of Basic Education (DBE) and educational institutions to support math teachers in comprehending and implementing AfL technique. In another study, Buabeng et al. (2019) examined how primary schools in the Cape Coast metropolitan area viewed the impact of assessment on mathematics instruction. The problem emanated from the concern regarding underperformance of learners in mathematics. As a result, the authors explored the forms and methods of assessment that local teachers utilize in the teaching of mathematics as well as any potential challenges they encounter while implementing the various assessment procedures. The study found that teachers frequently evaluate the advancement of learners in mathematics using a range of assessment methods. The approaches consist of trial work, homework, and in-class exercises. On the other hand, the teachers said they seldom utilized group or project work. Probably, the teachers are neglecting projects and group work because they either have difficulty understanding the benefits of these methods or do not have adequate time to administer them. The study has additionally revealed that low learner attendance, excessive teacher workloads, and inadequate assessment materials are some of the issues that impede assessment methods. These are some of the problems that are also experienced by mathematics teachers in South Africa.

Assessment encompasses all the decision-making processes related to how learners achieve their learning goals (Monteiro et al., 2021). Formative assessment incorporates results from both tests and examinations. On the part of the teacher, it leads to decisions on whether to review a topic further after the learners' performances (Ngunjiri, 2022; Takele & Melese, 2022). In the South African basic education context, these formative assessments consist of the school-based assessment (SBA), which includes the assignments, investigations, project, tests, as well as the final examination in relation to a specific grade (DBE, 2023; DBE, 2011). Veronica and Wiryanto (2021) have conducted a noteworthy study where they describe the assessment process of mathematics learning in primary schools in Indonesia. In accordance with the authors to strengthen the significance of mathematics learning, the method of assessment ought to address three assessment elements. These kinds of assessments include the cognitive assessment, which is conducted using knowledge and critical thinking tests. Followed by the affective assessment, which is concerned with attitudes, feelings, morals, and values; then the psychomotor assessment which is concerned with the learners' motor abilities. However, owing to various challenges encountered, the three assessments are not optimally conducted.

These challenges included a lack of teaching expertise, difficulties in creating assessment tools, a lack of facility availability, and a lack of learners' comprehension of the subject matter. Consequently, the authors recommended that teachers must be assisted in developing as many assessment tools as they can that focus on the affective, cognitive, and psychomotor domains. While these studies have shed light on the challenges that intermediate phase mathematics teachers experience when implementing formative assessments, none have specifically addressed how constructivist theory might be used for investigations and projects. For example, Mahlambi et al. (2022) made no mention of the utilization of projects and investigations as methods for assessment. However, these kinds of assessment methods assist learners' understanding of how to solve complex problems in mathematics. Buabeng et al. (2019) recommend that teachers must administer assessments such as investigations, projects, group exercises (cooperative learning exercises). The authors' projection that the teachers are neglecting projects and group work because they either have difficulty understanding the benefits of these methods or do not have adequate time to administer them might be alleviated if they apply Vygotsky's (1978) crucial elements of social constructivism theory; these are the role of social context, language, and mediation in assessment of projects and investigations. Subsequently, the research will make recommendations for potential alleviations through the application of the constructivist theory, more especially, the social constructivism as formulated by Vygotsky.

This paper is grounded within the social constructivism theory which was developed by Vygotsky in 1978. This theory maintains that knowledge is continuously constructed by individuals within real-world circumstances as opposed to being predetermined (Saleem et al., 2021). Social constructivism's main aim is that knowledge is inwardly created by an individual rather than being imposed by outside factors. The importance of language, social-context, and mediation are three key components of the theory. Language is an essential component of the cognitive process because it serves as people's primary way of communication in social relationships. Sign language, mathematical language, and other symbol systems are all included in addition to spoken and written language. The social context-activity principle holds that social contact is how cognitive development takes place. Then mediation is the way a child learns the mental tools necessary to formulate possible information.

There are significant pedagogical implications of the social constructivism theory in intermediate phase mathematics assessment. The theory highlights the critical role that teachers and other community members play as potential mediators in helping children acquire a specific cognitive development measure. Additionally, the emphasis is on extending learning outside of the classroom, including the home. Moreover, learner participation is mentioned as the key to social constructivism (Akpan et al., 2020). The theory is relevant since through the application of its tenets, learners can work together cooperatively, exchange views on tackling complex procedures and problem-solving techniques related to investigations and projects. Also, constructive scaffolding needs to be provided through mediation for the purpose of supporting learning and growth. Consequently, learners will be motivated to intentionally develop novel and valuable ideas. Teachers should therefore put the theory into practice as they administer formative assessments in mathematics, especially in investigations and projects which can be done in

groups by the learners. There could be some likelihood that the challenges highlighted can be addressed following this approach.

METHOD

The study is in the positivist paradigm. Positivism paradigm strives to clarify and anticipate what occurs in the social environment by attempting to identify consistency and connections of cause and effect amongst its different variables. Researchers' task is to generate deductive interpretations utilizing empirically measurable, universal mechanisms of cause and effect (Bonache & Festing, 2020). As defined by Park et al. (2021), positivism employs the hypothetical-deductive method to examine preconceived beliefs that are expressed quantitatively and that can be linked to outcomes through functional relationships (dependent variables) and causative and explanatory elements (independent variables). In terms of research methodology, it describes a research perspective that is predicated on what is referred to as the scientific process of inquiry. Al-Ababneh (2020) notes that the primary objective of positivism is to establish a comprehensive social structure that applies science to study society and humans for personal growth. As opposed to being based on speculation, it is based on real experience. Moreover, the acquisition of knowledge in this field of study is firmly and totally predicated on a proposition rather than conjecture.

The research for this paper is quantitative since it links well with the research paradigm of positivism. Quantitative research utilizes numerical data in an empirical, systematic framework. It obtains its data using a certain subgroup. The findings are then generally construed to include the sector under consideration. The primary objective of quantitative research is to discover patterns and relationships throughout particular study components (Maree & Pietersen, 2020). In agreement with Taherdoost (2022), quantitative research method entails quantifying and evaluating variables to come up with findings. It is a method of research that uses numerical data collection and mathematical analysis to describe a phenomena or problem. Moreover, it uses techniques and statistics which yield quantifiable or distinct results. Additionally, Ghanad (2023) asserts that the focus of a quantitative research design is on measurements, numbers, logical reasoning, control and experiments. It argues that to validate reality, phenomena should be objectively investigated. Quantitative research was appropriate for the study.

A survey was utilized in the study as a quantitative approach. Given its suitability for assessing attitudes, opinions, or trends within a particular group of people. The questionnaire was an ideal tool to gather information on the challenges that intermediate phase mathematics teachers encounter while implementing formative assessments. 151 intermediate phase mathematics teachers from Lejweleputswa schools, in the Free State province of South Africa made up the study's sample. The researchers employed a probability sampling method, precisely, the simple random sampling. Simple random sampling is effective for extremely homogeneous groups, and research participants are selected at random from the population. With this technique, there is a comparable probability for everyone to be selected for the population sample. Considering probability and randomness, the sample should include individuals who are representative of the general population, such as individuals who are older than others, younger than others, and more experienced in their field of work than others, just to mention a few of these characteristics. This suggests that to utilize random sampling effectively, the researcher ought to create universal traits shared by the population being sampled (Noor et al., 2022).

Using random sampling procedures is based on the basic assumption of making sure the sample is accurately representing the population it is intended to represent. In this study, these views were taken into consideration. Utilizing the Lejweleputswa district database, the researchers randomly chose forty-eight out of one hundred and sixty public primary schools to create a sample and administered the questionnaires to the schools. A biographical component of the questionnaire inquired the respondents' gender, age, teaching experience, number of learners in class, the highest grade taught and the school quintiles.

Moreover, random sampling is necessary for minimizing sample bias while enhancing study accuracy (Mulisa, 2022). This technique was deemed significant by the researchers for the study since it made it possible for them to select appropriate respondents from the intermediate phase teachers who were acquainted with teaching and learning in mathematics. The research questions which were addressed by the teachers in the implementation of formative assessments were:

- What challenges do teachers encounter while implementing formative assessments and,
- In which ways can these challenges be addressed to improve mathematics teaching and learning?

Data were gathered through the closed-ended questionnaire with the intermediate phase mathematics teachers. A timeframe of 48 to 72 hours after the day of administration was agreed upon with the respondents for the collection of completed questionnaires. It took the researchers a period of two months to complete the data collection process. The study observed all ethical considerations, which included requesting consent from the Free State Department of Education (FSDoE) to carry out the study in the Lejweleputswa district schools. The FSDoE provided the endorsement. In addition, the Central University of Technology gave ethical approval for the study, and FRIC assigned a number [D. FRIC.08/18/7] to the ethical clearance certificate.

The data were analyzed using descriptive statistics which were a collective term for all statistical techniques applied in the organization and logical data summaries (Pietersen & Maree, 2020a). Following the data collection, descriptive data must be used to draw attention to the salient aspects of its distribution. Descriptive statistics specifies two general distributional properties, thus the central tendency and the dispersion measurements. The mean, median, and mode collectively comprise the three "Ms" that make up a distribution's central tendency. Researchers can use a single variable rather than a collection of data when determining the number of the most prevalent value by employing the central tendency. "Mean" denotes the average of the values, "median" denotes the value in the middle of the data set, and "mode" denotes the value's most frequent amount.

Dispersion is referred to as the distribution of the variables around the central tendency. The range, variance, and standard deviation are the dispersion metrics that are most frequently used. In this study, the mean, median and standard deviation were used to analyze the data. The standard deviation illustrates how the results tend to cluster around the average number. It is used when two data sets need to be compared and there are two variables in the data set. Consequently, it could illustrate the relationships and linkages between the two variables (Salkind, 2018; Taherdoost, 2021). In this study, internal

reliability was employed to ensure data reliability. Based on this form of reliability, if multiple factors are created to measure a single notion, significant levels of similarity are anticipated considering measuring is done on a single basic construct. This also indicates the instrument's dependability. A scale score of .90 and higher indicates high reliability (Pietersen & Maree, 2020b). Table 1 below illustrates the study's reliability, which was .82. This Cronbach's Alpha value suggests that internal consistency reliability for the scale is moderate.

Table 1: Reliability of the questionnaire

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardised Items	N of Items
0.818	0.843	16

RESULTS AND DISCUSSION

This section presents and analyses data obtained from the questionnaire. Descriptive statistics address the following research question: *What challenges do teachers encounter while implementing formative assessments?*

Responses from the respondents are illustrated on Table 2 below.

Table 2: Challenges in mathematics formative assessments N=151

	Questionnaire items	Mean	Median	Standard Deviation
1	Formative assessments provide me adequate time to spend in content delivery.	4.62	4.00	1.15
2	My class sizes are appropriate for formative assessments.	4.23	4.00	1.28
3	I can mark formative assessment tasks whilst providing my learners with individual focus.	4.21	4.00	1.08
4	I have no difficulties focusing on learners' individualized needs.	4.17	4.00	1.06
5	I have no challenges with providing constructive feedback when implementing formative assessments.	4.44	4.00	1.17
6	I possess sufficient expertise and abilities for the implementation of formative assessments.	5.90	6.00	1.07
7	I received training to enable me implement formative assessments effectively.	5.48	6.00	1.75
8	I am properly qualified to teach mathematics.	5.84	6.00	1.07
9	I possess appropriate expertise in teaching mathematics.	5.83	6.00	1.07
10	I get ongoing professional growth which assists me address certain areas of my pedagogical difficulties.	5.47	5.00	1.18
11	The subject advisor provides me with sufficient assistance.	5.04	5.00	1.01

	Questionnaire items	Mean	Median	Standard Deviation
12	I possess extensive knowledge of the National Protocol on Assessment.	5.66	6.00	1.16
13	I consider the National Protocol on Assessment to be straightforward.	5.09	6.00	1.39
14	The language used in both teaching and learning supports my learners' comprehension of the instructions for the assessment questions.	3.66	3.00	1.42
15	My learners can solve word problems owing to language clarity and word structure.	3.23	3.00	1.24
16	My learners are capable of reading and writing in English proficiently, enabling them to achieve exceptionally well in mathematics.	3.24	3.00	1.26

Table 2 above illustrates that there is evident discrepancy among the respondents over several items as discussed in the upcoming paragraphs. Data demonstrate that respondents suggest that formative assessments moderately allow them to have adequate teaching time (*M*= 4.62; *MD*=4.00; *SD*=1.15). Also, class sizes are moderately suitable for formative assessments (*M*=4.23; *MD*=4.00; *SD*=1.28). Additionally, teachers are sometimes able to mark formative assessment tasks whilst providing learners with individual focus (*M=4.21 MD=4.00; SD=1.08*). Moreover, it sometimes becomes a challenge to give learners adequate feedback (*M= 4.44 MD=4.00; SD=1.17*).

The standard deviations for all the items immediately discussed are far from their means, indicating a discrepancy among the respondents regarding these items. Data for both items are positively skewed as the means are greater than their medians. It is crucial to note that teachers have proper qualifications to teach mathematics (*M=5.84; MD=6.00; SD=1.07*) and have proper experience in the subject (M= *5.83; MD= 6.00 SD= 1.07*). The standard deviations for both items are far from the means validating disagreement among the respondents for the item discussed. Furthermore, teachers get ongoing professional growth which assists them address certain areas of pedagogical difficulties (*M*=5.47; *MD*=5.00; *SD*=1.18). The standard deviation is far from the mean indicating that there is discord among the respondents. Data for this item is positively skewed as the mean is higher than the median. Teachers view the National Protocol on Assessment as clear and simple (*M*=5.09; *MD*=6.00; *SD*=1.39). Moreover, statistics reveal that respondents are provided with sufficient assistance from the subject advisor (*M*=5.04; *MD*=5.00; *SD*=1.01). Learners are occasionally capable of solving word problems owing to language clarity and word structure (*M*=3.23; *MD*=3.00; *SD*=1.24). Furthermore, learners are occasionally capable of achievement in mathematics owing to the challenges they encounter in reading and writing in English proficiently (*M*=3.24; *MD*=3.00; *SD*=1.26). The language of teaching and learning makes less easy for learners to understand the instruction for assessment questions (*M*=3.66; *MD*=3.00; *SD*=1.42).

Analysis of data reveals the following as the main challenges in mathematics formative assessments:

- Challenges with language clarity and word structure impede the capacity of learners to solve word problems.
- Learners' inability to read and write proficiently in English.
- The language used in both teaching and learning does not support the learners' comprehension of the instructions for the assessment questions.

In general, the use of formative assessments in mathematics is hindered by the language of learning and teaching (LoLT). Despite being stereotypically linked to working with numbers, teaching and learning mathematics is increasingly viewed as being inherently linked to language. Pimm and Keynes (1994), cited in McLachlan & Essien (2022) contend that language is used in all four of the tasks associated with teaching and learning mathematics, which include listening, reading, writing, and discussing. Thus, language is described as a means of solution to discussions that assist learners and teachers to interact and communicate. In intermediate phase mathematics, English is used as a language of teaching, learning and assessment in South Africa. Conversely, the quantitative data reveal that there are many obstacles associated with using English language as a LoLT. Responses to questionnaire items show that learners have difficulty understanding questions owing to the LoLT, additionally, language barriers prevent learners from addressing word problems, and moreover, learners' performance is subpar since they are unable to read and write in English. Literature attests that the LoLT is a challenging matter in the teaching and learning of mathematics, resultantly, being an obstacle to the efficient implementation of formative assessments (Al-Sehli & Maroof, 2020).

Alleviating challenges associated with the Language of Learning and Teaching in formative assessments

McLachlan and Essien (2022) suggest using multilingual education while teaching mathematics. The argument made is that research must inform language policies and consider a child's cognitive development. The author makes a compelling argument against English being the only LoLT for mathematics, especially in constructivist settings where meaning is created by dialogue and discussion. In like manner, various researchers suggest code-switching (CS) (utilization of learners' native languages) in mathematics instruction without hampering learners' acquisition of English language proficiency. Based on their research, they maintain that it is advantageous for learners to have access to mathematical activities in both English and their native language. The researchers contend that the notion of mathematics classes using one language is oversimplified. They suggest that to encourage exploratory conversation, CS needs to be employed (Celario, 2023; Mahlambi et al., 2022; Robertson, & Graven, 2020). This will in turn alleviate the challenges associated with language barriers in mathematics teaching and learning. Inversely, although CS can improve communication, questions regarding how it will affect language skills in future.

Long-term effects and consequences, such as those in online education and communication, should be investigated in future research (Albahoth et al., 2024). Another drawback of CS is that it can be confusing for learners who are not fluent in all the languages being spoken, which could lead to misconceptions. Additionally, given that CS is viewed as a sign of illiteracy or a lesser social standing, individuals who frequently switch between codes may face stigma or bad perception in certain settings. Furthermore, an over-reliance on CS can hinder the development of language proficiency, particularly in the case elementary learners who are still acquiring a variety of languages. Teachers must consequently use discretion and be mindful of any possible consequences when applying it

in classrooms. It could impede communication if not implemented with carefully (Savase & Khairdi, 2024). Moreover, it seems that there may be dispute regarding school language instruction and CS. Since a language translation may not accurately convey the message, it is occasionally not effective or dependable.

Thus, language learners may encounter several registers in both their native language and the medium of instruction while transitioning between languages, which can provide another dimension of challenges as well. Additionally, there are differences in how learners use and value a given language in various contexts. Moreover, learners tend not to speak in their native tongue during entire class discussions, as they do so in small group situations (Sharma, 2024). In view of the previously identified drawbacks of CS, the researchers considered a necessity to explore alternative approaches that might be employed to mitigate the challenges presented by the LoLT in formative mathematics assessments. Various strategies that may be employed to enhance mathematics teaching and learning, including formative assessments without minimizing the LoLT exist.

Noteworthy, Nahdi et al. (2024) indicate that there is a significant and positive connection between interest in mathematics, reading comprehension and mathematical problem-solving skills. This conclusion makes logic since interpreting text is essential to comprehending mathematical problems that incorporate narratives. The authors demonstrate how crucial it is to concentrate on affective factors and reading competence in addition to cognitive components (such comprehending mathematical principles) with the objective to improve learners' mathematical problem-solving skills. This demonstrates how enhancing learners' mathematical achievement can be accomplished by a holistic approach to mathematics teaching and learning if these factors are considered. Hence, the role of language as described in the theory that guides the study lends credence to the concepts that are put forth.

In like manner, Erbeli et al. (2021) demonstrate how at-risk learners' development of their mathematical abilities is facilitated by strong reading skills, especially if they achieve below average in mathematics. All the stated imply that teachers must employ the social constructivist approach when assessing learners, which will encourage reading with understanding to improve the learners' abilities to solve word problems. Comparatively, Karacaoğlu and Kasap (2023) argue that the ability to comprehend has been demonstrated to be the most fundamental ability for academic performance in science-related subjects like mathematics and mathematical literacy. In accordance with the authors, reading support and guidance from teachers can have a positive impact on the academic achievement of learners. Consequently, the authors recommend that affective training on reading competence perceptions, managing beliefs of reading challenges, and self-regulation abilities should be implemented for learners in mathematics classes. Reinforcing the discussed views are the findings of Serin (2023) when explaining that teachers who structure the curriculum delivery effectively can assist learners understand mathematics.

Through participating in discussions and problem-solving tasks, learners can make the connection between abstract mathematical ideas and realities. Basically, learners get a greater knowledge of concepts while investigating applications in the real world. Teachers need to help learners develop the ability to solve problems by guiding them in using suitable approaches and helping them analyze problems to discover solutions. Learners benefit from cooperative solving tasks as well since they develop critical thinking and

reasoning abilities. A key approach for solving challenging mathematics problems in the classroom is to encourage learners to collaborate with each other. Moreover, the authors also emphasize the significance of strong interpersonal procedures, which help learners comprehend problems more deeply and collaborate with one another. Considering this, teachers must facilitate discussions in the classrooms. Thus, learners who have developed their communication abilities become more able to collaborate, support their decisions, and solve problems as well. This additionally demonstrates how essential language, social context, and mediation are as the three main pillars of Vygotsky's theory, which serves as the framework for this study. Developing mathematical confidence is also considered as an important strategy. Learners find it difficult to succeed when they lack self-confidence. In view of this, it is crucial to establish a favorable learning atmosphere in mathematics classes. To build confidence, learners need tools like constructive criticism, scaffolding and guidance, frequent practice, and concise clarification. Subsequently, determination and confidence will foster a sense of achievement on the part of the learners.

CONCLUSION

Conclusively, the study has demonstrated that the challenges encountered by intermediate phase teachers when implementing formative assessments in mathematics teaching and learning stem from the LoLT. Evidently, the preceding discussion revealed the significance of social constructivism's three key components, thus language, social-context, and mediation as playing a significant role in mathematics assessments. Hence, the authors put a recommendation that the theory must be embraced in mathematics assessments. If the theory is applied effectively, its principles may assist in alleviating the challenges encountered in formative assessments. A suggestion is further made that subject advisors must continue mediating the curriculum, identifying ideas that require more development on the part of the teachers, and providing the necessary training and development. Social engagement is a highly appreciated approach to learning environments. As Johannesson (2020) and Townley (2020) argue, this implies that maintaining the interdependent networks and interacting with other stakeholders to foster growth and development must prevail for ensuring the accomplishment of the intended objectives.

CONFLICT OF INTERST

This study was derived from a Master of Education dissertation submitted by the first author and supervised by the second author.

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