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Investigating the teachers' use of assessment for learning in mathematics classroom: Case of selected public secondary schools Nyagatare District, Rwanda

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ABSTRACT

This study investigated formative assessment practices in public secondary schools in Nyagatare District, focusing on teachers' competency in planning assessment for learning activities using Bloom's taxonomy, their feedback provision, and their overall understanding of assessment for learning. Employing a qualitative case study approach, data were gathered through classroom observations, teacher interviews, and document analysis. Findings revealed varied formative assessment practices across schools in terms of frequency, type, and effectiveness; some teachers utilized diverse strategies like quizzes and peer/self-assessment, while others leaned on traditional summative methods. The study underscores the critical need for enhanced teacher training and professional development to improve formative assessment implementation and, consequently, mathematics learning outcomes for students.

Keywords: advanced secondary schools, educational practices, formative assessment, mathematics classroom

INTRODUCTION

Globally, formative assessment is recognized for its crucial role in supporting learning by pinpointing student strengths and weaknesses, boosting motivation, and providing timely feedback (Iyanda, 2025). It's a vital component of the teaching and learning process, especially in mathematics, where it can significantly encourage struggling students (Mohammadi Zenouzagh et al., 2025). Essentially, formative assessment is an ongoing pedagogical approach involving continuous feedback and evaluation, designed to inform and enhance the learning ride (Teles & Moreira, 2025). Effective mathematics instruction in secondary schools necessitates teachers employing diverse formative assessment techniques to gauge and showcase learning progress, ultimately supporting student development and achievement (Ndlovu, 2025).

Despite its importance, various scholars have identified shortcomings in formative assessment practices. For instance, Jatoi and Kabilan (2025) noted teachers often rely on traditional questioning and provide insufficient descriptive feedback, frequently limited to simple ticks, crosses, or generic comments In Rwanda, similar issues persist, with studies by Kazinyirako et al. (2024) indicating that formative assessment practices are rarely planned by teachers in public secondary schools. This study aimed to investigate teachers' use of assessment for learning in mathematics classrooms, with the findings expected to enrich the current understanding of formative assessment in mathematics education and offer practical guidance for teachers, administrators, and policymakers in Rwanda and globally.

Formative Assessment in Mathematics Education

The modern understanding of formative assessment originates from Black and Wiliam (1998), who defined it as any activities undertaken by teachers or students that provide feedback to modify teaching and learning. This foundational work highlights the crucial role of ongoing feedback in supporting student progress. Often termed assessment for learning, formative assessment is a cornerstone of effective mathematics education, encompassing various strategies used by teachers to gauge understanding, provide timely feedback, and adapt instruction to meet individual student needs. Research consistently demonstrates its positive impact on student achievement in mathematics, with Black and Wiliam's (1998) landmark study showing significant improvements when formative assessment is used effectively. Hattie and Timperley (2007) further reinforced this, finding that formative assessment practices have a substantial effect size of 0.90 on learning outcomes. It's not just about identifying struggles,

but actively providing feedback and opportunities for improvement, leading to enhanced understanding and retention of mathematical concepts (Hattie & Timperley, 2007; Rofi'ah et al., 2021). Various tools, including quizzes, written assignments, peer assessments, and classroom discussions, are employed to gather this ongoing data (Amoako et al., 2019).

Teachers' Formative Assessment Feedback and Strategies

Timely and constructive feedback is a fundamental element of formative assessment, providing students with actionable insights and helping them set goals for improvement (Dalby & Swan, 2019). Numerous studies confirm its positive impact on mathematics achievement (Amoako et al., 2019; Janeth, 2019; Nsabayezu et al., 2022; van der Nest et al., 2018). Immediate feedback, for instance, allows students to correct misconceptions and deepen their understanding (Janeth, 2019; Niyibizi et al., 2023). Formative assessment also raises an ongoing dialogue between students and teachers, promoting ownership and increased motivation (Amoako et al., 2019; Janeth et al., 2019). Strategies employed in mathematics education include peer assessment, self-assessment, quizzes, concept mapping, and feedback-rich problem-solving (Janeth et al., 2019). Peer assessment encourages collaboration and critical thinking (Nsabayezu et al., 2022), while self-assessment promotes metacognition and self-regulation (Amoako et al., 2019). The integration of technology, through online quizzes and simulations, further enhances formative assessment by providing immediate feedback and adaptive learning experiences (Humes, 2021). These various strategies help teachers address misconceptions and differentiate instruction effectively (van der Nest et al., 2018; Humes, 2021).

Questioning Types and Implementation Challenges

The types of questions asked during formative assessment, especially in relation to Bloom's taxonomy levels, are crucial. Computer-assisted assessment tools, like online quizzes and interactive simulations, allow teachers to collect real-time data and adapt instruction (Busaka et al., 2021; Humes, 2021). However, the implementation of formative assessment is not without its challenges. Time constraints in covering the curriculum pose a significant hurdle (Amoako et al., 2019), particularly in large classes where reviewing individual work and providing timely feedback becomes demanding (Janeth, 2019). Ensuring feedback is specific and actionable also requires extensive teacher training and expertise (Nsabayezu et al., 2022). The cost associated with incorporating technology for formative assessment, including access to devices and software, can be another barrier (Humes, 2021). Furthermore, aligning formative assessment activities with broader curriculum goals can be complex (van der Nest et al., 2018), and interpreting qualitative data from open-ended questions may introduce subjectivity and potential bias (Nsabayezu et al., 2022). Cultural and contextual factors also significantly influence successful implementation, necessitating adaptation to fit the unique needs of various student populations (Nsabayezu et al., 2022; van der Nest et al., 2018).

Theoretical Framework and Professional Development

Effective implementation of formative assessment strategies fundamentally relies on ongoing teacher professional development (Balbi et al., 2025). Studies consistently highlight the positive correlation between effective formative assessment practices and improved student achievement in mathematics (Amoako et al., 2019; Janeth, 2019; van der Nest et al., 2018; Wafubwa & Csíkos, 2022). The present study was guided by the constructivist learning theory and self-regulated learning theory. Constructivism posits that learning is an active process where individuals build knowledge from experience, suggesting that formative assessment should gauge prior knowledge and encourage self-assessment. This aligns with how formative assessment can support students' active construction of mathematical understanding. Self-regulated learning theory, on the other hand, emphasizes students' active involvement in goal-setting, progress monitoring, and strategy adjustment. Formative assessment is crucial here by providing feedback and encouraging self-regulation. These two theoretical frameworks provide a strong foundation for analyzing formative assessment practices in mathematics education within Rwandan public secondary schools, shedding light on how practices are influenced by educational theories and local context.

Therefore, this study is pursued to address the following research objectives:

1. To analyze the teachers' competency to plan assessment for learning activities using Bloom's taxonomy levels in public secondary schools in Nyagatare District.
2. To assess how teachers of mathematics provide feedback from assessment for learning activities in public secondary schools in Nyagatare District.
3. To evaluate the mathematics teachers' understanding of assessment for learning in Nyagatare public secondary schools.

METHODOLOGY

Research Design

The study adopted a qualitative research approach, specifically employing a case study design (Cui, 2025). This design was chosen to facilitate an in-depth exploration and understanding of formative assessment practices within the specific context of two public secondary schools in Nyagatare District. Qualitative research is particularly suited for investigating complex educational phenomena, allowing for a nuanced and detailed examination of how formative assessment is understood and implemented in real-world mathematics classrooms (Ramaila et al., 2025).

Population and Sample

The study's population focused on public secondary schools in Nyagatare District. From this, a sample of four public secondary schools was purposively selected to ensure variety in characteristics such as urban vs. rural settings, size, and performance levels.

Within these schools, the sample for the study comprised 13 mathematics teachers, consisting of 7 males and 6 females, who were teaching mathematics at the time of the study and were available for participation.

Data Collection Procedure

Data were collected through a multi-pronged approach to ensure comprehensive insights into formative assessment practices. Semi-structured interviews were conducted with the sampled mathematics teachers, utilizing open-ended questions to gather their perspectives and understanding of formative assessment (Niyibizi et al., 2025). Additionally, direct classroom observations were carried out to witness the real-time implementation of formative assessment strategies (Gangodawilage, 2025). Furthermore, relevant documents were analyzed to provide contextual information and corroborate observational and interview data (Ominyi et al., 2025).

Data Collection Instruments

The primary data collection instruments included a semi-structured interview guide for mathematics teachers, designed with open-ended questions to elicit detailed responses regarding their formative assessment practices and understanding. An observation checklist or protocol was likely used during classroom observations to systematically record the types and frequency of formative assessment activities. Document analysis involved reviewing school assessment policies, teacher guides, and students' exercise and homework books to gain insights into official and applied assessment practices.

Data Analysis Procedures

Qualitative data gathered from interviews, classroom observations, and document analyses were subjected to thematic analysis. This rigorous analytical process involved transcribing interview data, followed by careful coding to identify recurring patterns, concepts, and ideas related to formative assessment practices. Through this iterative process of coding and categorization, salient themes emerged, providing a structured framework for interpreting the complex qualitative data and answering the research questions.

Reliability and Validity

To ensure the validity of the study, all research instrument items were directly linked to the specific research objectives, ensuring that the data collected were relevant and addressed the intended areas of inquiry. Furthermore, the study enhanced its reliability and validity through triangulation, utilizing multiple data sources including teacher interviews, direct classroom observations, and document analysis. This convergence of evidence from different sources strengthened the credibility of the findings. It is acknowledged, however, that the findings are specific to the selected schools and may not be broadly generalizable.

Ethical Considerations

Throughout the study, rigorous ethical considerations were upheld to protect the rights and well-being of all participants. Informed consent was obtained from every participant, ensuring they fully understood the purpose of the study and their rights, including the right to withdraw at any time. To maintain confidentiality and privacy, the identities of all participants were carefully protected, and all collected data were anonymized, preventing any personal identification in the study's reporting and dissemination of findings.

RESULTS AND DISCUSSION

The dynamic realm of formative assessment in mathematics education was thoroughly explored through an in-depth investigation across four public secondary schools in Nyagatare District, Rwanda. By examining the experiences of both mathematics teachers and students in applying assessment for learning, this study provided valuable insights into its practical application and its role in enhancing mathematics learning outcomes. These findings offer a comprehensive look at the current landscape of formative assessment practices in Rwandan secondary schools and contribute significantly to the ongoing discourse on improving mathematics education.

Understanding of Formative Assessment

Our interviews with the 13 mathematics teachers revealed a foundational understanding of formative assessment, with all participants recognizing its importance in the teaching and learning of mathematics. As teacher 01 articulated,

> Formative assessment is an ongoing process of gathering information about a student's learning progress during the course of instruction. In the context of mathematics education, it's essential for tracking how students are grasping mathematical concepts.

This aligns with global perspectives on formative assessment (Iyanda, 2025). However, a grasp of the concept, particularly in distinguishing it from summative assessment, varied among teachers. Teacher 07 emphasized its practical application:

> One key aspect of formative assessment in mathematics is using quizzes, problem-solving tasks, and observations to provide immediate feedback to students. This helps them identify their strengths and weaknesses in the subject.

The teachers consistently acknowledged formative assessment's role in supporting student learning, with teacher 08 highlighting its preventative power:

> In teaching mathematics, formative assessment allows teachers to identify students who might be struggling early on. This early detection is crucial because it enables timely intervention to prevent the accumulation of learning gaps.

Furthermore, teacher 12 underscored its impact on mindset:

> Effective use of formative assessment in mathematics helps promote a growth mindset among students. It encourages them to view challenges as opportunities for learning and improvement rather than as failures.

A strong majority, 92% of the teachers, positively viewed formative assessment, emphasizing its potential to enhance student learning and pinpoint areas for improvement. Teacher 10 stated,

> Formative assessment plays a significant role in helping students build a strong foundation in mathematics. It ensures that they understand fundamental concepts before moving on to more complex topics, contributing to their long-term success in the subject.

This perspective resonates with constructivist theory, where continuous feedback fosters an environment for students to actively build understanding. Teacher 11 highlighted the metacognitive aspect:

> Formative assessment isn't just about evaluating students; it's also about self-assessment. In mathematics, students can learn to assess their own progress and make adjustments in their study strategies based on their performance in formative assessments.

This aligns with the constructivist view of learning as an iterative, self-directed process (Wafubwa & Csíkos, 2022).

Formative Assessment Strategies and Challenges

All 13 teachers reported using a variety of formative assessment strategies, including quizzes, exit tickets, peer assessment, and self-assessment, during mathematics instruction. This various approach aligns with constructivist principles, where active social learning through interaction and reflection is a key. Notably, 77% of teachers mentioned incorporating technology to facilitate formative assessment, using educational software and interactive whiteboards. As Teacher 05 remarked,

> Technology has revolutionized the way we assess students in mathematics classrooms. Online platforms and educational software provide us with tools to make assessments more efficient and effective.

This incorporation of technology further supports a constructivist learning environment by facilitating interactive and collaborative experiences. However, despite these efforts, teachers also identified challenges in implementing formative assessment effectively, such as large class sizes, limited resources, and time constraints. These challenges often hinder the full embrace of constructivist practices, underscoring the need for greater support and infrastructure.

Classroom Observations and Feedback

Classroom observations consistently showed active student engagement in the learning process, with teachers frequently employing formative assessment to gauge understanding. Questioning techniques were prevalent, promoting student involvement. While most teachers utilized questioning as a primary strategy, the quality and variety of questions varied significantly. Some teachers effectively used higher-order thinking questions to stimulate critical thinking, aligning with the constructivist goal of deeper understanding. In contrast, others relied on lower-order questions, potentially favoring rote memorization over comprehension. A positive finding was that 85% of observed mathematics teaching incorporated differentiated activities based on assessment results, reflecting the constructivist idea of individualized learning. Teachers also provided immediate feedback after formative assessments, raising a culture of continuous improvement. However, the nature of this feedback varied, with some offering detailed insights into misconceptions, while others provided only numerical scores. The use of peer and self-assessment was observed, though it was not yet a widespread practice, suggesting room for further development in collaborative and reflective learning within the constructivist framework.

Document Analysis and Systemic Support

Analysis of lesson plans revealed inconsistent integration of formative assessment, with some teachers regularly incorporating it while others used it carefully. This variation reflects differing levels of alignment with constructivist principles, which advocate for ongoing assessment to guide instruction. Examination of curriculum documents highlighted a greater emphasis on summative assessments, with formative assessment practices not explicitly prioritized. This finding aligns with concerns raised by Kazinyirako et al. (2024), about the prevalence of traditional methods and is consistent with observations in Rwanda by who indicated that formative assessment practices were rarely planned in public secondary schools. The lack of explicit emphasis in curriculum guidelines may inadvertently steer teachers towards summative evaluations, potentially hindering student-centered, interactive learning. Furthermore, assessment records showed inconsistent record-keeping and data analysis, with some teachers effectively utilizing data to inform instruction while others underutilized this information. This suggests a varied adherence to the constructivist emphasis on reflective practices. Crucially, the document analysis revealed limited resources and programs for

teacher training in formative assessment, indicating a significant barrier to fully embracing constructivism due to a lack of necessary support and professional development opportunities.

The findings from this study provide valuable insights into the current state of formative assessment practices in mathematics education within Nyagatare District. Overall, the results are encouraging, as teachers demonstrated a strong awareness of formative assessment's importance and a commitment to its effective implementation. This aligns with research globally that highlights formative assessment's role in identifying learning weaknesses and strengths, enhancing motivation, and providing essential feedback (Mohammadi Zenouzagh et al., 2025). The active involvement of students in the learning process, raised through observed formative assessment strategies, is a key takeaway, promoting a student-centered approach crucial for deeper understanding. The use of a variety of formative assessment methods, including technology, is a positive finding that should be further encouraged. This consistency with the work of Nsabayezu et al. (2022) suggests that formative assessment helps students understand expectations, promotes independent learning, and even improves information retention.

However, the study also revealed critical areas for improvement, consistent with previous research in Rwanda (Kazinyirako et al., 2024). There is a clear need for targeted professional development to deepen teachers' knowledge and promote more refined implementation, particularly regarding the quality of questioning techniques and the consistency of feedback (Balbi et al., 2025). While teachers understand its importance, the observed variations in feedback quality (e.g., good work versus detailed comments) indicate room for growth in providing more descriptive and actionable input. Promoting the widespread use of peer and self-assessment is also essential, as these strategies actively engage students in their own learning and enhance critical thinking skills, aligning strongly with constructivist learning theory and self-regulated learning theory. Furthermore, addressing challenges such as large class sizes, limited resources, and time constraints is vital. Encouraging teachers to maintain detailed assessment records and utilize this data to inform instruction will lead to more effective formative assessment and improved learning outcomes. Ultimately, while mathematics teachers in Nyagatare District possess a basic understanding of formative assessment, enhancing awareness, addressing challenges, and promoting more effective strategies will significantly contribute to the overall quality of mathematics education in the region.

CONCLUSION

The comprehensive study, which included interviews, observations, and document analysis with 13 mathematics teachers in Nyagatare District, Rwanda, illuminated the current landscape of formative assessment practices in mathematics education. The findings indicate a positive progression towards more student-centered and formative assessment methodologies within classrooms. Teachers demonstrated openness to adjusting their instructional strategies to better address student needs, emphasizing continuous feedback and tailored learning experiences, marking a significant and promising development for mathematics education in the region.

Based on these valuable insights, the study recommends implementing targeted professional development programs for mathematics teachers in Nyagatare District to further hone their expertise in formative assessment techniques, focusing on a deep understanding and effective integration into daily teaching. Additionally, fostering collaborative and peer-learning opportunities among teachers is encouraged to promote shared best practices and continuous improvement. Finally, it is crucial to establish an ongoing system for monitoring and evaluating formative assessment practices across Nyagatare District, with the national examination and school inspection authority playing a key role in strengthening these practices in public secondary schools.

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