MODESTUM EURASIA Journal of Mathematics, Science and Technology Education, 2026, 22(8), em2889
ISSN:1305-8223 (online)
OPEN ACCESS Research Paper https://doi.org/10.29333/ejmste/19050

Towards sustainable feedback in secondary mathematics: Teachers' perspectives on informal assessment practices

Eric Machisi [1*], Sontaga Elliot Selepe [2], Mpho Gift Manamela [3]

[1] Department of Mathematics, Fujairah Boys School (Cycle 3), Fujairah, UNITED ARAB EMIRATES
[2] Department of Mathematics Education, College of Education, University of South Africa, Pretoria, SOUTH AFRICA
[3] Department of Educational Leadership and Management, Morwasethula Primary School, Mashashane, SOUTH AFRICA

Received 26 June 2026 ▪ Accepted 28 July 2026

Abstract

Providing meaningful feedback on informal mathematics assessment tasks is widely recognized as an important component of formative assessment, yet sustaining teacher-generated feedback remains challenging in many secondary school classrooms. This study examined secondary school mathematics teachers' perceptions and reported feedback practices associated with informal mathematics assessment tasks, with particular attention to the sustainability of teacher-generated feedback, shared feedback practices, and institutional approaches that support effective formative assessment. An embedded mixed-methods design was employed, in which quantitative questionnaire data from 60 secondary school mathematics teachers in four education districts of Limpopo Province, South Africa, constituted the primary data source, while qualitative responses to an open-ended questionnaire item were used to explain and contextualize the quantitative findings. Quantitative data were analyzed using descriptive statistics and non-parametric procedures, including Spearman's rank-order correlation, while qualitative data were analyzed thematically. The integrated findings indicate that teachers valued feedback and continue to rely primarily on teacher-generated written feedback despite recognizing that large class sizes, workload demands, and limited instructional time were associated with difficulties in sustaining these practices. Although teachers reported moderate use of self- and peer-assessment, they emphasized that learner participation requires teacher guidance, explicit marking criteria, and monitoring to ensure feedback quality. Participants further identified technology-enhanced formative assessment, context-sensitive marking policies, professional learning, and additional institutional support as important enablers of sustainable feedback. The study concludes that sustainable feedback is best understood as a shared and context-dependent process that emerges through the interaction of teacher practices, learner participation, contextual conditions, and institutional support. These findings contribute to the growing literature on sustainable feedback by extending discussions beyond feedback effectiveness to include its long-term feasibility within authentic secondary mathematics classrooms.

Keywords: formative assessment, informal mathematics assessment, sustainable feedback, shared feedback, mathematics education, embedded mixed methods

INTRODUCTION

Assessment is widely recognized as an essential component of effective teaching and learning because it provides evidence that informs instructional decisions and supports learners' academic development. Contemporary conceptions of assessment extend beyond its traditional role of measuring achievement to emphasize its formative purpose of generating evidence that teachers and learners use to improve teaching and learning (Black & Wiliam, 2018; Schildkamp et al., 2020). Rather than serving solely as a mechanism for grading or accountability, formative assessment enables teachers to identify learners' strengths and misconceptions, adapt

✉ e.machisi@yahoo.com **(*Correspondence)** ✉ eselepse@unisa.ac.za ✉ mphogiftbrain@gmail.com

Contribution to the literature

- This study extends research on formative assessment by shifting attention from the effectiveness of feedback to the sustainability of feedback practices in secondary mathematics classrooms.
- The study provides empirical evidence that sustaining meaningful feedback requires balancing teacher-generated feedback with learner participation, feedback literacy, and supportive institutional conditions within the practical realities of secondary mathematics classrooms.
- The study extends the conceptualization of sustainable feedback by demonstrating that meaningful feedback emerges through the interaction of teacher practices, learner participation, contextual conditions, and institutional support, with implications for mathematics assessment policy and practice.

instruction, and provide timely support while learning is still taking place. Consequently, assessment and instruction are increasingly viewed as complementary processes that work together to promote meaningful learning.

Central to the formative purpose of assessment is feedback. Feedback enables learners to compare their current understanding with intended learning goals, identify gaps in their learning, and determine appropriate actions for improvement (Hattie & Timperley, 2007; Wisniewski et al., 2020). For teachers, feedback provides valuable evidence of learners' developing understanding, enabling them to diagnose misconceptions, evaluate the effectiveness of instruction, and make informed pedagogical decisions. Meta-analytic evidence consistently demonstrates that effective feedback positively influences learner achievement, motivation, self-regulation, and engagement when it is timely, specific, and actively used by learners (Hattie & Timperley, 2007; Wisniewski et al., 2020). More recently, feedback has been reconceptualized as a dialogic process in which teachers and learners jointly interpret evidence of learning and use that evidence to improve future performance, rather than as information transmitted unidirectionally from teacher to learner (Boud & Molloy, 2013; Nicol, 2021; Winstone & Carless, 2019). This shift reflects broader developments in formative assessment that position learners as active participants in constructing and using feedback.

Within secondary mathematics classrooms, feedback assumes particular importance because learners' written responses reveal considerably more than whether answers are correct or incorrect. These written responses provide evidence of learners' conceptual understanding, procedural fluency, mathematical reasoning, use of mathematical representations, and problem-solving strategies. Consequently, mathematics teachers rely on learners' written work to diagnose misconceptions, identify incomplete reasoning, and provide guidance that promotes conceptual understanding rather than merely correcting errors (Luneta & Legesse, 2023). Such opportunities arise primarily through informal assessment practices, including classroom exercises, homework, worked examples, investigative activities, and other routine learning tasks embedded within everyday instruction. Unlike formal assessments, which primarily serve summative or certification purposes, informal assessment tasks generate continuous evidence of learning, enabling teachers to monitor learners' progress and provide timely support before misconceptions become entrenched. Their educational value therefore depends not only on the quality of the assessment tasks themselves but also on the quality, relevance, and timeliness of the feedback that accompanies them.

Despite widespread agreement regarding the educational value of formative feedback, an important tension has emerged within contemporary mathematics classrooms. Educational policies and curriculum expectations increasingly require teachers to provide regular, detailed, and individualized feedback on learners' work. However, comparatively little attention has been given to whether such expectations are realistically sustainable within teachers' everyday professional contexts. Secondary mathematics teachers often teach multiple classes, work with large numbers of learners, prepare lessons, fulfil administrative responsibilities, and meet curriculum coverage requirements while simultaneously being expected to provide meaningful feedback on substantial volumes of learners' written work. Providing high-quality feedback in mathematics is particularly demanding because evaluating learners' responses requires careful examination of mathematical reasoning, solution strategies, procedural accuracy, and conceptual understanding rather than simply checking the correctness of final answers. Consequently, the challenge facing secondary mathematics education is no longer whether feedback improves learning, but how meaningful feedback can be sustained within the practical realities of contemporary classrooms.

Recognition of this challenge has stimulated growing interest in sustainable approaches to feedback. Rather than asking how teachers can provide more feedback, recent scholarship has shifted attention towards how feedback can remain educationally valuable while also being feasible for teachers and productive for learners. Sustainable feedback extends traditional conceptions of formative assessment by emphasizing learners' capacity

to seek, interpret, generate, and use feedback beyond individual assessment events, thereby supporting their long-term development as independent learners (Boud & Soler, 2016; Carless & Boud, 2018). This perspective recognizes that meaningful feedback cannot depend exclusively on teachers' written comments but should progressively develop learners' capacity to evaluate the quality of their own work and that of their peers.

Closely related to sustainable feedback is the concept of feedback literacy, which refers to the understandings, capacities, and dispositions that enable learners to appreciate feedback, make informed evaluative judgments, manage the emotional dimensions of feedback, and use feedback to improve subsequent learning (Carless & Boud, 2018; Tai et al., 2018; Yan & Carless, 2022). Feedback literacy therefore shifts attention from what teachers provide to how learners engage with, interpret, and apply feedback in future learning situations. Together, sustainable feedback and feedback literacy provide complementary perspectives that move beyond teacher-centered models of feedback towards approaches in which responsibility for learning is increasingly shared among teachers, learners, and the wider educational environment. Such perspectives are particularly relevant in secondary mathematics classrooms, where learners benefit from opportunities to explain their reasoning, evaluate alternative solution strategies, identify misconceptions, and develop increasingly independent mathematical thinking.

Although previous research has established the educational value of formative feedback and highlighted the potential of learner participation through self-assessment and peer assessment, several important gaps remain. First, much of the literature has focused on the effectiveness of feedback in improving learning outcomes, while comparatively limited attention has been given to the sustainability of feedback within the realities of everyday classroom practice. Second, although learner engagement with feedback has received increasing scholarly attention, relatively little is known about secondary school mathematics teachers' perspectives on implementing sustainable feedback within routine classroom contexts. Third, existing research has typically examined teacher feedback, learner participation, workload, and assessment policy as separate areas of inquiry, resulting in limited understanding of how these factors interact to influence sustainable feedback practices in mathematics classrooms. Addressing these gaps is essential because feedback practices that are educationally desirable may not necessarily be feasible to implement consistently within the practical realities of schools.

The present study addresses these gaps by examining secondary school mathematics teachers' perspectives on feedback practices associated with informal assessment tasks. Guided by the complementary perspectives of sustainable feedback and feedback literacy, the study investigates teachers' current feedback practices, the contextual challenges affecting their sustainability, and teachers' perceptions of learner participation and institutional approaches that may support more sustainable feedback. By focusing on teachers' experiences of implementing feedback within everyday mathematics classrooms, the study contributes to a deeper understanding of how meaningful feedback can be sustained without compromising either educational quality or practical feasibility.

Accordingly, the study was guided by the following research questions (RQs):

1. What are secondary school mathematics teachers' current feedback practices and perceptions regarding informal assessment tasks?
2. To what extent are teachers' perceived contextual challenges associated with their reported feedback practices for informal mathematics assessment tasks?
3. How do secondary school mathematics teachers perceive shared feedback practices and institutional approaches for supporting sustainable feedback associated with informal assessment tasks?

Conceptual Framework

This study is guided by a conceptual framework that integrates principles from formative assessment, sustainable feedback, and feedback literacy to explain how meaningful feedback can be sustained within secondary mathematics classrooms. The framework recognizes that sustainable feedback is not determined by a single factor but emerges through the interaction of contextual conditions, supportive organizational structures, teachers' professional dimensions, learners' active engagement with feedback, and an interactive feedback process. Rather than conceptualizing feedback as a one-way transmission of information from teacher to learner, the framework views feedback as a collaborative and cyclical process in which teachers, learners, and schools share responsibility for improving learning.

The framework draws primarily on the concept of sustainable feedback proposed by Carless and Boud (2018), which emphasizes learners' capacity to seek, interpret, generate, and use feedback beyond individual assessment events, together with the complementary concept of feedback literacy, which highlights the knowledge, skills, and dispositions required for learners to engage productively with feedback (Carless & Boud, 2018; Tai et al., 2018; Yan & Carless, 2022). These perspectives are situated within the broader tradition of formative assessment, which positions assessment as an integral component of teaching and learning rather than merely a mechanism for measuring achievement (Black & Wiliam, 2018). Collectively, these perspectives suggest

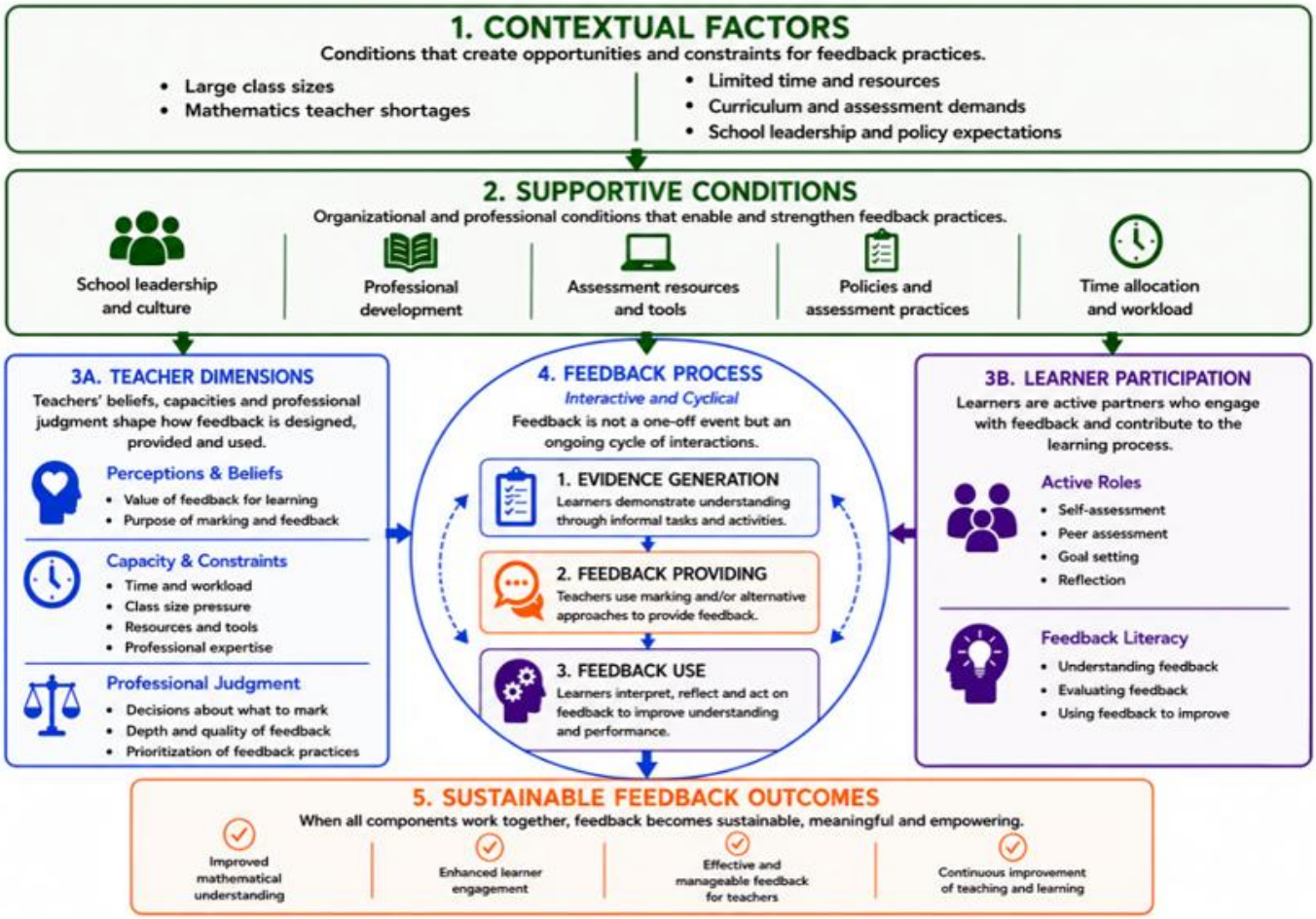

Figure 1. Conceptual framework for sustainable feedback practices in informal mathematics assessment (the authors' own conceptualization)

that sustaining meaningful feedback requires more than increasing the quantity of teacher-generated comments; it requires creating classroom environments in which learners progressively develop the capacity to evaluate their own work, engage constructively with peers, and use feedback to regulate future learning.

As illustrated in **Figure 1**, the framework comprises five interrelated dimensions that collectively explain how sustainable feedback is developed within informal mathematics assessment. The framework begins with contextual factors, which represent the broader educational conditions that create opportunities and constraints for classroom feedback practices. These include large class sizes, shortages of mathematics teachers, limited instructional time and resources, curriculum and assessment demands, and school leadership and policy expectations. Although these contextual factors do not directly determine teachers' feedback practices, they influence the conditions under which feedback is implemented and therefore shape the feasibility of sustaining meaningful feedback within everyday mathematics classrooms.

Building upon these contextual influences are supportive conditions, which represent the organizational and professional structures that enable effective feedback practices. These include supportive school leadership and culture, professional development, assessment resources and tools, assessment policies, and adequate time allocation. Together, these conditions strengthen teachers' capacity to implement feedback practices that are consistent with the principles of formative assessment and sustainable feedback. They also create learning environments that encourage learner participation and support the effective operation of the feedback process.

The third component of the framework comprises teacher dimensions, which encompass teachers' perceptions and beliefs about feedback, their professional capacity and constraints, and their professional judgment when implementing informal assessment. Teachers' beliefs about the value and purpose of feedback influence the approaches they adopt, while factors such as workload, class size, available resources, and professional expertise shape the depth and quality of feedback they can provide. Professional judgment further determines decisions regarding what should be assessed, the level of detail provided in feedback, and the prioritization of feedback practices within the realities of classroom teaching.

Complementing teacher dimensions is learner participation, which recognizes learners as active participants in the feedback process rather than passive recipients of teacher comments. This dimension includes learner engagement through self-assessment, peer assessment, goal setting, reflection, and the development of feedback literacy. By actively interpreting, evaluating, and using feedback, learners become increasingly capable of regulating their own learning, identifying misconceptions, and improving subsequent performance. Within mathematics classrooms, these opportunities encourage learners to justify mathematical reasoning, compare alternative solution strategies, and develop greater independence in mathematical thinking.

At the center of the framework is the feedback process, conceptualized as an interactive and cyclical sequence comprising evidence generation, feedback providing, and feedback use. The process begins when learners demonstrate their understanding through informal assessment tasks and classroom activities. Teachers then interpret this evidence and provide feedback using written comments, verbal interactions, or alternative feedback approaches. Learners subsequently interpret, reflect upon, and use this feedback to improve their understanding and future performance. Because this process is cyclical rather than linear, evidence generated from subsequent learning informs further feedback, thereby creating a continuous cycle of assessment, feedback, and improvement.

The interaction among contextual factors, supportive conditions, teacher dimensions, learner participation, and the feedback process gives rise to sustainable feedback outcomes. These outcomes include improved mathematical understanding, enhanced learner engagement, effective and manageable feedback for teachers, and the continuous improvement of teaching and learning. Within this framework, sustainable feedback is conceptualized as feedback that remains educationally meaningful while also being practically feasible for teachers and increasingly empowering for learners.

The conceptual framework informed the design and implementation of this study in several ways. First, it guided the development of the questionnaire by identifying the principal constructs investigated, including contextual factors, supportive conditions, teacher dimensions, learner participation, the feedback process, and sustainable feedback outcomes. Second, it informed the organization and interpretation of the qualitative themes by providing a conceptual lens through which teachers' experiences and perceptions were examined. Finally, the framework guided the integration of the quantitative and qualitative findings, enabling the study to examine how these interrelated dimensions collectively shape sustainable feedback associated with informal mathematics assessment. Consequently, the framework serves not only as the theoretical foundation of the study but also as the organizing structure that links the RQs, data collection, analysis, and interpretation of the findings.

METHODOLOGY

Research Design

This study adopted an embedded mixed-methods design in which a supplementary qualitative component was incorporated within a predominantly quantitative cross-sectional survey. The design was selected because the RQs required both numerical evidence of general patterns in teachers' perceptions and reported feedback practices and contextual explanations of how teachers experienced the demands of providing feedback on informal mathematics assessment tasks. In an embedded design, one form of data assumes a supportive role within a study primarily guided by another form of data, allowing the supplementary component to elaborate, contextualize, or extend the principal findings (Creswell & Plano Clark, 2025; Tashakkori & Teddlie, 2021).

The quantitative component constituted the principal strand of the study. Closed-end agreement and frequency items were used to examine teachers' perceptions of feedback, their reported classroom practices, the challenges associated with sustaining teacher-generated feedback, and their views on learner participation and school-level support. The embedded qualitative component consisted of responses to an open-ended question included in the same online questionnaire. This question allowed participants to describe experiences, concerns, and recommendations that could not be adequately captured through predetermined response categories (Creswell & Plano Clark, 2025).

Quantitative and qualitative data were therefore collected concurrently from the same participants through a single survey instrument. Qualitative responses were not obtained through separate interviews or a subsequent qualitative phase. Instead, they were embedded within the questionnaire to provide contextual depth and teacher-generated explanations of the quantitative patterns. This arrangement was appropriate because the qualitative component was intended primarily to explain, expand, and occasionally qualify the survey findings rather than constitute an independent strand of equal methodological priority (Creswell & Plano Clark, 2025).

The two components were initially analyzed separately. Quantitative responses were analyzed using descriptive and associational statistical procedures, while open-ended responses were examined thematically. Integration occurred after the separate analyses through comparison of the statistical patterns with the qualitative themes and participant explanations. The integration process considered

whether the qualitative evidence confirmed, expanded, qualified, or diverged from the quantitative results. These relationships were subsequently represented in a joint display and used to develop integrated interpretations concerning the sustainability of feedback practices (Fetters et al., 2013).

The embedded design was aligned with the RQs in the following manner. The quantitative component primarily addressed **RQ1** by describing teachers' perceptions and reported practices and **RQ2** by examining associations between perceived challenges and feedback practices. Both quantitative and qualitative evidence contributed to **RQ3**: closed-ended items captured the extent of teachers' support for shared and institutional feedback approaches, while the embedded qualitative responses explained the conditions under which teachers considered these approaches workable. The qualitative component also provided supporting explanations for patterns identified under **RQ1** and **RQ2**, particularly those concerning workload, large classes, learner involvement, and institutional support.

Because data were collected at one point in time and no variables were experimentally manipulated, the study was cross-sectional and non-causal. Statistical relationships were therefore interpreted as associations rather than evidence that one variable caused changes in another. The embedded qualitative responses were used to deepen the interpretation of these associations but not to establish causal explanations (Bryman, 2016).

Research Context

The study was conducted in four education districts within Limpopo Province, South Africa, namely Capricorn South, Sekhukhune East, Vhembe East, and Vhembe West. These districts comprise a diverse range of secondary schools that differ in geographical location, learner enrolment, resource availability, and teacher workloads. Such diversity provided an appropriate context for investigating mathematics teachers' feedback practices across varying school environments while maintaining a common provincial curriculum and assessment policy framework.

South African secondary school mathematics teachers are expected to assess learners continuously through both formal and informal assessment activities. While formal assessment tasks contribute to program-based assessment and reporting, informal mathematics assessment tasks refer to routine classroom activities that support day-to-day teaching and learning but do not necessarily contribute directly to learners' promotion marks. In the present study, informal mathematics assessment tasks included classwork, homework, practice exercises, investigations, quizzes used for formative purposes, correction activities, and other teacher-designed classroom tasks used to monitor learners' understanding and provide feedback.

Table 1. Distribution of secondary school mathematics teacher participants across selected Limpopo education districts

District	Participants (n)	Percentage (%)
Capricorn South	15	25.0
Sekhukhune East	22	36.7
Mopani West	20	33.3
Vhembe West	3	5.0
Total	**60**	**100**

Formal examinations, controlled tests, and officially moderated program-based assessment tasks were excluded because they are governed by separate assessment requirements and fulfill predominantly summative purposes.

The selected context was particularly appropriate for examining sustainable feedback because mathematics teachers routinely mark and provide feedback on large volumes of learners' informal written work while simultaneously managing curriculum coverage, administrative responsibilities, and diverse learner needs. These contextual conditions create practical challenges for sustaining timely, meaningful, and educationally valuable feedback and therefore provide a suitable setting for investigating teachers' perspectives on sustainable feedback associated with informal mathematics assessment.

Participants and Sampling

Four education districts (Capricorn South, Sekhukhune East, Mopani West, and Vhembe West) were randomly selected from the ten districts administered by the Limpopo Department of Basic Education. Following district selection, secondary schools within the selected districts were contacted, and school principals or Heads of Department were requested to circulate an invitation containing a link to the online questionnaire among mathematics teachers.

Purposive sampling was subsequently employed to identify the target participants, namely secondary school mathematics teachers who were actively teaching mathematics and were directly involved in assessing learners through informal mathematics assessment tasks. Teachers who met these inclusion criteria and voluntarily consented to participate completed the online questionnaire, resulting in a final sample of 60 secondary school mathematics teachers.

Since official records indicating the exact number of secondary school mathematics teachers within the selected districts were not publicly available, a response rate could not be calculated. Consequently, the number of participants obtained from each district reflected teachers' voluntary participation rather than proportional allocation across districts. **Table 1** summarizes the distribution of participants across the four selected districts.

Table 2. Alignment between the conceptual framework, questionnaire constructs, RQs, and data sources

Conceptual framework component	Questionnaire construct (item codes)	Research question(s)	Data source
Teacher dimensions	TD1–TD6	RQ1	Quantitative
Contextual factors	CF1–CF6	RQ2	Quantitative
Learner participation: Perceptions	LPP1–LPP3	RQ3	Quantitative
Learner participation: Practices	LPr1–LPr5	RQ3	Quantitative
Feedback process	FP1–FP2	RQ1 & RQ2	Quantitative
Supportive conditions	SC1–SC3	RQ3	Quantitative
Sustainable feedback outcomes	OQ1	RQ3	Embedded qualitative

Participants were responsible for teaching mathematics across grade 8-grade 12 and therefore met the inclusion criteria for the study. The sample comprised 40 male teachers (66.7%) and 20 female teachers (33.3%). With respect to teaching experience, 55.0% had between five and ten years of experience, 31.7% had fewer than five years, 8.3% had between 11 and 20 years, 3.3% had between 21 and 30 years, and 1.7% had more than 30 years of teaching experience. Including teachers with varying levels of professional experience enabled the study to capture perspectives from educators at different stages of their careers.

Although the sample comprised 60 participants, this was considered appropriate for the objectives of the study. The quantitative component was primarily descriptive and exploratory, focusing on identifying patterns and examining associations rather than estimating population parameters or testing complex predictive models. Furthermore, the qualitative component served an embedded explanatory role rather than an independent strand requiring saturation across multiple participant groups. Consequently, the sample was considered adequate to address the study's RQs within the context of an embedded mixed-methods design.

Instrument Development

Data were collected using a researcher-developed online questionnaire designed to investigate secondary school mathematics teachers' perspectives on sustainable feedback practices associated with informal mathematics assessment. The questionnaire was developed following an extensive review of the literature on formative assessment, sustainable feedback, feedback literacy, and classroom assessment practices in mathematics education (Black & Wiliam, 2018; Carless & Boud, 2018; Tai et al., 2018; Yan & Carless, 2022). The conceptual framework presented in **Figure 1** served as the principal guide for operationalizing the study constructs and developing the questionnaire items. Consequently, each item was designed to measure one or more components of the framework, thereby ensuring alignment between the theoretical foundations of the study, the RQs, the instrument, and the subsequent analyses.

To strengthen this alignment, questionnaire items were organized into six construct-based sections corresponding to the principal components of the conceptual framework. Each section was assigned a coding prefix to facilitate interpretation and to provide a transparent link between the conceptual framework, questionnaire items, RQs, and data analysis procedures. The questionnaire comprised demographic items (A1-A3), teacher dimensions (TD1-TD6), contextual factors (CF1-CF6), learner participation perceptions (LPP1-LPP3), learner participation practices (LPr1-LPr5), feedback process (FP1-FP2), supportive conditions (SC1-SC3), and one embedded open-ended question (OQ1) that enabled participants to elaborate on their experiences and recommendations regarding sustainable feedback practices.

The questionnaire incorporated multiple response formats appropriate to the constructs being measured. Demographic questions collected background information relating to participants' teaching experience, gender, and grade levels taught. Items measuring teachers' beliefs, contextual factors, and learner participation employed five-point Likert-type response scales ranging from strongly disagree to strongly agree. Items examining the frequency of classroom feedback practices used a five-point frequency scale (always, often, sometimes, rarely, and never), while questions concerning school support structures employed categorical response options (yes, no, and not sure). The final open-ended question provided participants with an opportunity to describe challenges, alternative approaches, and recommendations that could not be adequately captured through closed-ended items. The inclusion of this embedded qualitative component complemented the quantitative findings by providing contextual explanations and illustrative examples of teachers' experiences.

Table 2 presents the alignment between the conceptual framework, questionnaire items, and RQs. This mapping demonstrates how each construct investigated in the study was operationalized through specific questionnaire items and illustrates the way the conceptual framework informed instrument development and subsequent data analysis.

Validity, Pilot Testing, and Reliability

The questionnaire was developed following an extensive review of the literature on formative

assessment, teacher feedback practices, feedback literacy, and sustainable feedback in mathematics education. The questionnaire items were designed to reflect the principal constructs identified in previous research, including teachers' feedback beliefs, contextual factors influencing feedback practices, learner participation in assessment, teacher feedback practices, and institutional support for sustainable feedback. The conceptual framework presented in **Figure 1** further guided the organization of the questionnaire by ensuring that each construct investigated in the study was adequately represented through relevant questionnaire items. To enhance transparency, each questionnaire item was subsequently coded according to the construct it measured (e.g., TD: teacher dimensions and CF: contextual factors), thereby providing an explicit link between the conceptual framework, questionnaire, RQs, and data sources (**Table 2**).

Content validity was established through expert review. Five mathematics education specialists from South African universities independently evaluated the questionnaire for clarity, relevance, and representativeness using a four-point rating scale. The item-level content validity index ranged from 0.80 to 1.00, while the modified kappa statistic (κ^*) ranged from 0.76 to 1.00, indicating substantial to excellent agreement beyond chance regarding the relevance of the questionnaire items (Polit et al., 2007). In addition to assigning quantitative ratings, the reviewers provided written comments on the wording, sequencing, and clarity of individual items. Their recommendations informed revisions to ambiguous statements, improved the clarity of several questionnaire items, and strengthened the alignment between the instrument, the conceptual framework, and the research objectives.

Prior to the main study, the revised questionnaire was pilot tested with 11 secondary school mathematics teachers from a South African province other than Limpopo. These teachers possessed characteristics comparable to those of the target population but were excluded from the main study to avoid contamination of the research sample. The pilot study evaluated the clarity of questionnaire items, the suitability of the response formats, the logical sequencing of questions, and the estimated time required for completion. Feedback obtained during the pilot resulted in minor refinements to item wording and questionnaire instructions, while the overall structure and content of the instrument remained unchanged.

The internal consistency reliability of the questionnaire was evaluated using data obtained from the main study sample (N = 60) rather than the pilot participants. Reliability analysis was conducted on the two principal Likert-type sections of the original questionnaire because these sections were designed and validated as the instrument's primary measurement scales. The 15-item perception section demonstrated acceptable internal consistency (Cronbach's alpha = .78), exceeding the commonly recommended threshold of .70 (Nunnally & Bernstein, 1994). The eight-item practice section yielded a Cronbach's alpha coefficient of .61. Although this value is below the conventional benchmark of .70, Cronbach's alpha should be interpreted in relation to the nature and purpose of the scale rather than according to a single universal threshold (Taber, 2018). Unlike the perception section, which assessed relatively homogeneous beliefs about feedback, the practice section intentionally captured a diverse range of distinct classroom behaviors, including teacher-generated feedback, learner self- and peer-assessment, follow-up practices, written feedback, and the use of teaching assistants. High inter-item correlations were not necessarily expected because these practices represent complementary rather than interchangeable dimensions of classroom assessment. Consequently, the reliability coefficient was considered acceptable for an exploratory study investigating multidimensional classroom feedback practices (George & Mallery, 2024; Hair et al., 2019). Overall, the reliability analysis indicated that the questionnaire possessed adequate consistency to support the descriptive and associational analyses undertaken in this study.

To ensure structural alignment, the questionnaire items were organized around the study's primary conceptual framework to facilitate a clearer interpretation and integration of the findings. This conceptual grouping served an organizational and analytical purpose by demonstrating how the measured variables aligned with the theoretical constructs underpinning the study and was not intended to redefine the original psychometric scales on which the reliability analyses were based. Collectively, the evidence from the content validation process, pilot testing, and reliability analysis indicated that the questionnaire was appropriate for investigating secondary school mathematics teachers' perspectives on sustainable feedback practices associated with informal mathematics assessment. The complete revised questionnaire is provided in **Appendix A**.

Data Collection

Data were collected using the researcher-developed online questionnaire described in the previous section. Following the selection of the four education districts, the questionnaire link was distributed to eligible secondary school mathematics teachers through the official district communication channels. The invitation explained the purpose of the study, the voluntary nature of participation, the eligibility criteria, and the approximate time required to complete the questionnaire.

Before accessing the questionnaire, participants were provided with an information sheet explaining the

purpose of the study, the confidentiality of their responses, and their rights as research participants. Informed consent was obtained electronically before participants proceeded to complete the questionnaire. Participation was entirely voluntary, and teachers were free to withdraw from the study at any stage before submitting their responses. The questionnaire remained open throughout the data collection period, after which the completed responses were downloaded and prepared for quantitative and qualitative analysis.

A total of 60 secondary school mathematics teachers completed the questionnaire. The use of an online questionnaire enabled teachers from geographically dispersed districts to participate at a time convenient to them, thereby minimizing disruption to normal school activities while facilitating efficient data collection across multiple educational contexts.

Data Analysis

Consistent with the embedded mixed-methods design adopted in this study, quantitative and qualitative data were analyzed separately before being integrated during the interpretation stage. Quantitative analyses were conducted to examine teachers' perceptions, reported feedback practices, and the relationships among the principal study variables, while qualitative analyses were undertaken to provide contextual explanations of teachers' experiences, challenges, and recommendations regarding sustainable feedback practices. Integration of the two datasets occurred after the separate analyses to generate a more comprehensive understanding of sustainable feedback practices in secondary mathematics classrooms.

Quantitative data analysis

Quantitative questionnaire responses were analyzed using R version 4.5.1 Prior to the main analysis, the data were screened for completeness, response accuracy, and coding consistency. The internal consistency reliability of the principal Likert-type sections of the questionnaire was evaluated using Cronbach's alpha, as described in the previous section.

Descriptive statistics, including frequencies, percentages, means, and standard deviations, were computed to summarize teachers' demographic characteristics, perceptions of sustainable feedback, reported classroom feedback practices, contextual challenges, learner participation, and institutional support. To facilitate interpretation of the descriptive statistics, mean scores obtained from the five-point Likert scale were interpreted using predetermined intervals adapted from common Likert-scale conventions: 1.00-1.80 = strongly disagree; 1.81-2.60 = disagree; 2.61-3.40 = undecided; 3.41-4.20 = agree; and 4.21-5.00 = strongly agree. These intervals were used to ensure consistent interpretation of teachers' responses across all questionnaire items. These analyses addressed the first RQ by describing the patterns of teachers' perceptions and reported practices.

To investigate the second RQ, composite indices representing perceived workload challenges, teacher-generated feedback practices, and shared feedback practices were computed by averaging conceptually related questionnaire items. These indices were developed to facilitate the examination of relationships among the principal study variables and were not intended to represent new psychometric scales. Given the ordinal nature of the Likert-type responses, the relatively small sample size, and the absence of assumptions required for parametric correlation analyses, Spearman's rank-order correlation coefficient was used to examine associations among the study variables. Because the study employed a cross-sectional, non-experimental design, statistically significant relationships were interpreted as associations rather than evidence of causality.

Additional exploratory analyses were undertaken to examine whether perceived workload challenges differed across selected teacher characteristics. A Mann-Whitney U test was used to compare responses by gender, while a Kruskal-Wallis test was employed to examine differences across teaching experience categories. These analyses were intended to provide contextual insights into teachers' experiences rather than to establish causal or predictive relationships. Statistical significance was evaluated at the 5% level ($\alpha = .05$).

Qualitative data analysis

Qualitative responses to the embedded open-ended questionnaire item were analyzed using the six-phase thematic analysis approach proposed by Braun and Clarke (2006). The responses were read repeatedly to achieve familiarity with the data before initial codes were generated. Related codes were subsequently organized into candidate themes, which were reviewed, refined, defined, and named through an iterative process. The analysis was informed by the study's conceptual framework while remaining open to themes that emerged inductively from the data. Representative quotations were selected to illustrate each theme and were identified using participant codes (T1-T60) to preserve participants' anonymity.

Integration of Quantitative and Qualitative Findings

Following the separate analyses, the quantitative and qualitative findings were integrated during the interpretation stage. A joint display was constructed to compare quantitative patterns with qualitative themes, enabling the identification of areas of convergence, complementarity, and expansion between the two strands of evidence. The qualitative findings were used primarily to explain, elaborate, and contextualize the

Table 3. Teachers' perceptions of sustainable feedback practices associated with informal mathematics assessment tasks

Code	Statements	M	SD
Teacher dimensions			
TD1	Marking learners' informal mathematics tasks every day is necessary for effective learning.	4.03	1.15
TD2	I prefer giving learners verbal feedback rather than writing comments in their exercise books.	3.12	1.33
TD3	I prefer writing comments in learners' exercise books rather than providing only verbal feedback.	3.35	1.26
TD4	Written comments in learners' mathematics exercise books are necessary for effective feedback.	4.03	0.96
Contextual factors			
CF1	Marking all learners' informal mathematics tasks every day is challenging because of large class sizes.	4.18	1.02
CF2	Marking all learners' informal mathematics tasks every day is challenging due to my teaching workload.	3.90	1.05
CF3	Marking learners' informal mathematics tasks takes a lot of time that could be used for lesson planning and preparation.	3.28	1.24
CF4	School management pressures teachers to mark learners' informal mathematics tasks every day.	2.98	1.32
CF5	Learners and parents complain when mathematics exercise books are not checked or marked regularly.	3.20	1.29
CF6	I have no problem with school administrators checking learners' exercise books at any time to monitor marking and feedback.	3.78	1.39
Learner participation			
LPP1	Learners in grade 8-grade 12 can accurately mark their own informal mathematics tasks when using teacher-provided solutions or marking guidelines.	2.97	1.13
LPP2	Self-marking and peer-marking should be used as feedback strategies for informal mathematics tasks across grade 8-grade 12.	3.33	1.28
LPP3	Self- and peer-marking should be used only in higher grades (grade 10-grade 12).	3.38	1.32
Institutional support			
IS1	Teaching assistants should be used to support teachers by marking learners' informal mathematics tasks.	2.93	1.36
IS2	Schools should have clear marking and feedback policies that guide informal assessment practices.	3.63	1.26

Note. N = 60 & Responses were measured using a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree)

quantitative results, thereby generating integrated interpretations (meta-inferences) regarding the factors influencing sustainable feedback practices in secondary mathematics classrooms. This integration reflected the embedded mixed-methods design adopted in the study, in which the qualitative component served a supportive role by enriching the interpretation of the quantitative findings rather than functioning as an independent strand of equal methodological priority.

RESULTS

RQ1. What are secondary school mathematics teachers' perceptions and reported feedback practices associated with informal mathematics assessment tasks?

Descriptive statistics were first examined to understand teachers' perceptions and reported feedback practices associated with informal mathematics assessment tasks. **Table 3** presents teachers' perceptions measured on a five-point Likert scale, while **Table 4** summarizes the frequency with which teachers reported implementing selected feedback practices. The findings are presented according to the principal constructs of the conceptual framework.

Teachers' Perceptions of Feedback Practices

The findings presented in **Table 3** indicate that teachers generally recognized the educational importance of providing meaningful feedback through the marking of informal mathematics assessment tasks. Under the teacher dimensions construct, participants agreed that marking learners' informal mathematics tasks every day was necessary for effective learning (TD1; mean [*M*] = 4.03, standard deviation [*SD*] = 1.15) and that written comments in learners' exercise books were necessary for effective feedback (TD4; *M* = 4.03, *SD* = 0.96). However, teachers expressed mixed preferences regarding the mode of feedback delivery, with neither verbal feedback (TD2; *M* = 3.12, *SD* = 1.33) nor written feedback (TD3; *M* = 3.35, *SD* = 1.26) being clearly preferred over the other.

The contextual factors construct revealed that teachers perceived substantial barriers to sustaining regular feedback practices. Participants agreed that large class sizes (CF1; *M* = 4.18, *SD* = 1.02) and teaching workload (CF2; *M* = 3.90, *SD* = 1.05) made it difficult to mark all learners' informal mathematics tasks every day. Although teachers were less certain that marking reduced lesson preparation time (CF3; *M* = 3.28, *SD* = 1.24) or that school management exerted pressure to mark learners' work daily (CF4; *M* = 2.98, *SD* = 1.32), they generally accepted routine administrative monitoring of learners' exercise books (CF6; *M* = 3.78, *SD* = 1.39). Collectively, these findings indicate a clear tension between teachers' commitment to providing regular feedback and the contextual constraints that limit the consistent implementation of these practices.

Teachers' perceptions regarding learner participation were more cautious. Participants neither agreed nor

Table 4. Teachers' reported feedback practices associated with informal mathematics assessment tasks

Code	Statements	M	SD
Feedback practices			
FP1	How often do you thoroughly mark all learners' informal mathematics tasks (e.g., class activities, homework, and practice exercises)?	3.72	0.94
FP2	How often do you provide written comments in learners' exercise books when giving feedback?	3.87	1.00
Learner participation			
LPr1	How often do you ask learners to mark their own informal mathematics tasks using teacher-provided solutions or marking guidelines?	3.33	1.19
LPr2	How often do you ask learners to mark their peers' informal mathematics tasks using teacher-provided solutions or marking guidelines?	3.18	1.21
LPr3	How often do you teach learners how to mark their own or peers' informal mathematics tasks correctly?	3.28	1.13
LPr4	How often do you check learners' self-marked or peer-marked work to ensure that feedback is accurate?	3.55	1.03
LPr5	How often do you notice mistakes when learners mark their own or peers' mathematics tasks?	3.37	1.06
Institutional support			
IS3	How often are teaching assistants used to support the marking of learners' informal mathematics tasks?	1.33	0.79

Note. N = 60 & Responses were measured using a five-point frequency scale ranging from 1 (never) to 5 (always)

disagreed that learners across grade 8-grade 12 could accurately mark their own informal mathematics tasks using teacher-provided solutions or marking guidelines (LPP1; $M = 2.97$, $SD = 1.13$). Similarly, teachers expressed moderate support for the use of self- and peer-marking across all grades (LPP2; $M = 3.33$, $SD = 1.28$) and for limiting these practices to higher grades (LPP3; $M = 3.38$, $SD = 1.32$). These findings suggest that, although teachers recognized the potential value of learner participation in feedback processes, reservations remained regarding learners' readiness to generate accurate and reliable feedback independently.

Under the institutional support construct, teachers generally agreed that schools should establish clear marking and feedback policies to guide informal assessment practices (IS2; $M = 3.63$, $SD = 1.26$). However, participants expressed more neutral views regarding the use of teaching assistants to support the marking of learners' informal mathematics tasks (IS1; $M = 2.93$, $SD = 1.36$), suggesting uncertainty about the feasibility or availability of such support within their school contexts.

Teachers' Reported Feedback Practices

Teachers' reported classroom feedback practices are presented in **Table 4**. Under the feedback practices construct, participants reported that they frequently provided written comments in learners' exercise books (FP2; $M = 3.87$, $SD = 1.00$) and thoroughly marked learners' informal mathematics assessment tasks (FP1; $M = 3.72$, $SD = 0.94$). These findings indicate that teacher-generated feedback remained the predominant approach to supporting learners' understanding during informal assessment.

Within the learner participation construct, teachers reported occasional to moderate use of learner-centered feedback practices. Participants sometimes asked learners to mark their own work (LPr1; $M = 3.33$, $SD = 1.19$) or their peers' work (LPr2; $M = 3.18$, $SD = 1.21$), and they sometimes taught learners how to conduct self- and peer-marking correctly (LPr3; $M = 3.28$, $SD = 1.13$). Teachers also reported frequently checking learners' self- and peer-marked work for accuracy (LPr4; $M = 3.55$, $SD = 1.03$) and occasionally noticing inaccuracies in learners' marking (LPr5; $M = 3.37$, $SD = 1.06$). Together, these findings suggest that learner participation was incorporated into classroom feedback practices but remained dependent on teacher monitoring to maintain the accuracy and educational value of the feedback provided.

Consistent with teachers' perceptions, the Institutional Support construct showed that teaching assistants were rarely used to support the marking of learners' informal mathematics assessment tasks (IS3; $M = 1.33$, $SD = 0.79$). The limited availability of additional human support suggests that responsibility for providing feedback continued to rest primarily with classroom teachers.

RQ2. To what extent are teachers' perceived contextual challenges associated with their reported feedback practices for informal mathematics assessment tasks?

To address the second RQ, Spearman's rank-order correlation analysis was conducted to examine the associations between teachers' perceived contextual challenges and their reported feedback practices for informal mathematics assessment tasks. The contextual challenges construct comprised teachers' perceptions of workload, large class sizes, time demands, and related contextual constraints associated with providing feedback on informal mathematics assessment tasks. Because the study employed a cross-sectional, non-experimental design, the findings are interpreted as statistical associations rather than evidence of causal relationships.

Spearman's rho (ρ) provides information about both the direction and the strength of an association and was therefore interpreted as a measure of effect size. The sign of the coefficient (+ or -) indicates the direction of the

Table 5. Spearman rank-order correlations between perceived contextual challenges and reported feedback practices associated with informal mathematics assessment tasks

Variables	1	2	3
1. Perceived contextual challenges	-		
2. Teacher-generated feedback practices	-.346**	-	
3. Shared feedback practices	.214	-.370**	-

Note. N = 60; Values represent Spearman's rho (ρ) correlation coefficients; & p < .01

Table 6. Non-parametric comparisons of perceived contextual challenges across selected teacher characteristics

Variable	Test	Statistic	*p*
Gender	Mann-Whitney U	308.00	.144
Teaching experience	Kruskal-Wallis H	3.18	.529

Note. N = 60; Mann-Whitney U tests were used for two-group comparisons, and Kruskal-Wallis tests were used for comparisons involving more than two groups; Statistical significance was evaluated at $p < .05$

association, whereas its absolute value ($|\rho|$) indicates its strength. Following the guidelines proposed by Cohen (2013), absolute correlation coefficients of approximately .10, .30, and .50 were interpreted as representing weak, moderate, and strong associations, respectively. **Table 5** summarizes the Spearman rank-order correlations between perceived contextual challenges and the reported feedback practice constructs.

As shown in **Table 5**, the correlation analysis revealed a statistically significant moderate negative association between perceived contextual challenges and teacher-generated feedback practices ($\rho = -.346$, $p = .007$). This indicates that teachers who reported greater contextual challenges also tended to report less frequent use of teacher-generated feedback practices. Although the observed association does not imply that contextual challenges caused lower levels of teacher-generated feedback, it suggests that workload, large class sizes, time demands, and related contextual conditions were associated with less frequent implementation of these practices.

A statistically significant moderate negative association was also observed between teacher-generated feedback practices and shared feedback practices ($\rho = -.370$, $p = .004$). Teachers who reported more frequent use of teacher-generated feedback also tended to report less frequent use of shared feedback approaches, including self-assessment and peer assessment. Although this association does not indicate that the two approaches are mutually exclusive, it suggests that teachers tended to place greater emphasis on one approach than the other when organizing feedback associated with informal mathematics assessment tasks.

The association between perceived contextual challenges and shared feedback practices was positive but not statistically significant ($\rho = .214$, $p > .05$). This finding suggests that perceived contextual challenges alone were not associated with greater use of learner-centered feedback approaches. The implementation of shared feedback practices may therefore depend on additional conditions, including teachers' confidence in learner participation, learners' feedback literacy, the availability of clear marking guidelines, and institutional support for formative assessment.

Additional exploratory analyses were conducted to examine whether teachers' perceived contextual challenges differed across selected demographic characteristics. Given the ordinal nature of the questionnaire responses and the unequal group sizes, non-parametric tests were considered appropriate. A Mann-Whitney U test examined differences by gender, while a Kruskal-Wallis test compared teachers across teaching experience categories. **Table 6** summarizes the non-parametric comparisons of perceived contextual challenges across the selected teacher characteristics.

The Mann-Whitney U test indicated no statistically significant difference in perceived contextual challenges between male and female teachers ($U = 308.00$, $p = .144$). Similarly, the Kruskal-Wallis test showed no statistically significant differences across teaching experience groups ($H(4) = 3.18$, $p = .529$). These findings suggest that teachers experienced similar contextual challenges regardless of gender or years of teaching experience. Consequently, the challenges associated with sustaining feedback practices appear to reflect broader contextual conditions within secondary mathematics classrooms rather than differences associated with individual teacher characteristics.

RQ3. How do secondary school mathematics teachers perceive feedback practices and institutional approaches for supporting sustainable feedback associated with informal assessment tasks?

To address the third RQ, responses to the embedded open-ended questionnaire item were analyzed thematically to explore teachers' perceptions of shared feedback practices and institutional approaches for supporting sustainable feedback associated with informal mathematics assessment tasks. The qualitative analysis was undertaken to explain and expand the quantitative findings by providing teachers with an opportunity to describe their experiences, concerns, and recommendations in their own words. Three interrelated themes emerged from the analysis:

(a) challenges affecting the sustainability of teacher-generated feedback practices,

(b) learner involvement as a strategy for sustainable feedback, and

(c) the need for institutional support and context-sensitive feedback structures.

Although the themes are presented separately for clarity, they should be viewed as interconnected aspects of sustainable feedback. Together, they explain how teachers balanced the educational value of feedback with the practical realities of classroom implementation and identify classroom- and school-level approaches that may support more sustainable feedback practices. The qualitative findings are subsequently integrated with the quantitative results through a joint display to develop meta-inferences regarding sustainable feedback associated with informal mathematics assessment tasks.

Theme 1: Challenges to Sustaining Teacher-Generated Feedback Practices

Teachers consistently recognized the educational value of providing meaningful feedback on informal mathematics assessment tasks but questioned the sustainability of relying exclusively on teacher-generated written feedback under prevailing classroom conditions. Participants described large class sizes, heavy teaching workloads, limited instructional time, and administrative demands as major constraints that made it difficult to provide regular individualized feedback while maintaining the quality of teaching. These contextual challenges created tension between teachers' professional commitment to meaningful feedback and the practical realities of classroom implementation.

For example, T22 explained:

> "Due to high enrolment in our school, it is not easy to check every learner's book. Thus, peer marking is the only way out." (T22)

Similarly, T46 highlighted the influence of overcrowded classrooms on daily marking practices:

> "With a class of more than 70 learners in the classroom, it is not easy to mark and sign their books daily. It is important to have a teacher assistant to control learners' books while I teach and give them feedback." (T46)

Another participant described how competing instructional responsibilities affected the quality of both teaching and feedback:

> "I find it hard to prepare, teach, assess, give feedback, and control learners' books in one hour daily. Quality of teaching is compromised." (T55)

Collectively, these responses explain why teachers reported strong agreement that large class sizes, workload demands, and limited instructional time made regular marking difficult (**Table 3**). They also complement the quantitative finding of a moderate negative association between perceived contextual challenges and teacher-generated feedback practices (**Table 5**). Together, the quantitative and qualitative findings suggest that teachers did not question the educational value of feedback itself; rather, they questioned the sustainability of maintaining frequent teacher-generated written feedback under prevailing classroom conditions.

Theme 2: Learner Involvement as a Strategy for Sustainable Feedback

Teachers generally viewed learner involvement through self-assessment and peer assessment as a practical strategy for promoting more sustainable feedback practices. Participants recognized that involving learners in the feedback process could reduce teachers' marking workload while simultaneously encouraging learners to engage more actively with assessment. However, they consistently emphasized that learner participation should be supported by teacher guidance, monitoring, and clear marking criteria to ensure that the feedback remained accurate and educationally meaningful.

T25 explained:

> "In overcrowded classrooms, self-marking and peer-marking are valuable assessment strategies that reduce teacher workload, provide immediate feedback, and encourage learner participation. However, teachers should monitor the process." (T25)

Similarly, T8 highlighted the educational benefits of learner participation:

> "Learners learn from their own mistakes while marking their own activities and are rectifying mistakes during marking. They are also made aware of how marks are allocated." (T8)

Another participant described how technology could facilitate learner participation outside the classroom:

> "I am sending a memo of homework on the Maths WhatsApp group for learners to mark. It saves time in class, and then I answer any questions they may have." (T4)

Collectively, these responses complement the quantitative findings showing moderate support for self- and peer-marking as feedback strategies (**Table 3**) and moderate use of learner participation during classroom feedback practices (**Table 4**). They also

explain why teachers reported regularly checking learners' self- and peer-marked work despite encouraging learner participation. Rather than viewing shared feedback as a substitute for teacher involvement, participants perceived it as a collaborative approach that distributed responsibility for feedback while maintaining teacher oversight to safeguard the accuracy and educational value of the feedback provided.

Theme 3. Institutional Approaches for Supporting Sustainable Feedback

Teachers consistently recognized that sustainable feedback cannot be achieved through individual teacher effort alone. Participants emphasized that schools and education authorities have an important role in creating organizational conditions that enable teachers to provide meaningful feedback while managing the realities of secondary mathematics classrooms. Suggested institutional approaches included employing teaching assistants, developing context-sensitive marking policies, integrating educational technologies, and aligning feedback expectations with school circumstances.

T1 argued that additional human resources were necessary to support teachers' feedback responsibilities:

> "The department of basic education should hire teaching assistants on a permanent basis to help with marking. Alternatively, they should hire more mathematics teachers to reduce the teaching load for each teacher." (T1)

Other participants emphasized the need for clearer policy guidance. For example, T10 stated:

> "Policy on marking informal tasks is needed in schools." (T10)

Similarly, T15 argued that marking expectations should reflect the realities of different school contexts:

> "Policies of marking should be different for each school depending on the number of learners each school has." (T15)

Participants also identified technology as an important institutional resource for supporting sustainable feedback. T9 described how digital platforms could reduce teachers' marking workload while providing immediate feedback to learners:

> "I suggest we move to IT integration, where we use platforms like Google Classroom, where we can give learners multiple-choice questions and it marks and gives us analysis. That is what I use more frequently, and it makes my work much easier." (T9)

Collectively, these responses complement the quantitative findings showing teachers' support for clear school marking and feedback policies while also highlighting the limited availability of teaching assistants (**Table 3** & **Table 4**). The qualitative findings extend the quantitative results by identifying additional institutional approaches, including technology integration, context-sensitive policy development, and increased staffing, that were not fully captured through the closed-end questionnaire. Together, the quantitative and qualitative evidence suggests that sustainable feedback depends not only on teachers' classroom practices but also on institutional structures that enable the effective implementation of formative assessment.

Overall, the qualitative findings showed that teachers valued meaningful feedback but questioned the sustainability of relying exclusively on teacher-generated feedback under prevailing classroom conditions. Participants advocated for approaches that combine teacher guidance, learner participation, technological support, and context-sensitive institutional policies to support more sustainable feedback practices. These findings not only complement the quantitative results but also provide deeper insight into the contextual realities and organizational conditions that shape teachers' feedback practices. The following section integrates the quantitative and qualitative findings to develop meta-inferences regarding sustainable feedback associated with informal mathematics assessment tasks.

Integration of Quantitative and Qualitative Findings

The quantitative and qualitative findings were integrated to develop a more comprehensive understanding of secondary school mathematics teachers' perceptions and reported feedback practices associated with informal mathematics assessment tasks. Consistent with the embedded mixed-methods design, the quantitative findings constituted the primary strand of the study, whereas the embedded qualitative findings were used to explain, expand, and contextualize the statistical results. Integration occurred after the separate analyses through the development of a joint display that enabled comparison of findings from both strands and the generation of meta-inferences regarding sustainable feedback practices. **Table 7** summarizes the integrated findings.

The joint display demonstrates substantial convergence and complementarity between the quantitative and qualitative findings. The quantitative analyses identified broad patterns in teachers' perceptions, reported feedback practices, and perceived contextual challenges, whereas the qualitative findings explained how these patterns were shaped by the realities of secondary mathematics classrooms.

Table 7. Joint display of integrated quantitative and qualitative findings on sustainable feedback practices

Quantitative finding	Qualitative evidence	Meta-inference
Teachers strongly agreed that marking informal mathematics tasks is important and that written feedback supports learning.	Teachers acknowledged that marking helps monitor learner understanding and provides opportunities to address errors.	Teachers valued feedback as an important component of mathematics learning; however, maintaining consistent feedback required approaches that were realistic within classroom conditions.
Teachers reported that daily marking was challenging due to large class sizes and heavy workloads. Perceived contextual challenges were moderately negatively associated with teacher-generated feedback practices (ρ = -.346, p = .007).	"With a class of more than 70 learners in the classroom, it is not easy to mark and sign their books daily." (T46)	The expectation that teachers should provide frequent individual written feedback may become unsustainable when learner numbers and workload demands increase.
Teachers reported moderate use of self- and peer-marking strategies but expressed uncertainty regarding learners' ability to provide accurate feedback independently.	"Self-marking and peer-marking are valuable assessment strategies that reduce teacher workload, provide immediate feedback, and encourage learner participation. However, teachers should monitor the process." (T25)	Learner involvement may contribute to sustainable feedback practices, but effective implementation requires teacher guidance, learner training, and quality assurance mechanisms.
Teaching assistants were rarely available to support informal task marking (M = 1.33, SD = 0.79), although teachers expressed interest in additional support structures.	"The department of basic education should hire teaching assistants on a permanent basis to help with marking." (T1)	Sustainable feedback requires not only changes in classroom strategies but also institutional support systems that reduce excessive reliance on individual teachers.
Teachers supported the development of clearer marking and feedback policies.	"Policies of marking should be different for each school depending on the number of learners each school has." (T15)	Context-sensitive marking and feedback policies may help balance accountability expectations with the practical realities of secondary mathematics classrooms.

The qualitative evidence further extended the quantitative findings by identifying teacher guidance during learner participation, technology integration, additional staffing, and context-sensitive institutional policies as important conditions for implementing sustainable feedback practices. Collectively, these meta-inferences suggest that sustainable feedback is best understood as a shared responsibility involving teachers, learners, schools, and education authorities rather than as a practice that depends exclusively on individual teachers.

These integrated findings support the study's conceptual framework by demonstrating that sustainable feedback emerges through the interaction of teacher practices, contextual conditions, learner participation, and institutional support. The following discussion interprets these findings in relation to existing literature and the conceptual framework.

DISCUSSION

This study examined secondary school mathematics teachers' perceptions and reported feedback practices associated with informal mathematics assessment tasks, with particular attention to the sustainability of teacher-generated feedback and the potential contribution of shared feedback practices and institutional support. Drawing on an embedded mixed-methods design, the study integrated quantitative and qualitative evidence to develop a comprehensive understanding of how teachers balance the educational value of feedback with the practical realities of classroom implementation. Overall, the findings suggest that although teachers regarded meaningful feedback as an essential component of mathematics learning, sustaining traditional teacher-generated feedback was constrained by contextual challenges, including large class sizes, workload demands, and limited instructional time. The findings further indicate that sustainable feedback is more likely to be achieved through a combination of teacher guidance, learner participation, and supportive institutional conditions than through increased reliance on teacher-generated written feedback alone.

Teachers' Perceptions and Reported Feedback Practices Associated With Informal Mathematics Assessment Tasks

The findings indicate that secondary school mathematics teachers continue to view feedback as an essential component of effective teaching and learning. Teachers strongly valued providing feedback on informal mathematics assessment tasks and regarded written feedback as an important means of identifying

learners' misconceptions, monitoring mathematical understanding, and supporting improvement. However, the integrated findings suggest that teachers distinguish between marking learners' work and providing meaningful feedback. Although marking was widely perceived as an important professional responsibility, participants recognized that feedback is valuable only when it helps learners understand their errors, improve their mathematical reasoning, and apply that understanding to future tasks. This distinction reinforces contemporary perspectives that conceptualize feedback as an interactive process aimed at improving learning rather than simply correcting learners' work (Carless & Winstone, 2023; Winstone & Carless, 2019).

The findings extend previous research emphasizing feedback as one of the most influential components of formative assessment (Hattie & Timperley, 2007; Wisniewski et al., 2020). Whereas much of the existing literature has focused on the effectiveness of teacher feedback, the present study demonstrates that teachers also consider the sustainability of feedback practices when deciding how feedback should be provided in everyday mathematics classrooms. The integrated quantitative and qualitative findings suggest that teachers do not reject teacher-generated feedback; rather, they question the feasibility of relying exclusively on frequent individual written feedback under prevailing classroom conditions. This distinction contributes to the growing literature on sustainable feedback by highlighting that effective feedback should be evaluated not only in terms of its educational value but also in terms of its practical feasibility within authentic classroom contexts.

The findings further indicate that teachers were beginning to view learner participation as an important component of effective feedback rather than solely as a strategy for reducing marking workload. Teachers expressed moderate support for self-assessment and peer assessment while emphasizing that learner involvement should be accompanied by teacher guidance and clear marking criteria. This finding is consistent with contemporary perspectives on sustainable feedback, which position learners as active participants in feedback processes and emphasize the development of evaluative judgement and feedback literacy (Carless & Boud, 2018; Tai et al., 2018; Yan & Carless, 2022). It also aligns with evidence that well-structured peer assessment can improve learners' academic performance while promoting deeper engagement with learning (Double et al., 2020). Rather than replacing teachers' professional role, learner participation appeared to redistribute responsibility for feedback in ways that maintained teacher oversight while encouraging learners to engage more actively with mathematical learning.

Perceived Contextual Challenges and Their Associations With Teacher-Generated and Shared Feedback Practices

An important finding of this study was that teachers' perceived contextual challenges were moderately associated with their reported use of teacher-generated feedback practices. Although the cross-sectional design does not permit causal inferences, the integrated findings suggest that contextual conditions, including large class sizes, heavy teaching workloads, and limited instructional time, were associated with teachers' ability to sustain frequent teacher-generated feedback. Rather than reflecting a lack of commitment to providing feedback, these findings indicate that teachers were attempting to balance the educational benefits of detailed feedback with the practical demands of classroom teaching. This interpretation is consistent with sustainable feedback perspectives, which argue that effective feedback practices should be educationally valuable while remaining feasible within authentic teaching contexts (Boud & Soler, 2016; Winstone & Carless, 2019).

The findings are also consistent with previous studies reporting that increasing class sizes and workload demands reduce opportunities for teachers to provide timely and individualized feedback (Graham, 2023; Jerrim & Sims, 2021; West & Meier, 2020). However, the present study extends this literature by demonstrating that teachers themselves recognize the tension between maintaining traditional teacher-generated feedback and responding to contextual realities. The qualitative findings showed that teachers were not questioning the importance of feedback; instead, they questioned whether expectations for frequent individual marking were realistic under prevailing classroom conditions. This distinction is important because it shifts the focus from increasing the quantity of teacher-generated feedback towards identifying feedback practices that are both educationally meaningful and sustainable over time.

Interestingly, perceived contextual challenges were not significantly associated with teachers' reported use of shared feedback practices. This finding suggests that experiencing contextual challenges alone may not be sufficient to encourage teachers to adopt learner-centered feedback approaches. Instead, the qualitative findings indicate that teachers viewed successful implementation of shared feedback as dependent on additional conditions, including learners' feedback literacy, teacher confidence in learner participation, clear marking criteria, and supportive school environments. Together, these findings reinforce the view that sustainable feedback requires more than simply responding to workload pressures; it requires deliberate pedagogical and organizational strategies that enable

teachers and learners to share responsibility for feedback effectively.

Teachers' Perspectives on Shared Feedback Practices and Institutional Approaches for Supporting Sustainable Feedback

The integrated findings suggest that teachers viewed sustainable feedback as extending beyond individual classroom practices to include broader institutional approaches that support the effective implementation of formative assessment. Although participants recognized the educational value of teacher-generated feedback, they consistently argued that sustaining meaningful feedback requires shared responsibility among teachers, learners, schools, and education authorities. The qualitative findings highlighted several complementary approaches, including learner participation, context-sensitive marking policies, additional staffing, and technology integration, all of which were viewed as important for supporting sustainable feedback practices.

A notable finding was teachers' recognition of educational technology as a means of enhancing both efficiency and quality of feedback. Participants described using digital platforms, such as Google Classroom and WhatsApp, to distribute worked solutions, facilitate learner self-marking, provide immediate feedback, and reduce the time required for routine marking. Rather than replacing teachers' professional judgement, these technologies were perceived as supporting more efficient feedback processes while enabling teachers to focus on interpreting learners' misconceptions, providing targeted guidance, and facilitating mathematical discussion. This finding aligns with growing evidence that technology-enhanced formative assessment can improve the timeliness, accessibility, and responsiveness of feedback while reducing teachers' administrative workload (Bikanga Ada, 2023; Nicol, 2021). The findings therefore suggest that technology should be viewed not merely as a tool for automating marking but as an enabler of sustainable feedback systems that promote learner engagement and informed instructional decision-making.

The findings also highlight the importance of institutional support in creating conditions that enable sustainable feedback. Teachers' recommendations regarding teaching assistants, context-sensitive marking policies, and realistic workload expectations indicate that sustainable feedback cannot depend solely on individual teachers' commitment or efficiency. Similar concerns have been reported internationally, where excessive workload and the associated emotional demands have been identified as important contributors to teachers' intentions to leave the profession (McKay et al., 2022). Instead, effective feedback systems require organizational structures that recognize contextual differences across schools and provide teachers with appropriate resources and professional support. These findings extend previous work on sustainable assessment by demonstrating that the successful implementation of sustainable feedback depends not only on developing teachers' and learners' feedback capabilities but also on creating institutional environments that enable these practices to flourish.

Taken together, the integrated findings suggest that sustainable feedback should be conceptualized as a shared and context-dependent process rather than as the sole responsibility of individual teachers. While learner participation distributes responsibility for feedback within the classroom, institutional approaches, including supportive policies, digital technologies, professional learning opportunities, and additional human resources, provide the organizational conditions necessary for sustaining meaningful feedback practices over time.

Integrated Interpretation Through the Conceptual Framework

The integrated findings support the study's conceptual framework by demonstrating that sustainable feedback is shaped by the interaction of teacher-generated feedback practices, contextual conditions, learner participation, and institutional support rather than by any single dimension operating in isolation. Although teachers continued to value teacher-generated feedback as an important component of mathematics learning, the findings indicate that its long-term sustainability depends on the extent to which contextual constraints are addressed and learners are supported to participate actively in feedback processes. Sustainable feedback should therefore be viewed as a shared and context-dependent process that balances educational effectiveness with practical feasibility.

The study also extends the conceptual framework in several respects. While the original framework recognized institutional support as an enabling condition, the integrated findings highlight the importance of context-sensitive marking policies, technology-enhanced feedback, and additional human resources as specific institutional mechanisms that can support sustainable feedback practices. Similarly, although learner participation formed part of the original framework, the findings suggest that effective implementation depends on developing learners' feedback literacy through teacher guidance, explicit marking criteria, and structured opportunities for self- and peer-assessment. These findings demonstrate that institutional support and learner participation are not independent dimensions but mutually reinforcing components of sustainable feedback.

More broadly, the findings contribute to the international literature on sustainable feedback by demonstrating that the sustainability of feedback should

be evaluated not only in terms of its impact on learning but also in relation to its feasibility within authentic classroom contexts. Although the study was conducted with secondary school mathematics teachers in South Africa, many of the challenges identified, including increasing teacher workload, large classes, competing instructional demands, and sustaining meaningful formative feedback, have also been reported in diverse international education systems (Morris et al., 2023; OECD, 2025; Stovner et al., 2021). Consequently, the findings have broader relevance for education systems seeking to strengthen formative assessment while ensuring that feedback practices remain educationally meaningful, manageable, and sustainable.

Implications for Mathematics Teaching and Assessment Practice

The findings of this study have important implications for the development of sustainable feedback practices in secondary school mathematics classrooms. First, the findings suggest that feedback should be conceptualized as a shared learning process rather than solely as teacher-generated marking. Although teachers continued to value written feedback, the integrated findings indicate that sustainable feedback is more likely to be achieved when learners are actively engaged in feedback processes through structured self-assessment and peer assessment. Mathematics teachers should therefore create regular opportunities for learners to analyze worked solutions, identify misconceptions, evaluate mathematical reasoning, and use explicit marking criteria to improve subsequent performance. Such practices may strengthen learners' feedback literacy while allowing teachers to focus on providing targeted feedback where it is most needed.

Second, the findings highlight the importance of professional learning that supports teachers in implementing sustainable feedback practices. Professional development programs should extend beyond traditional approaches to marking and provide teachers with practical strategies for facilitating learner participation, developing evaluative judgement, using technology-enhanced formative assessment, and managing feedback efficiently in large mathematics classrooms. Strengthening teachers' pedagogical knowledge in these areas may enhance both the quality and sustainability of classroom feedback.

Third, the findings have important implications for school leaders and education authorities responsible for assessment policy and teacher support. The study suggests that sustainable feedback cannot depend solely on the efforts of individual teachers but requires institutional conditions that enable effective feedback practices. Schools should therefore develop context-sensitive marking and feedback policies that recognize variations in class size, workload, and available resources rather than adopting uniform expectations for all schools. Similarly, education authorities should consider providing additional support through professional learning opportunities, technology infrastructure, digital assessment platforms, and, where feasible, teaching assistants to help reduce excessive marking demands while maintaining the quality of formative assessment.

Finally, the findings have implications for initial teacher education and continuing professional development. Teacher education programs should prepare prospective mathematics teachers to implement shared feedback practices, cultivate learners' feedback literacy, and integrate digital technologies that support timely and meaningful feedback. Equipping teachers with these competencies from the beginning of their careers may contribute to the development of sustainable feedback practices that balance educational effectiveness with the practical realities of contemporary mathematics classrooms.

Limitations and Future Research

Although this study provides important insights into secondary school mathematics teachers' perceptions and reported feedback practices associated with informal mathematics assessment tasks, several limitations should be acknowledged. First, the study involved 60 secondary school mathematics teachers from four education districts in Limpopo Province. Although participants were drawn from multiple districts, participation was voluntary and district representation was uneven, with some districts contributing relatively few participants. Consequently, the findings should be interpreted as reflecting the perspectives of the participating teachers rather than as being statistically representative of all secondary school mathematics teachers in South Africa.

Second, the study relied on teachers' self-reported questionnaire responses. Although self-report data provide valuable insight into teachers' experiences and perceptions, they may not fully reflect actual classroom feedback practices because responses may be influenced by recall bias and social desirability bias. Future studies could strengthen the evidence base by combining questionnaires with classroom observations, teacher interviews, analyses of learners' written work, or other qualitative methods to triangulate teachers' reported practices.

Third, the study focused primarily on teachers' perceptions and reported practices and did not collect several contextual variables, including average class size, and teachers' academic qualifications. Although the findings identified contextual challenges as important influences on sustainable feedback, future research should examine how these and other school-level

characteristics shape teachers' feedback practices across different educational contexts.

Finally, the cross-sectional design provided a snapshot of teachers' perceptions and reported practices at a single point in time. Consequently, the findings should be interpreted as demonstrating associations rather than causal relationships among the study constructs. Longitudinal and intervention studies are needed to examine how sustainable feedback practices develop over time and how specific interventions influence teachers' feedback practices, learner feedback literacy, and mathematics learning outcomes.

Building on the findings of the present study, several directions for future research emerge. First, intervention studies should investigate the effectiveness of structured programs designed to develop learners' feedback literacy and teachers' capacity to facilitate shared feedback practices in secondary mathematics classrooms. Second, future research should examine the potential of technology-enhanced formative assessment, including digital feedback platforms and artificial intelligence-supported feedback tools, to improve the efficiency, quality, and sustainability of feedback practices. Third, comparative studies involving different provinces, countries, or education systems would provide valuable insight into how contextual and institutional factors influence sustainable feedback across diverse educational settings. Such research would contribute to the development of evidence-informed models of sustainable feedback that are both educationally effective and practically feasible across a range of mathematics education contexts.

CONCLUSION

This study examined secondary school mathematics teachers' perceptions and reported feedback practices associated with informal mathematics assessment tasks, with particular attention to the sustainability of teacher-generated feedback, shared feedback practices, and institutional approaches that support effective formative assessment. By integrating quantitative and qualitative evidence through an embedded mixed-methods design, the study provides a comprehensive understanding of how teachers experience the opportunities and challenges associated with providing meaningful feedback in secondary mathematics classrooms.

The findings demonstrate that teachers continue to regard feedback as an essential component of mathematics teaching and learning but question the sustainability of relying exclusively on frequent teacher-generated written feedback under prevailing classroom conditions. Rather than rejecting teacher-generated feedback, participants recognized the need to complement it with shared feedback practices that actively involve learners while maintaining teacher guidance and oversight. The study further highlights that sustainable feedback depends not only on classroom practices but also on supportive institutional conditions, including context-sensitive marking policies, professional learning, technology-enhanced formative assessment, and appropriate organizational support.

The study contributes to the growing literature on sustainable feedback by extending the discussion beyond effectiveness to include its long-term feasibility within authentic mathematics classrooms. The integrated findings support the conceptual framework by demonstrating that sustainable feedback emerges through the interaction of teacher practices, contextual challenges, learner participation, and institutional support. These interacting dimensions should therefore be considered collectively when designing policies and practices intended to strengthen formative assessment in mathematics education.

Ultimately, sustainable feedback should not be viewed as the sole responsibility of individual teachers. Instead, it should be understood as a collaborative and context-dependent process in which teachers, learners, schools, and education authorities share responsibility for creating feedback practices that are educationally meaningful, practically manageable, and capable of supporting learners' continued mathematical development.

Author contributions: EM: conceptualization, formal analysis, methodology, writing – original draft; **SES:** data curation, writing – original draft; **MGM:** supervision, writing – reviewing & editing. All authors agreed with the results and conclusions.

Funding: No funding source is reported for this study.

Ethical statement: This study was approved by the Limpopo Department of Education on 29 January 2026 with approval number 2/2/2. Participation was voluntary, informed consent was obtained from all participants prior to data collection, and participants' anonymity and confidentiality were maintained throughout the study. The research was conducted in accordance with accepted ethical principles for research involving human participants.

AI statement: The authors used Grammarly to proofread, improve coherence, and ensure grammatical accuracy. This tool was used to improve readability and uphold academic standards. The authors alone bear responsibility for the content, analysis, and interpretations presented.

Declaration of interest: No conflict of interest is declared by the authors.

Data sharing statement: Data supporting the findings and conclusions are available upon request from the corresponding author.

REFERENCES

Bikanga Ada, M. (2023). Evaluation of a mobile web application for assessment feedback. *Technology, Knowledge and Learning, 28*(1), 23-46. https://doi.org/10.1007/s10758-021-09575-6

Black, P., & Wiliam, D. (2018). Classroom assessment and pedagogy. *Assessment in Education: Principles, Policy & Practice, 25*(6), 551-575. https://doi.org/10.1080/0969594X.2018.1441807

Boud, D., & Molloy, E. (2013). Rethinking models of feedback for learning: The challenge of design. *Assessment & Evaluation in Higher Education, 38*(6), 698-712. https://doi.org/10.1080/02602938.2012.691462

Boud, D., & Soler, R. (2016). Sustainable assessment revisited. *Assessment & Evaluation in Higher Education, 41*(3), 400-413. https://doi.org/10.1080/02602938.2015.1018133

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77-101. https://doi.org/10.1191/1478088706qp063oa

Bryman, A. (2016). *Social research methods* (5th ed.). Oxford University Press.

Carless, D., & Boud, D. (2018). The development of student feedback literacy: Enabling uptake of feedback. *Assessment & Evaluation in Higher Education, 43*(8), 1315-1325. https://doi.org/10.1080/02602938.2018.1463354

Carless, D., & Winstone, N. (2023). Teacher feedback literacy and its interplay with student feedback literacy. *Teaching in Higher Education, 28*(1), 150-163. https://doi.org/10.1080/13562517.2020.1782372

Cohen, J. (2013). *Statistical power analysis for the behavioral sciences*. Routledge. https://doi.org/10.4324/9780203771587

Creswell, J. W., & Plano Clark, V. L. (2025). *Designing and conducting mixed methods research* (4th ed.). SAGE.

Double, K. S., McGrane, J. A., & Hopfenbeck, T. N. (2020). The impact of peer assessment on academic performance: A meta-analysis of control group studies. *Educational Psychology Review, 32*, 481-509. https://doi.org/10.1007/s10648-019-09510-3

Fetters, M. D., Curry, L. A., & Creswell, J. W. (2013). Achieving integration in mixed methods designs – Principles and practices. *Health Services Research, 48*(6pt2), 2134-2156. https://doi.org/10.1111/1475-6773.12117

George, D., & Mallery, P. (2024). *IBM SPSS statistics 29 step by step: A simple guide and reference*. Routledge. https://doi.org/10.4324/9781032622156

Graham, M. A. (2023). Overcrowded classrooms and their association with South African learners' mathematics achievement. *African Journal of Research in Mathematics, Science and Technology Education, 27*(2), 169-179. https://doi.org/10.1080/18117295.2023.2244217

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2019). *Multivariate data analysis* (8th ed.). Cengage Learning.

Hattie, J., & Timperley, H. (2007). The power of feedback. *Review of Educational Research, 77*(1), 81-112. https://doi.org/10.3102/003465430298487

Jerrim, J., & Sims, S. (2021). When is high workload bad for teacher wellbeing? Accounting for the non-linear contribution of specific teaching tasks. *Teaching and Teacher Education, 105*, Article 103395. https://doi.org/10.1016/j.tate.2021.103395

Luneta, K., & Legesse, M. (2023). Discourse-based mathematics instruction on grade 11 learners' mathematical proficiency in algebra topics. *Pythagoras, 44*(1), Article a686. https://doi.org/10.4102/pythagoras.v44i1.686

McKay, A., Bright, D., Kim, M., Longmuir, F., & Magyar, B. (2022). 'I cannot sustain the workload and the emotional toll': Reasons behind Australian teachers' intentions to leave the profession. *Australian Journal of Education, 66*(2), 196-209. https://doi.org/10.1177/00049441221086654

Morris, R., Gorard, S., See, B. H., & Siddiqui, N. (2023). Can a code-based approach to marking and feedback reduce teachers' workload? An evaluation of the FLASH marking intervention. *Oxford Review of Education, 50*(4), 552-569. https://doi.org/10.1080/03054985.2023.2258779

Nicol, D. (2021). The power of internal feedback: Exploiting natural comparison processes. *Assessment & Evaluation in Higher Education, 46*(5), 756-778. https://doi.org/10.1080/02602938.2020.1823314

Nunnally, J. C., & Bernstein, I. H. (1994). *Psychometric theory* (3rd ed.). McGraw-Hill.

OECD. (2025). *Results from TALIS 2024: The state of teaching*. OECD Publishing. https://doi.org/10.1787/90df6235-en

Polit, D. F., Beck, C. T., & Owen, S. V. (2007). Is the CVI an acceptable indicator of content validity? Appraisal and recommendations. *Research in Nursing & Health, 30*(4), 459-467. https://doi.org/10.1002/nur.20199

Schildkamp, K., van der Kleij, F. M., Heitink, M. C., Kippers, W. B., & Veldkamp, B. P. (2020). Formative assessment: A systematic review of critical teacher prerequisites for classroom practice. *International Journal of Educational Research, 103*, Article 101602. https://doi.org/10.1016/j.ijer.2020.101602

Stovner, R. B., Klette, K., & Nortvedt, G. A. (2021). The instructional situations in which mathematics teachers provide substantive feedback. *Educational Studies in Mathematics, 108*(3), 533-551. https://doi.org/10.1007/s10649-021-10065-w

Taber, K. S. (2018). The use of Cronbach's alpha when developing and reporting research instruments in science education. *Research in Science Education, 48*(6), 1273-1296. https://doi.org/10.1007/s11165-016-9602-2

Tai, J., Ajjawi, R., Boud, D., Dawson, P., & Panadero, E. (2018). Developing evaluative judgement: Enabling students to make decisions about the quality of work. *Higher Education, 76*(3), 467-481. https://doi.org/10.1007/s10734-017-0220-3

Tashakkori, A., & Teddlie, C. (2021). *SAGE handbook of mixed methods in social and behavioral research*. SAGE.

West, J., & Meier, C. (2020). Overcrowded classrooms – The Achilles heel of South African education? *South African Journal of Childhood Education, 10*(1), Article a617. https://doi.org/10.4102/sajce.v10i1.617

Winstone, N., & Carless, D. (2019). *Designing effective feedback processes in higher education: A learning-focused approach* (1st ed.). Routledge. https://doi.org/10.4324/9781351115940

Wisniewski, B., Zierer, K., & Hattie, J. (2020). The power of feedback revisited: A meta-analysis of educational feedback research. *Frontiers in Psychology, 10*. https://doi.org/10.3389/fpsyg.2019.03087

Yan, Z., & Carless, D. (2022). Self-assessment is about more than self: The enabling role of feedback literacy. *Assessment & Evaluation in Higher Education, 47*(7), 1116-1128. https://doi.org/10.1080/02602938.2021.2001431

APPENDIX A: QUESTIONNAIRE ITEMS

Towards Sustainable Feedback in Secondary School Mathematics: Teachers' Perspectives on Informal Assessment Practices

Instructions: Please answer each question honestly based on your current classroom practice. All responses will be treated confidentially and used for research purposes only.

Table A1. Questionnaire items

Section A: Demographic information						
Code	Question	Response				
A1	Which grade(s) do you currently teach? (grades 8-12) (select all that apply)	⊙8 ⊙9 ⊙10 ⊙11 ⊙12				
A2	Teaching experience (in years)	⊙<5 ⊙5-10 ⊙11-20 ⊙21-30 ⊙>30				
A3	Gender	⊙Male ⊙Female ⊙Prefer not to say				
Section B: Teacher dimensions (TD) (response scale: SD: strongly disagree, D: disagree, U: undecided, A: agree, SA: strongly agree)						
Code	Statement	SD	D	U	A	SA
TD1	Daily marking of learners' informal mathematics tasks is necessary.	⊙	⊙	⊙	⊙	⊙
TD2	I prefer to provide learners with verbal feedback rather than written feedback.	⊙	⊙	⊙	⊙	⊙
TD3	I prefer to provide learners with written feedback rather than verbal feedback.	⊙	⊙	⊙	⊙	⊙
TD4	Writing comments or remarks in learners' exercise books while marking informal tasks is necessary.	⊙	⊙	⊙	⊙	⊙
TD5	Teaching assistants should be responsible for marking learners' informal mathematics tasks.	⊙	⊙	⊙	⊙	⊙
TD6	A school marking and feedback policy specifying how frequently learners' informal tasks should be marked is required.	⊙	⊙	⊙	⊙	⊙
Section C: Contextual factors (CF) (response scale: SD: strongly disagree, D: disagree, U: undecided, A: agree, SA: strongly agree)						
Code	Statement	SD	D	U	A	SA
CF1	Large class sizes make daily marking of learners' informal tasks difficult.	⊙	⊙	⊙	⊙	⊙
CF2	My workload makes daily marking of learners' informal tasks difficult.	⊙	⊙	⊙	⊙	⊙
CF3	Marking learners' informal tasks reduces the time available for lesson planning and preparation.	⊙	⊙	⊙	⊙	⊙
CF4	School management expects me to mark learners' informal tasks every day.	⊙	⊙	⊙	⊙	⊙
CF5	Learners and/or parents complain when feedback on informal tasks is delayed.	⊙	⊙	⊙	⊙	⊙
CF6	I have no problem with school administration requesting samples of learners' exercise books.	⊙	⊙	⊙	⊙	⊙
Section D: Learner participation (response scale: SD: strongly disagree, D: disagree, U: undecided, A: agree, SA: strongly agree)						
Code	Statement	SD	D	U	A	SA
LPP1	Learners at all grade levels (grades 8-12) can accurately mark their own informal mathematics tasks.	⊙	⊙	⊙	⊙	⊙
LPP2	Self- and peer-marking should be used across all grade levels (grades 8-12).	⊙	⊙	⊙	⊙	⊙
LPP3	Self- and peer-marking should only be used in grades 10-12.	⊙	⊙	⊙	⊙	⊙
Response scale: N: never, R: rarely, S: sometimes, O: often, A: always						
Code	Practice item	N	R	S	O	A
LPr1	How frequently do you ask learners to mark their own informal mathematics tasks?	⊙	⊙	⊙	⊙	⊙
LPr2	How frequently do you ask learners to mark their peers' informal mathematics tasks?	⊙	⊙	⊙	⊙	⊙
LPr3	How often do you teach learners how to conduct self- and peer-marking?	⊙	⊙	⊙	⊙	⊙
LPr4	How often do you follow up learners' self- and peer-marking to correct inaccuracies?	⊙	⊙	⊙	⊙	⊙
LPr5	How frequently do you observe inaccuracies in learners' self- and peer-marking?	⊙	⊙	⊙	⊙	⊙

Table A1 (Continued).

Section E: Feedback process (FP) (response scale: N: never, R: rarely, S: sometimes, O: often, A: always)						
Code	Practice item	N	R	S	O	A
FP1	How often do you thoroughly mark learners' informal mathematics tasks?	⊙	⊙	⊙	⊙	⊙
FP2	How frequently do you leave written comments or remarks in learners' exercise books?	⊙	⊙	⊙	⊙	⊙
Section F: Supportive conditions (SC)						
Code	Question	Response				
SC1	Does your school have teaching assistants who help teachers mark learners' informal mathematics tasks?	⊙Yes ⊙No ⊙Not sure				
SC2	How often do teaching assistants mark learners' informal mathematics tasks?	⊙Always ⊙Often ⊙Sometimes ⊙Rarely ⊙Never ⊙Not applicable				
SC3	Does your school have a marking and feedback policy for informal mathematics tasks?	⊙Yes ⊙No ⊙Not sure				
Section G: Embedded qualitative question						
Code	Question					
OQ1	Please provide any additional comments, perspectives or suggestions regarding sustainable feedback practices associated with informal mathematics assessment.					