Optimizing Classroom Engagement in National Certificate (Vocational) Mathematics: A Framework for Questioning Techniques

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Abstract: This study develops and tests a questioning model aimed at enhancing interactive engagement in financial mathematics instruction within a single NC(V) Level 2 classroom. Grounded in formative assessment principles, the model incorporates structured and open-ended questions to foster procedural and conceptual understanding. The intervention used real-world financial scenarios like budgeting and loan repayments to make abstract concepts more relatable. Data were collected through classroom observations and a preparatory examination to evaluate student engagement and understanding. The findings indicate that consistent questioning fosters active participation, while higher-order questions promote critical thinking and real-world application. While performance improvements were noted, the primary focus was on engagement quality rather than academic outcomes. This study offers insights into how questioning strategies can enhance interactive learning in vocational education. Future research should expand the model to other subjects, gather student feedback, and integrate advanced digital tools for deeper interactivity.

Keywords: *Questioning Techniques, Interactive Engagement, Formative Assessment, Financial Mathematics*

INTRODUCTION

Globally, education systems are tasked with creating a workforce that is adaptable and equipped to meet the evolving demands of the labor market. Vocational education, particularly through Technical and Vocational Education and Training (TVET) institutions, is recognized as a crucial mechanism for bridging the gap between education and employment, providing students with the relevant skills and competencies required by industries worldwide (Venkatraman et al., 2018). Disparities between developed and developing countries regarding resources and infrastructure challenge the effectiveness of these educational frameworks. While developing countries grapple with limited resources in TVET classrooms, developed nations face the challenge of continuously updating curricula, laboratories, and equipment to keep pace with the 5th Industrial Revolution (Al-Ismail et al., 2023).

In South Africa, TVET colleges are essential in addressing unemployment and closing the skills gap by offering industry-relevant training that prepares students for direct entry into the workforce (Ramaligela, 2022). One of the key qualifications provided by these colleges is the National Certificate (Vocational) [NC(V)], spanning three levels, each typically completed in one year. Within the NC(V) engineering program, mathematics is central to understanding other engineering disciplines and is a fundamental subject (Siddiqi, 2017).

A significant challenge that compounds these issues is the low completion rates in NC(V) qualifications, particularly in foundational subjects like mathematics. Reports indicate that students enrolled in NC(V) qualifications in 2019 had a completion rate of just 10.8% by 2021, with engineering programs showing an even lower rate of 5.7% (Khuluvhe, 2023). Moreover, Ngoveni (2018) reported that only 15.4% of NC(V) Level 2 mathematics students who enrolled in 2016 passed their final exams. These statistics highlight the need to address fundamental gaps in the program, especially in Level 2 mathematics (Financial Mathematics), which lays the groundwork for many technical skills essential in the workplace (Lago & DiPerna, 2010).

The reliance on traditional teaching methods, such as the "banking" approach where students passively receive information, further exacerbates the problem. This method limits students' engagement and fails to connect mathematical concepts to real-life applications, which is crucial for vocational training (Vimbelo & Bayaga, 2023). Teachers often fail to expose students to diverse representations of mathematical concepts, hindering deep understanding (Sehole et al., 2023). The effectiveness of mathematics instruction at TVET colleges is hampered by the reliance on traditional teaching methods and textbooks, highlighting the need for innovative teaching strategies that connect mathematical concepts to practical applications and enhance students' understanding and retention of mathematical knowledge (Adelabu & Pharamela, 2024).

Given this context, effective questioning techniques become increasingly relevant, as they can actively engage students, enhance comprehension, and foster a more interactive learning environment (Machaba & Mangwiro, 2024). Although the benefits of effective questioning in promoting student engagement and understanding are well documented across various educational settings, research on their specific application within NC(V) mathematics at TVET colleges remains limited.

This gap is particularly pronounced in financial mathematics, a foundational subject in vocational education that equips students with essential skills for navigating real-world financial situations, including budgeting, interest calculations, and loan repayments. However, the abstract nature of financial mathematics and reliance on passive teaching methods often lead to disengagement and poor conceptual understanding among students. To address this issue, this study proposes an interactive framework for questioning techniques designed to enhance student engagement and improve learning outcomes within the National Certificate (Vocational) Mathematics curriculum. By integrating structured questioning strategies that encourage critical thinking and real-world application, the study aims to bridge this gap and provide empirical insights that can inform and improve teaching practices in South African TVET colleges (Mahmud & Mohd Drus, 2023; Mauigoa-Tekene, 2023; Dahal, 2022; Røed et al., 2023).

The research question guiding this study is thus: "What interactive framework for questioning can be proposed to enhance engagement and learning outcomes in the National Certificate (Vocational) Mathematics curriculum at TVET colleges?"

CONCEPTUAL FRAMEWORK

The conceptual framework used in this study incorporates one of the five strategies for understanding formative assessment, as outlined in the study "Developing a Theory for Formative Assessment" (Black & Wiliam, 2009). This strategy is also recognized as a pillar of effective formative assessment in Ngoveni's (2024) research. In Ngoveni's (2024) work, two indicators were drawn from the literature and applied as benchmarks to achieve this pillar.

Pillar: Monitoring: Posing Questions That Inform Teaching

This pillar emphasizes the role of well-crafted questioning in fostering an interactive learning environment where formative assessment is integral to teaching and learning (Black & Wiliam, 2009). Adapting to NC(V) emphasizes creating responsive teaching dynamics with evaluative and instructional questions (Wiliam, 2011a).

Indicators of Monitoring: Posing Questions That Inform Teaching:

1. Engaging Students in Educational Encounters Through Consistent Questioning

Consistent questioning methods are crucial in engaging students by encouraging active participation and providing educators with immediate feedback to adjust teaching strategies (Heritage, 2007). Continuous, high-quality questioning fosters deeper comprehension and knowledge retention while promoting a dialogic and interactive learning environment (Cowie & Bell, 1999).

2. Questioning Techniques Used to Gather Evidence of Procedural and Conceptual Knowledge

Effective questioning techniques go beyond rote responses, involving open-ended and probing questions that assess students' deeper conceptual understanding and procedural knowledge (Ziyaeemehr, 2016). Such questions enhance cognitive engagement and improve learning outcomes (Mangwiro & Machaba, 2022), especially in vocational education, where the practical application of knowledge is critical. This indicator and consistent questioning will guide the design of the questioning model used during the intervention, ensuring it assesses and deepens procedural and conceptual knowledge (Martino & Maher, 1999; Ngoveni, 2024).

How the Framework Supports the Study and its Implication for NC(V) Mathematics

The conceptual framework supports the study's goal of developing an interactive questioning model to enhance student engagement and learning outcomes in NC(V) Mathematics at TVET colleges. Grounded in the two key indicators, the framework ensures that questioning techniques are aimed at engaging students and assessing their procedural and conceptual understanding. The intervention, designed around consistent and open-ended questions, allows for real-time formative assessment, enabling educators to adjust their teaching strategies based on immediate student feedback. By comparing the performance of students who received the intervention with those who did not, the study evaluates the effectiveness of the questioning model (Heritage, 2007).

This framework also highlights the relevance of questioning techniques in vocational education, aligning with labor market needs by focusing on the practical application of mathematical concepts (Boaler & Brodie, 2004). The findings will inform professional development programs, emphasizing questioning as a pedagogical tool for vocational educators (Fisher & Frey, 2014). The study improves teaching practices by embedding these techniques into the NC(V) curriculum, ensuring students are better prepared to apply their knowledge in real-world contexts.

LITERATURE REVIEW

This section explores the role of questioning techniques in mathematics education, their impact on student engagement and learning, challenges in implementation within the NC(V) context, and the potential of mobile learning as a complementary tool for enhancing interactive engagement.

The Role of Questioning Techniques in Mathematics Education

Questioning techniques in mathematics education are pivotal for enhancing student learning and engagement. Effective questioning assists teachers in assessing students' understanding, promotes critical thinking, and guides the learning process. However, the literature indicates that many educators do not consistently use these techniques to gather essential learning evidence, a strategy known as planned formative assessment (Ngoveni & Machaba, 2024). This approach involves the deliberate preparation and execution of tasks to measure intended learning outcomes

(Cowie & Bell, 1999; Wiliam, 2011a). Effective questions should stimulate thinking and provide data that informs teaching, integrating skills required by the evolving labor market (Venkatraman et al., 2018; Mangwiro & Machaba, 2022). Gholami (2024) found that while traditional teaching often emphasizes routine exercises, collaborative approaches such as the Lesson Study program significantly enhance lecturers' pedagogical knowledge and improve students' problem-solving and higher-order thinking skills. This aligns with the argument that effective questioning techniques should extend beyond procedural recall to promote deep conceptual understanding and critical engagement in mathematics.

These contemporary insights highlight the importance of teacher-student interactions and peer collaboration in deepening conceptual understanding and skill development. In formative assessment, dialogue, feedback, and collaborative learning are crucial in shaping students' knowledge construction (Mercer & Littleton, 2007; Yu, 2023). Building on this, Khusna et al. (2024) emphasize that incorporating non-routine mathematical problems, particularly those requiring justification and graphical analysis, enhances students' critical thinking abilities. Their findings suggest that structured peer discussions, where students exchange ideas, assess reasoning, and refine solutions, foster deeper cognitive engagement and promote more effective problem-solving strategies.

Strategies for Effective Formative Assessment

To maximize the effectiveness of formative assessments, educators should employ various techniques to regularly evaluate student progress. These include classroom discussions, relevant questions, and tracking tasks (Fisher & Frey, 2014; Heritage, 2007). Multiple response formats, such as verbal, written, electronic, and visual, coupled with effective questioning strategies like open-ended questions and adequate wait time, can enhance student engagement and deepen their understanding (Boaler & Brodie, 2004).

Challenges in Implementing Effective Questioning Techniques

Despite the well-documented benefits of effective questioning, there remains a significant gap in developing targeted intervention strategies within the NC(V) mathematics context. The effectiveness of mathematics instruction at TVET colleges is often hampered by the reliance on traditional teaching methods and textbooks (Adelabu & Pharamela, 2024). These authors further argue that the reliance highlights the urgent need for innovative teaching strategies that connect mathematical concepts to practical applications and enhance students' understanding and retention of mathematical knowledge. Teachers often fail to expose students to diverse representations of mathematical concepts, limiting engagement and connecting learning to real-life applications crucial for vocational training (Vimbelo & Bayaga, 2023; Sehole et al., 2023).

Gaps in Questioning Practices in NC(V) Mathematics

The study by Ngoveni and Machaba (2024) critically evaluates the effectiveness of questioning techniques used by mathematics lecturers at South African TVET colleges. Their research reveals a predominance of lower-order questions, significantly limiting student engagement and understanding. It advocates for a shift toward higher-order questioning that fosters critical thinking and deeper learning, aligned with Bloom's Taxonomy and Vygotsky's Social Constructivism. This shift is essential for developing the cognitive abilities necessary for students to thrive in complex vocational environments.

The Need for Targeted Questioning Interventions

This gap highlights the critical necessity for more rigorous research that examines and formulates specific interventions to refine questioning practices. Such efforts are essential for developing educational strategies tailored to meet the distinct demands of NC(V) mathematics education. Undertaking this research will pave the way for more dynamic and effective educational methodologies, ensuring that questioning techniques substantially enhance student learning and engagement (Dahal, 2022; Mahmud & Mohd Drus, 2023; Mauigoa-Tekene, 2023). This study aims to develop a customized intervention for NC(V) Level 2 students who frequently face difficulties with both the conceptual and procedural aspects of mathematics. The intervention is designed to address the specific challenges these students experience and to enhance their mathematical comprehension and problem-solving abilities.

The Role of Consistent Questioning in Student Engagement

Effective questioning not only assesses knowledge but also fosters an environment of critical thinking and knowledge construction. Educators can enhance learning by defining clear objectives and systematically collecting data to monitor progress. This structured approach, as described by Cowie and Bell (1999), involves careful preparation and execution of tasks aimed at measuring intended outcomes.

Consistent questioning is crucial for engaging students, fostering dialogic interactions, and promoting active participation. Specific questioning patterns have been shown to effectively engage students in dialogic talk by encouraging early contributions, vital for developing skills necessary for the modern workforce (Hartmeyer et al., 2018). Moreover, questioning in contexts such as mathematics education can foster deeper reflection and understanding, emphasizing the versatility and importance of effective questioning across different fields (Di Teodoro et al., 2011). Another component with the potential to support questioning techniques while enhancing learning is digital learning.

Mobile Learning as a Support for Questioning Techniques

Integrating mobile technology in mathematics education transforms active learning by providing students immediate access to real-time information and resources, fostering a more interactive and engaging learning environment. Parry et al. (2021) highlight that mobile technology enables students to interact dynamically with content, while Pollara and Broussard (2013) emphasize its role in promoting active participation in learning. In financial mathematics, Nuphanudin et al. (2023) argue that mobile devices facilitate a hands-on approach, allowing students to apply financial concepts to real-world scenarios, thereby deepening their conceptual understanding. Similarly, Mueangpud et al. (2019) found that mobile learning applications incorporating interactive, scenario-based tasks significantly enhance students' financial literacy and decision-making skills.

Beyond enhancing engagement, mobile technology is crucial in bridging the gap between theoretical knowledge and practical application. Zhou (2023) notes that mobile devices allow students to research financial topics such as interest rates and inflation in real-time, making abstract concepts more tangible and relevant. Munoto et al. (2021) further assert that accessibility to digital tools supports knowledge retention by enabling students to apply mathematical concepts in diverse contexts. Likewise, Bónus and Korom (2022) emphasize that mobile technology encourages students to explore financial concepts through everyday experiences, reinforcing understanding and critical thinking.

Despite limited access to digital resources in some educational settings, studies indicate that technology-supported instruction can improve student performance (Mendoza-Rodriguez & Caranqui-Sánchez, 2024). Integrating mobile learning tools within structured questioning techniques can enhance student engagement, encourage deeper reasoning, and improve problem-solving skills in financial mathematics. These insights support the need for innovative teaching strategies incorporating mobile technology to facilitate meaningful, inquiry-driven learning in vocational mathematics education.

METHODS

This section discusses the research design, sample selection, data collection methods, intervention process, data analysis techniques, and ethical considerations undertaken in the study.

Research Design

This study employed a single-case qualitative research design with a quantitative component to develop and propose an interactive framework for questioning techniques to enhance student engagement in the National Certificate (Vocational) Mathematics curriculum at Technical and Vocational Education and Training (TVET) colleges. The intervention was conducted over a three-week period with one Level 2 mathematics class, while a comparison group followed traditional instruction without the intervention. The study was situated in a real classroom environment, allowing for naturalistic observations of student engagement and performance.

Sample Selection

The study comprised seventeen students in the intervention class and thirteen in the comparison group, both from the same TVET college, ensuring curriculum and instructional consistency. The sample was selected to preserve an authentic classroom environment while maintaining a manageable class size. The intervention class, chosen for its higher enrollment, allowed for a more extensive range of engagement levels. The researcher delivered the intervention while a regular lecturer instructed the comparison group.

The comparison group was included to illustrate differences in performance between students exposed to structured questioning techniques and those following conventional instruction. The comparison was not intended for rigorous statistical performance analysis but rather for illustrative purposes, providing contextual insights into how questioning techniques may influence student participation, which may ultimately improve comprehension. Since pre-existing classroom structures were used, randomization was not applied. However, both groups had equal curriculum exposure and instructional time. The comparison group adhered to conventional teaching methods, whereas the intervention group engaged with structured questioning techniques to foster deeper engagement and conceptual understanding. This approach, widely used in pedagogical research, offers meaningful contextual insights (Creswell & Poth, 2018; Yin, 2014; Merriam & Tisdell, 2016).

Data Collection Instruments and Procedures

Data collection involved qualitative classroom observations, student assessments, and thematic coding of student interactions to ensure methodological rigor (Braun & Clarke, 2022). Observations were systematically conducted to capture student engagement with various questioning techniques and inform instructional adjustments in real-time. Field notes documented student participation, misconceptions, and engagement patterns, focusing on questioning activities and general discussions to identify emerging trends.

A preparatory examination assessed students' understanding of financial mathematics through a 20-mark question, divided into two sections: a 10-mark component requiring the definition of five key financial concepts, and a 10-mark section involving simple and compound interest calculations. The results were analyzed to compare the effectiveness of structured questioning techniques against conventional instruction, offering insights into the possible relationship between student engagement and learning outcomes.

Intervention Process

The intervention was structured into five key phases to ensure a systematic implementation of questioning strategies and an evaluation of their impact on student engagement and understanding.

1. *Planning the Intervention*: The intervention was designed to enhance student engagement using structured and open-ended questioning techniques grounded in real-world financial scenarios. Mobile learning tools and multimedia resources were integrated to provide practical, interactive experiences.
2. *Continuous Monitoring Through Questioning*: Structured and spontaneous questions were used to assess procedural and conceptual understanding in real-time. Immediate feedback allowed for instructional adjustments, fostering deeper engagement and active participation.
3. *Implementation of Open-Ended and Wait-Time Strategies*: Open-ended questions encouraged students to reflect on financial concepts and apply them in personal finance decisions. Wait-time strategies enhanced critical thinking by allowing students to formulate well-reasoned responses.
4. *Group Activities and Collaboration*: Students worked in groups to solve practical financial problems, such as loan repayment calculations, reinforcing their understanding through peer discussions. Real-time feedback during group presentations helped clarify misconceptions and strengthened learning.
5. *Evaluation and Reflection*: The intervention's effectiveness in enhancing interactive engagement was assessed through student participation and performance trends. Results confirmed that structured questioning fostered deeper conceptual understanding and active learning in financial mathematics.

Data Analysis Methods

Following Braun and Clarke's (2006) framework, thematic analysis was applied to field notes to systematically identify engagement patterns, student misconceptions, and the effectiveness of questioning techniques. Responses were analyzed to distinguish between procedural knowledge (calculation-based responses) and conceptual understanding (explanation-based responses). To ensure reliability, a panel of experts independently reviewed classroom observation records to maintain consistency in engagement classifications and reduce researcher bias (Miles et al., 2014; Lincoln & Guba, 1985).

A comparative analysis of preparatory examination results was conducted to assess differences in performance between Group A (intervention) and Group B (reference group). The financial mathematics question was used as the primary measure for comparison. Given the small sample size, the focus was on identifying performance trends through descriptive comparative analysis rather than applying inferential statistics. This approach aligns with established practices in small-sample educational research (Cohen et al., 2018).

Ethical Considerations

Ethical approval for this study was obtained from the relevant institutional review committee before implementation, following ethical guidelines for educational research (Cohen et al., 2018). Informed consent was collected from all participating students, ensuring they were fully aware of the study's purpose and voluntary participation. Confidentiality and anonymity were maintained, and all data was securely handled to protect student identities.

FINDINGS

Step 1: Planning the Intervention

Objective: The primary aim of this phase was to establish a strong foundation for using effective questioning strategies to continuously monitor and enhance student understanding of "Financial Mathematics," a key element of the NC(V) Level 2 curriculum. The intervention aimed to connect theoretical financial concepts to students' everyday lives by applying real-world financial examples, such as Mashonisa (informal money lending).

Selection of Topic: The researcher selected "Financial Mathematics" because it covered essential concepts such as budgeting and interest calculations, which are crucial for personal financial management. This topic aligned directly with the NC(V) Level 2 requirements and supported the broader educational goals of preparing students for real-world financial challenges. Additionally, the topic allowed the researcher to address economic challenges by exploring informal lending systems like Mashonisa and savings schemes like Stokvel to foster deeper engagement with real-world financial issues.

Development of a Questioning Framework: The questioning framework was designed to include structured, consistent, and open-ended questions. The structured questions were posed regularly throughout the lessons to track how well students understood the key concepts. On the other hand, the open-ended questions were intended to encourage students to think more deeply about the practical applications of financial mathematics. This included budgeting, interest calculations, and comparisons between formal and informal financial institutions like banks and Mashonisa.

Integration of Technology and Resources: To support the teaching material, the researcher used online videos to visually explain concepts such as simple and compound interest. In addition, students were encouraged to use their mobile phones to research, for example, current interest rates, inflation, and budgeting in real-time, making the learning experience more interactive and grounded in practical applications.

Resource Readiness: All resources, including videos and online tools, were pre-checked by the researcher to ensure that they functioned properly, allowing class time to focus on learning rather than dealing with technical issues. The digital tools used during the intervention were limited to the researcher's laptop and the students' mobile phones.

Incorporation of Real-Life Financial Examples: To ensure relevance, the researcher incorporated specific real-world examples, such as the following:

1. "Pinkie buys a laptop priced at R13,495. She makes a 20% deposit and finances the balance at 15% per annum simple interest. Calculate her total cost and monthly payment."
2. "Eric bought a pre-owned car for R50,000 with a five-year hire-purchase agreement at 12% per annum simple interest and an additional R350 per month for insurance. Calculate Eric's total monthly payment."
3. "Advise a friend who is new to investing about the differences between simple and compound interest. Which would you recommend for long-term financial growth, and why?"
4. "Create a detailed monthly budget based on your actual income and expenses, including your monthly allowance from parents and any bursary funds you receive."

These examples were designed to highlight the practical implications of financial decisions and prepare students for similar situations they might encounter in their personal lives.

Step 2: Implementation of Indicator 1 - Continuous Monitoring Through Questioning

Overview: This phase focused on ongoing monitoring of student progress using both structured and unstructured questioning techniques. The integration of real-world financial problems, such as informal lending and the effects of interest rates, allowed the researcher to dynamically assess student understanding.

Classroom Engagement: The structured and unstructured questions assessed students' understanding of procedural and conceptual aspects of financial mathematics. For instance, students were asked to calculate Pinkie's monthly payment based on her 20% deposit and the 15% simple interest rate on her laptop purchase (see example below).

As part of the classroom discussion, they were also asked why Pinkie might have opted for simple interest financing and what alternative options could have been available to her. The researcher also engaged students with a question about compound interest, asking them to investigate where compound interest is applied and how it differs from simple interest in terms of long-term costs.

Additionally, questions about the Mashonisa concept were introduced, prompting students to explore why some people rely on informal lenders and the risks and benefits of such practices compared to formal institutions like banks.

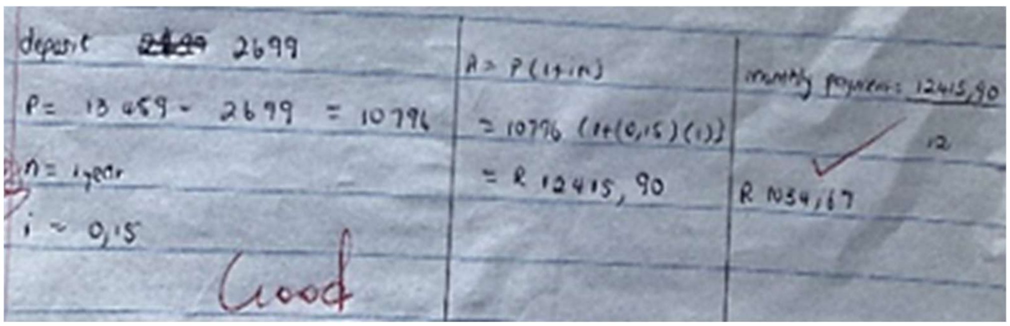


Figure 1: Student's work Example 1

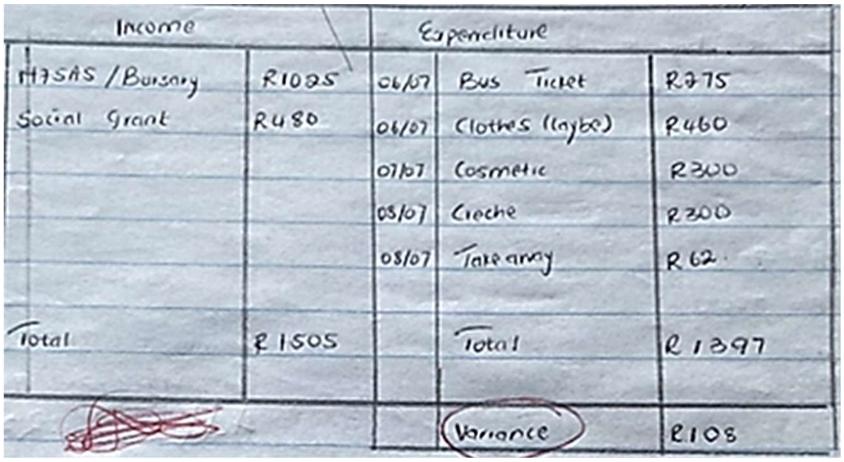
Diverse Question Formats: Both verbal and written formats were used for questioning to ensure students engaged with the material in various ways. This approach encouraged students to reflect on their responses during class discussions and individual assessments.

Feedback Mechanism: The researcher utilized students' responses to provide real-time feedback, identifying areas where they struggled or excelled. This allowed for prompt intervention to address gaps in understanding, ensuring that the learning objectives were met.

Step 3: Implementation of Indicator 2 - Use of Open-Ended and Wait-Time Strategies

Objective: This phase was designed to foster deeper student engagement through strategic questioning and personalized financial scenarios. Students were encouraged to apply financial concepts to real-life situations, such as managing a personal budget or deciding between loan options.

Design of Personalized Questions: The researcher asked students to create detailed monthly budgets based on their income and expenses (Example below). This exercise served as a foundation for understanding how to manage finances effectively. Furthermore, the activity introduced students to challenging financial concepts, such as variance, which refers to the difference between projected and actual outcomes in budgeting.



Income			Expenditure	
NSFAS / Bursary	R1025	06/07	Bus Ticket	R275
Social Grant	R480	06/07	Clothes (layby)	R460
		07/07	Cosmetic	R300
		08/07	Creche	R300
		08/07	Take away	R62
Total	R1505		Total	R1397
			Variance	R108

Figure 2: Student's work Example 2

Open-Ended Questions: To deepen understanding of simple interest, students were asked to investigate where simple interest is applied, why it is referred to as "simple," and what makes it different from compound interest. Similarly, they were tasked with explaining why compound interest is called "compound," where it is used, and how it impacts long-term financial growth. These questions prompted students to consider the practical implications of these types of interests in real-world financial contexts.

The researcher observed that students had expenses surpassing their income, leading to a negative balance. This allowed them to discuss variance, helping them understand that it could be positive or negative. Additionally, the occurrence of negative balances served as a teaching moment to guide students in practicing responsible spending.

Wait-Time and Reflection: The researcher incorporated sufficient wait-time after each question to encourage students to reflect on their answers and develop thoughtful responses. This approach promoted critical thinking and allowed students to engage with the material fully. For example, the researcher observed that when students were asked to explain their budgeting decisions, many initially struggled to justify their expenditure exceeding income. However, with extended wait-time they began recognizing the implications of negative balances. Additionally, when prompted to reflect on real-life financial scenarios, students gradually articulated the importance of responsible spending, linking their understanding of variance to personal financial management.

Peer Discussions: Throughout the intervention, students participated in peer discussions, sharing insights and strategies with their classmates, particularly during open-ended questioning sessions. These discussions allowed students to collaboratively reflect on financial concepts, helping to solidify their understanding through group learning and shared problem-solving approaches. The researcher observed that during peer discussions, students actively challenged each other's financial decisions, particularly when debating the impact of deposit size on total interest payments, which deepened their understanding of loan repayment structures. Additionally, when comparing simple and compound interest, students engaged in collaborative problem-solving, with some referencing real-life family investments, leading to a more practical grasp of long-term financial growth strategies.

Step 4: Group Activities and Collaboration

Step 4 formalized the collaborative approach by focusing on structured group activities. In this phase, students were assigned complex financial problems that required them to work together, applying procedural and conceptual knowledge to real-world scenarios. Group work was designed to enhance deeper understanding through collective problem-solving and discussion.

Group-Based Problem Solving: Students worked in groups to solve practical financial problems, such as calculating the monthly payment for Eric's car purchase (Example 2 in Step 1). Each group calculated Eric's monthly payment, including the simple interest and monthly insurance, and discussed how the interest rate affected the overall cost. Additionally, they were asked to consider whether Eric's payment would have been significantly different if compound interest had been used instead of simple interest. This comparison helped students understand the long-term implications of different interest types.

It is important to mention that not all groups arrived at the correct answer, as demonstrated in the example below. The students received immediate feedback, including the group in the example. This group only calculated the total amount payable after five years with interest and stopped there. The real-time feedback made them aware that they still needed to divide the total amount by the number of months and include the monthly insurance payment.

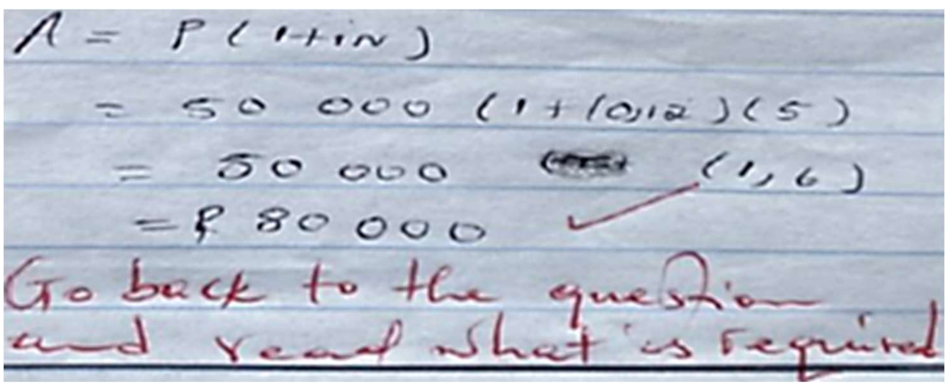


Figure 3: Student's work Example 3

In another example, students were tasked with advising a friend new to investing about the differences between simple and compound interest. The groups were required to research real-world applications of both types of interest and recommend which option would be more beneficial for long-term financial growth. They also explored how the frequency of compounding (annually, monthly, or daily) would affect the total amount of interest earned or paid in the long term.

Presentation and Feedback: Each group presented its findings on the whiteboard, explaining their calculations, decisions, and recommendations. The researcher provided constructive feedback, reinforcing key financial concepts and ensuring students understood the theoretical and practical aspects of interest rates.

Researcher's Observations on Group Activities and Collaboration

The researcher observed that group-based problem-solving activities encouraged students to actively engage with financial concepts, fostering peer-led learning and deeper conceptual understanding. During discussions, for example, on Eric's car purchase, students debated the impact of different interest rates on the total cost, with some initially struggling to distinguish between simple and compound interest. As they worked through the calculations, the real-time feedback process proved instrumental in correcting misconceptions, particularly for groups that overlooked dividing the total amount by the number of months or factoring in the monthly insurance cost.

Additionally, when tasked with advising a friend on investment strategies, students demonstrated varying levels of financial literacy, with some confidently explaining compounding effects. In contrast, others relied on their peers for clarification. The researcher noted that the requirement to present findings on the whiteboard prompted students to articulate their reasoning more clearly, reinforcing their understanding through peer critique and instructor feedback. Some groups conducted further research beyond the classroom discussion, highlighting the practical relevance of financial literacy in real-world decision-making.

Step 5: Evaluation and Reflection

Objective: The final phase evaluated the impact of the intervention on student learning. The focus was on assessing how well students understood financial mathematics through practical application and strategic questioning.

Evaluation Methods: The initial evaluation of this study included real-time observations, where the researcher observed students during classroom learning and adjusted the teaching approach based on their feedback. The second evaluation phase focused on analyzing student performance in the Financial Mathematics chapter covered during the intervention. This analysis compared the results of Group A (the class that received the intervention) and Group B (the class taught by the regular Lecturer), as shown in Table 1. Financial Mathematics accounted for 20 marks out of 100 in Paper 1 during the preparatory and final exams. Table 1 presents the students' performance in the preparatory exam, categorizing them into Group A and Group B. For example, Student 1a from Group A scored 13 out of 20, while Student 1b from Group B scored 7 out of 20.

Group A		**Group B**	
Student 1a: 13	Student 2a: 14	Student 1b: 7	Student 2b: 4
Student 3a: 16	Student 4a: 10	Student 3b: 12	Student 4b: 10
Student 5a: 8	Student 6a: 8	Student 5b: 10	Student 6b: 13
Student 7a: 14	Student 8a: 18	Student 7b: 14	Student 8b: 6
Student 9a: 12	Student 10a: 8	Student 9b: 7	Student 10b: 5
Student 11a: 6	Student 12a: 9	Student 11b: 4	Student 12b: 9
Student 13a: 8	Student 14a: 20	Student 13b: 6	
Student 15a: 10	Student 16a: 9		
Student 17a: 13			
Average (n = 17) **= 11.5**		**Average** (n = 13) **= 8.2**	

Table 1: Group A versus Group B in 2022

The evaluation of student performance in financial mathematics revealed a significant difference between Group A, which received an intervention, and Group B, which did not. Group A achieved an average score of 11.5 out of 20, compared to Group B's 8.2, suggesting that there could be a link between the intervention and learning outcomes. The wider range of scores in Group A (6 to 20) suggests that while many students benefited from the intervention, some struggled, showing that the approach was not uniformly effective.

The intervention included consistent questioning, personalized tasks, and group activities, all contributing to enhanced understanding and engagement. Real-time feedback was critical in helping students correct mistakes and deepen their learning. However, the lower performers in both groups indicate a need for further differentiation in teaching methods. The role of digital tools was supportive during the intervention and will be discussed next as one of the emerging themes.

Mobile Learning and Digital Tools as a Means of Supporting Interactive Engagement

Digital tools played a complementary role in enhancing student engagement by bridging theoretical financial concepts with real-world applications. Students used mobile devices to research current interest rates and inflation trends, making financial mathematics more relevant to their daily lives. This real-time research allowed them to compare financial products, evaluate different loan repayment structures, and develop informed financial strategies, reinforcing their conceptual understanding.

To visually enhance learning, online videos were incorporated to illustrate complex financial concepts, such as simple and compound interest. These videos provided step-by-step explanations supporting procedural and conceptual knowledge, reinforcing students' ability to analyze financial decisions critically. The combination of visual learning and structured questioning encouraged deeper engagement and allowed students to reflect on financial principles beyond the classroom context.

Additionally, mobile learning supported peer discussions, where students collaboratively analyzed financial scenarios, compared their calculations, and debated financial choices. These interactions helped clarify misconceptions and reinforced knowledge through collaborative learning. Mobile learning complemented the questioning framework, allowing students to actively engage with real-world data and digital resources, fostering a more interactive and student-centered learning environment.

DISCUSSION

This study sought to explore the application of questioning techniques in enhancing interactive engagement in teaching financial mathematics for NC(V) Level 2 students. Rooted in formative assessment theories, the primary objective was to design a model that promotes deeper conceptual understanding and procedural fluency rather than simply improving performance. The findings, centered on two main indicators, 1) Engaging Students Through Consistent Questioning and 2) Questioning Techniques to Gather Evidence of Procedural and Conceptual Knowledge, offer significant insights into how these strategies foster a more dynamic and participatory learning environment.

Indicator 1: Engaging Students Through Consistent Questioning

The findings show that consistent questioning was crucial in maintaining student engagement and fostering a dialogic learning environment. Embedding questioning into daily lessons consistently challenged students to apply, reflect on, and extend their understanding of financial concepts. Black and Wiliam (1998) emphasize that consistent questioning is a vital aspect of formative assessment, offering opportunities for students to engage actively in their learning while allowing teachers to adjust instruction based on real-time feedback.

The approach to questioning, which was grounded in real-world financial examples such as budgeting and hire-purchase agreements, aligns with Adelabu and Pharamela (2024), who argue that formative assessment should be integrated into the learning process rather than treated as a separate activity. By continually asking students to solve financial problems related to their daily lives, such as calculating loan repayments or advising on investment strategies, the questions made abstract mathematical concepts more accessible. Venkatraman et al. (2018) support this by stating that students are more likely to engage with and retain mathematical concepts when presented in practical, relatable contexts. In this study, examples like Pinkie's laptop purchase and Eric's car loan provided students with concrete frameworks to explore financial mathematics.

However, while consistent questioning effectively engaged most students, the preparatory examination results revealed that some students in Group A still performed poorly. This underscores that consistent questioning alone may not guarantee improved academic outcomes for all learners, particularly those with weaker foundational knowledge. Ngoveni and Machaba (2024) suggest that while questioning is an effective formative assessment tool, it must be coupled with instructional scaffolding for students with lower comprehension levels. Vygotsky's (1978) zone of proximal development (ZPD) theory reinforces this, suggesting that tasks or questions should challenge students within their ZPD to ensure growth without causing disengagement. Similarly, Vimbelo and Bayaga (2023) highlight the need for differentiated questioning strategies to address diverse learning needs. Future interventions should integrate scaffolding and differentiated questioning approaches to support student learning across varying ability levels.

Indicator 2: Questioning Techniques to Gather Evidence of Procedural and Conceptual Knowledge

In addition to promoting engagement, the findings show that questioning techniques effectively gathered evidence of both procedural and conceptual knowledge. Open-ended and reflective questions allowed students to articulate their understanding, apply concepts in new contexts, and engage in higher-order thinking. This aligns with Bloom's Revised Taxonomy (Anderson & Krathwohl, 2001), emphasizing the need for questions that push beyond recall, promoting analysis, evaluation, and creation.

For example, the question "Investigate where compound interest is applied and explain why it's called compound" encouraged students to perform calculations and explain the rationale behind financial mechanisms. This is consistent with Martino and Maher (1999), who advocate for questioning that promotes justification and generalization, helping students move beyond procedural fluency to develop a deeper conceptual understanding. Similarly, questions like "Advise a friend who is new to investing about the differences between simple and compound interest" required students to apply mathematical knowledge to real-life scenarios, reinforcing Hiebert and Carpenter's (1992) assertion that transferring knowledge to practical problems enhances mathematical understanding.

While many students in Group A exhibited both procedural and conceptual mastery, some encountered difficulties with higher-order questions. To address these challenges, Ngoveni (2025) recommends pedagogical strategies that simultaneously enhance conceptual understanding and procedural fluency to strengthen mathematical proficiency in vocational education. Similarly, Ramaligela (2022) attributes performance disparities to students' struggles with higher-order thinking, often influenced by their prior knowledge and cognitive development. Mauigoa-Tekene (2023) underscores the importance of aligning questioning techniques with students' cognitive abilities to facilitate meaningful engagement. Therefore, additional scaffolding and targeted support may be required to ensure that lower-performing students fully benefit from the questioning framework.

Group A vs Group B

Although the study's primary aim was to design a model for interactive engagement, the improved performance of Group A compared to Group B suggests that questioning techniques may positively impact academic outcomes. Group A's average score of 11.5 out of 20, compared to Group B's 8.2, highlights that the questioning model, while focused on engagement, may have positively affected learning outcomes. Mueangpud et al. (2019) argue that formative assessment techniques, such as effective questioning, may lead to measurable improvements in student outcomes, even when focused on engagement rather than performance. This reinforces the value of questioning as both an engagement and assessment tool.

Mobile Learning and Digital Tools in Supporting Interactive Engagement

Although the study primarily focused on questioning techniques, the role of mobile technology in supporting interactive engagement was also noteworthy. Mobile devices allowed students to access real-time financial data, such as interest rates and inflation, providing context for the mathematical concepts taught. Zhou (2023) notes that mobile technology enhances learning by providing students immediate access to relevant information, making the learning experience more dynamic and interactive. Allowing students to research financial data independently supported the questioning model by bridging theoretical knowledge and practical application. This aligns with Nuphanudin et al. (2023), who emphasize that mobile learning encourages greater autonomy and engagement by enabling students to explore and apply concepts in real-world contexts.

Additionally, online videos were incorporated to visually illustrate complex financial concepts, such as simple and compound interest, through step-by-step explanations. Research by Dipon & Dio (2024) indicates that video-based instruction significantly improves students' performance in mathematics, with an effect size of $g=1.79$. This suggests that instructional videos enhance the understanding of abstract concepts and foster critical analytical skills through real-world applications. In this study, visual learning and structured questioning deepened engagement, enabling students to reflect on financial principles beyond the classroom.

CONCLUSION

The findings of this study emphasize the effectiveness of a questioning model designed to enhance interactive engagement in NC(V) Level 2 financial mathematics classrooms. The intervention fostered a more dynamic and participatory learning environment by grounding the questions in real-world financial contexts and promoting procedural and conceptual understanding. While improved performance was a secondary outcome, it highlights the potential for questioning techniques to enhance engagement and academic success.

This study contributes a practical, evidence-based model for questioning to enhance engagement and understanding in vocational education. It extends the theoretical framework of formative assessment and questioning techniques by situating them within real-world, context-driven financial mathematics supported by digital tools. The study's findings offer immediate and scalable implications for improving interactive learning in vocational classrooms, with broader relevance for other disciplines and settings within technical education. This study expands the body of knowledge and addresses the existing gap in the literature within the TVET sector.

LIMITATIONS

This study has several limitations that may impact the interpretation and generalizability of its findings. The small sample size (n=17) and the focus on NC(V) Level 2 financial mathematics restrict broader applicability, necessitating further research across diverse student cohorts. Additionally, the three-week intervention may not have been sufficient to capture long-term learning gains, underscoring the need for extended studies. The absence of direct student feedback limited insights into engagement and perceptions. At the same time, the researcher's dual role as both educator and investigator introduced potential bias, which independent facilitators in future research could mitigate. Although many students actively participated, some required additional prompting, suggesting the need for structured scaffolding to enhance early engagement. Technological constraints also led to inconsistencies in digital engagement due to limited access to mobile learning tools. Furthermore, despite the structured questioning techniques, some students struggled with fundamental financial concepts, highlighting the need for additional instructional support.

RECOMMENDATIONS FOR FUTURE STUDIES

Future studies should incorporate qualitative feedback through surveys, interviews, or focus groups to better understand how questioning strategies influence student motivation, comprehension, and engagement. Expanding the application of the questioning model to other vocational subjects, such as science and technical trades, would provide insights into its broader effectiveness. Additionally, research involving larger and more diverse samples across multiple classrooms or institutions would enhance generalizability and reveal variations in student responses across different educational settings. A longer-term study is also recommended to assess the sustained impact of the model, as extending the intervention beyond three weeks could provide valuable data on long-term engagement and retention. Furthermore, future research should explore the deeper integration of digital tools to support interactive engagement, enable real-time feedback, and facilitate adaptive learning in formative assessment practices.

ACKNOWLEDGMENTS

I thank Dr. du Plooy and Prof. Machaba for their contribution while conceptualizing the primary study and their roles as a team of experts.

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