International Journal of Learning, Teaching and Educational Research
Vol. 25, No. 4, pp. 271-292, April 2026
https://doi.org/10.26803/ijlter.25.4.13
Received Dec 15, 2025; Revised Feb 11, 2026; Accepted Mar 25, 2026

From Checking for Understanding to Pressing for Reasoning: High School Mathematics Teachers' Questioning Repertoires

Tirivanhu Muchuweni* and Zingiswa Jojo
Rhodes University
Eastern Cape, South Africa

Abstract. This study examined how high school mathematics teachers plan and use questions to support both procedural understanding and mathematical reasoning. Questioning plays an important role in helping students explain ideas, justify steps, and connect concepts; yet many classrooms still rely on short answer-based questions. Guided by Dialogic Teaching Theory and an interpretivist perspective, this study explored how teachers plan questions and how they adjust them during instruction. A qualitative multiple case study design was employed, and through purposive sampling, four high school mathematics teachers from a large public school district in central Florida participated. Data were collected through individual open-ended questionnaires and semi-structured interviews conducted both remotely and in person. The study found that teachers planned both procedural and reasoning questions but continued to rely heavily on spontaneous questioning during instruction to respond to student thinking. Teachers also used structured routines and real-time adaptations to engage learners and better understand their reasoning. Based on these findings, the study recommends professional development that strengthens reasoning-based questioning, supports teachers in anticipating common errors, and promotes equitable participation routines. These results show that questioning is a flexible and deliberate practice shaped by teacher intentions, curriculum expectations, and emerging student ideas. The study offers insight into how questioning can support deeper mathematical thinking and how schools can help teachers build stronger questioning repertoires.

Keywords: classroom discourse; dialogic teaching; mathematics questioning; reasoning; secondary mathematics; teacher practices

Citation:
Muchuweni, T., & Jojo, Z. (2026). From Checking for Understanding to Pressing for Reasoning: High School Mathematics Teachers' Questioning Repertoires. *International Journal of Learning, Teaching and Educational Research, 25*(4), 273–292. https://doi.org/10.26803/ijlter.25.4.13

*Corresponding author: Tirivanhu Muchuweni; *tirivanhu.muchuweni@gmail.com*

1. Introduction

Effective questioning constitutes a fundamental aspect of robust mathematics instruction, as it influences how students think, articulate their thoughts, and comprehend mathematical concepts (Moyer & Milewicz, 2002; Di Teodoro et al., 2011; Roberts, 2021). In this paper, the term "students" refers specifically to secondary mathematics learners, adhering to standard terminology in mathematics education research (Remillard & Heck, 2014). Within the context of high school classrooms, mathematics teachers utilise questions for purposes that extend beyond merely assessing students' recall of rules. Well-structured questions can stimulate students to elucidate their reasoning, justify their choices, compare various methods, and connect concepts across different problems (Zhuang & Conner, 2022; Lee, 2025; Faria et al., 2024). When mathematics teachers employ questions with intention, they foster opportunities for deeper cognitive engagement and active participation.

Nevertheless, research indicates that many mathematics classrooms continue to rely predominantly on brief, closed questions that solicit a single correct answer (Hsu et al., 2023; Yildizli & Günaydin, 2022). Such questions frequently curtail students' opportunities to articulate their thought processes or explore alternative solution strategies, potentially reinforcing a perception of mathematics as mere answer retrieval rather than as a discipline of reasoning (Mosvold & Thente, 2025; Aziza, 2021). Even when mathematics teachers acknowledge the importance of discussion, they may encounter difficulties in formulating questions that extend student thinking or promote substantive dialogue.

Consequently, it is essential to comprehend not only the types of questions teachers pose but also the manner in which they pose them, their responses to student thinking, and their ability to adapt their questions in real time. These practices significantly influence the quality of classroom discourse and the nature of the mathematical thinking in which students engage (Paoletti et al., 2018; Walter, 2018; Haiduc et al., 2023). In this study, questioning repertoires are defined as the comprehensive array of questioning strategies that teachers plan, implement, and modify throughout instruction (Nolan, 2025; Yılmaz & Koştur, 2025). An examination of these repertoires elucidates the moment-to-moment instructional decisions teachers make. Thus, this study investigates how high school mathematics teachers plan and execute their questioning practices while endeavouring to support reasoning-focused classroom dialogue (Cumhur & Guven, 2022; Hansel, 2022; Murray, 2019).

1.1. Problem Statement

Although questioning is widely recognised as essential in mathematics teaching, many classrooms still do not employ questioning methods that fully support conceptual understanding or mathematical reasoning (Moyer & Milewicz, 2002; Di Teodoro et al., 2011; Zhuang & Conner, 2022). Mathematics teachers often pose questions that primarily check procedural accuracy. These questions typically involve recalling steps or naming rules, rather than engaging students in deeper thinking, asking them to justify their ideas, or encouraging multiple solution strategies (Hsu et al., 2023; Yildizli & Günaydin, 2022; Lee, 2025). Teachers frequently report practical constraints that limit their ability to utilise richer questioning techniques. Common concerns include limited class time, pressure to swiftly cover the curriculum, adherence to pacing guides, and assessment demands (Hansel, 2022; Murray, 2019).

Most existing research focuses on short-term observations or the quantification of question types, which fails to capture how teachers think, plan, or make real-time decisions during instruction (Cumhur & Guven, 2022; Dahal et al., 2025). Additionally, there is a paucity of qualitative research examining teachers lived experiences with questioning, including how they design questions, respond to student thinking, and reflect on their choices (Roberts, 2021; Fletcher, 2023). If this gap is not addressed, teachers may continue to use questioning practices that emphasise quick procedural answers over reasoning, thereby limiting opportunities for students to explain, justify, and develop a robust mathematical understanding (Di Teodoro et al., 2011; Zhuang & Conner, 2022). Over time, this practice can diminish student participation and confidence (Aziza, 2021; Yildizli & Günaydin, 2022; Fletcher, 2023; Haiduc et al., 2023). Therefore, there is a pressing need for deeper insight into how teachers develop and implement questioning practices that support reasoning-focused instruction.

1.2. Rationale for the study

Teachers' questioning practices strongly shape how students think, participate, and understand mathematics (Hsu et al., 2023; Yildizli and Günaydin, 2022). To enhance reasoning-focused instruction, it is important to closely examine how high school mathematics teachers plan and use questions while managing pacing and classroom demands (Hansel, 2022; Murray, 2019). A qualitative, interpretivist approach is beneficial because it allows researchers to explore teachers' lived experiences, including the decisions they make before, during, and after lessons (Roberts, 2021; Fletcher, 2023). This perspective helps to reveal the strategies teachers use, the challenges they face, and the beliefs that shape their questioning choices (Cumhur and Guven, 2022; Dahal et al., 2025). Such insights can guide professional learning that strengthens reasoning-focused questioning. This study, therefore, examined how high school mathematics teachers planned and used their questions in real classroom contexts, focusing on how questioning supported student thinking over time (Haiduc et al., 2023; Paoletti et al., 2018).

2. Literature review

This section summarises research on teacher questioning in mathematics classrooms. It is organised into two areas: studies that address how teachers plan questions to support procedural understanding and reasoning, and studies that examine how teachers plan, use, and adapt questioning during instruction. These areas provide a foundation for understanding teachers' questioning skills.

2.1. Planning Questions to Support Procedural and Reasoning Goals

Nolan (2025) and Purdum-Cassidy et al. (2015) indicate that planning is an important aspect of how teachers develop their questioning practices in mathematics. When teachers carefully consider the questions, they wish to ask before a lesson, they are more likely to support students' understanding and reasoning during instruction. Planned questions help teachers decide when to check procedural knowledge and when to encourage deeper thinking, such as explaining, justifying, or comparing strategies (Hsu et al., 2023). Studies by Moyer and Milewicz (2002), Di Teodoro et al. (2011), and Aziza (2021) have found that teachers often plan a mix of factual, procedural, and open-ended questions; however, they sometimes struggle to design questions that prompt students to explain their reasoning or make connections among ideas. This pattern is common across secondary mathematics settings, where teachers balance time constraints with the need to promote conceptual understanding.

Planning is influenced by many factors identified in the literature, including curriculum goals, pacing expectations, and the specific needs of students (Dong et al., 2015; Hansel, 2022). Some studies show that teachers tend to plan more procedural questions when they feel pressured to complete required content quickly or when they believe students may struggle with complex tasks (Alhayyan, 2023; Murray, 2019). Cumhur and Matteson (2017) and Roberts (2021) indicate that teachers with stronger beliefs about the value of discussion and explanation are more likely to plan questions that encourage reasoning and reflection. These beliefs shape teachers' expectations about what students can do and how much time a lesson can devote to thinking and dialogue.

Researchers Nolan (2025), Yenmez et al. (2018), and Heng and Sudarshan (2013) highlight that planning reasoning-focused questions requires specialised knowledge and support. Teachers often need assistance in identifying mathematical ideas that can generate discussion, anticipate student misconceptions, and design prompts that allow for explanation rather than quick answers. Approaches such as lesson study, collaborative planning, and clinical interviews have been shown to help teachers design richer questions by providing them with time to reflect on student thinking and practice writing open-ended prompts (Cumhur & Guven, 2022; Kabar & Tasdan, 2020). These professional learning structures support teachers in planning questions that align with both procedural understanding and higher-level reasoning.

Even with planning, teachers often find it challenging to balance different types of questions, as noted in prior research by Walkoe and Levin (2018). Studies show that teachers may plan high-level questions but later simplify them due to time constraints or uncertainty about students' responses (Walkoe & Levin, 2018; Dong et al., 2015). This suggests that planning alone does not guarantee rich questioning; rather, it creates an important foundation for reasoning-oriented instruction. The literature demonstrates that careful planning helps teachers clarify their goals, anticipate student thinking, and design questions that promote meaningful engagement with mathematical ideas.This study builds on these insights by examining how teachers plan both procedural and reasoning questions and how these plans shape their questioning practices during instruction.

2.2. Enacting Questioning Repertoires During Instruction

When teachers move from planning to actual instruction, the complexity of questioning increases, as it is contingent upon real-time decisions and student responses (Eddy & Kuehnert, 2018). Hsu et al. (2023) and Paoletti et al. (2018) demonstrate that even when teachers prepare thoughtful questions, the manner in which these questions are enacted during a lesson significantly shapes the quality of classroom discourse. Enactment encompasses how teachers pose questions, the duration of their waits for responses, their reactions to students' ideas, and their adjustments to questions based on the lesson's direction (Walter, 2018). These actions impact whether students provide brief answers or engage in more profound reasoning and explanation.

Research (Mosvold & Thente, 2025; Yildizli & Günaydin, 2022) indicates that many teachers tend to pose a high volume of factual or recall questions during instruction, even if they had planned for more open-ended questions. This alteration frequently occurs as teachers must react quickly to classroom dynamics, particularly regarding pacing, student misunderstandings, or time constraints. Consequently, teachers may abbreviate their questions, simplify them, or accept succinct responses when they perceive the need to advance the lesson (McCarthy et al., 2016; Liang, 2024). This pattern highlights a common challenge in maintaining high-level questioning within fast-paced classroom environments.

Another critical aspect of enactment is how teachers follow up on student responses. Haiduc et al. (2023) and Walter (2018) identify several follow-up strategies that can foster deeper thinking, including probing for explanations, asking students to compare ideas, or inviting them to justify their reasoning. When teachers use these strategies, they often assist students in building confidence and participating more actively in mathematical discussions. However, studies also reveal that many teachers default to quick evaluations of student answers, which can limit opportunities for elaboration and reflection (Martin et al., 2015; McCarthy et al., 2016). This suggests a tendency for certain instructional exchanges to remain superficial rather than exploratory.

Classroom interaction is also influenced by how teachers distribute participation among students (Zhu & Edwards, 2019). Some teachers call on volunteers, while others intentionally spread questions across the class to involve a broader range of students (Liang, 2024). Kaya and Ceviz (2017) and Clivaz et al. (2023) indicate that equitable distribution of questions promotes wider engagement, particularly when complemented by adequate wait time that allows all students to think. Although longer wait times are associated with improved reasoning and more thoughtful responses, many teachers reduce waiting periods due to pacing demands or uncertainty regarding whether students know the answer (Faria et al., 2024; Liang, 2024). This pattern reveals tensions between instructional goals and time constraints.

Adapting questions during instruction is a crucial aspect of teachers’ questioning repertoires (Cumhur & Matteson, 2017). Teachers often modify questions in response to student confusion, unexpected insights, or new ideas that arise during class discussions (Roberts, 2021; Yilmaz & Cakiroglu, 2024). These adaptations necessitate that teachers make swift judgments regarding which ideas to pursue and how to maintain coherence in the lesson while still fostering reasoning. Clivaz et al. (2023) and Paoletti et al. (2018) suggest that teacherss with a stronger comprehension of student thinking or more developed beliefs about the value of dialogue are generally more adept at making such adjustments. This underscores the significance of teacher expertise in guiding responsive instruction.

Technology also plays a role in the implementation of questioning practices (Akkoç, 2015). Digital tools, such as computer-supported questioning systems and technology-enhanced platforms, can aid teachers in posing a diverse array of questions, gathering responses efficiently, and gaining insight into student thinking more easily. However, Yilmaz and Cakiroglu (2024) contend that technology cannot supplant the necessity for high-quality follow-up. Teachers still need to interpret student responses, pose probing questions, and decide how to extend reasoning beyond the initial prompt.

The literature indicates that enacting questioning during instruction is a dynamic, moment-to-moment process shaped by teacher beliefs, classroom conditions, and the responses students provide throughout the lesson. While meticulous planning establishes a foundation, the manner in which teachers respond, probe, and adapt in real time determines whether questioning promotes deeper reasoning or remains focused on quick answers. This paper builds on these insights to analyse how the teachers in this study enacted their questioning repertoires across different instructional contexts.

The literature shows that teacher questioning is important for supporting procedural understanding and mathematical reasoning. However, many studies focus on identifying question types or analysing classroom talk at a surface level, with limited attention given to how teachers plan questions before lessons and adapt them during instruction. Additionally, there is a lack of qualitative research that captures teachers' perspectives on these decisions in real classroom contexts. This study addresses these gaps by examining how high school mathematics teachers plan, use, and adapt questioning practices to support student reasoning.

3. Conceptual Framework

This study is informed by Dialogic Teaching Theory, which posits that learning is a communicative process co-constructed through purposeful teacher–student discourse (Alexander, 2020; Kim and Wilkinson, 2019). Within this framework, questioning serves as a fundamental tool for engaging students in reasoning, reflection, and collaborative meaning-making. Rather than functioning solely as a form of assessment, questioning is recognised as a pedagogical practice that fosters cognitive development and classroom participation (Zhuang and Conner, 2022; Faria et al., 2024). Dialogic teaching underscores that meaningful mathematical understanding is cultivated when teachers employ questions to challenge thinking, extend ideas, and actively involve students in discussions (Roberts, 2021; Fletcher, 2023).

In this study, questioning is conceptualised through three interrelated dimensions of dialogic teaching: cognitive, interactional, and belief based. The cognitive dimension pertains to the level of thinking required by questions, ranging from recall to explanation and metacognition (Lee, 2025; Yildizli and Günaydin, 2022; Nolan, 2025). The interactional dimension examines how questions are distributed, sequenced, and followed up during discourse to sustain reasoning and participation (Paoletti et al., 2018; Hsu et al., 2023; Walter, 2018).

The belief-based dimension considers teachers' assumptions regarding effective questioning and the ways in which these beliefs interact with pacing, curriculum expectations, and student needs (Cumhur and Matteson, 2017; Hansel, 2022; Murray, 2019). These dimensions provide a framework for examining both the types of questions posed by teachers and the professional reasoning that underpins them. They also informed the design of the interview and questionnaire items, which were structured to investigate teachers' cognitive intentions, interactional routines, and belief systems concerning questioning. Figure 1 illustrates how the three dimensions function cohesively within dialogic teaching.

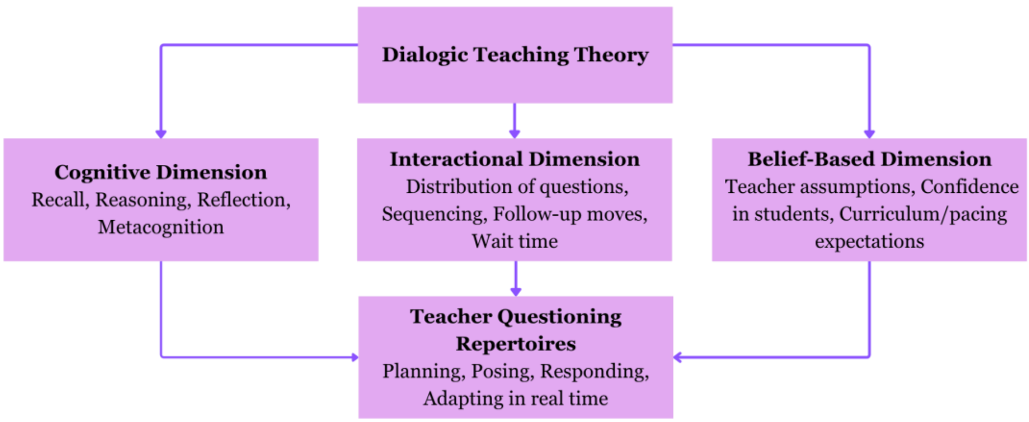

Figure 1: Conceptual framework showing the cognitive, interactional, and belief-based dimensions of teachers' questioning repertoires.

4. Methodology

This study was guided by an interpretivist paradigm and employed a qualitative multiple case study design to explore how high school mathematics teachers plan and use questions in their daily practice (Roberts, 2021; Hansel, 2022). A case study design was appropriate as it allowed for the examination of teachers' lived experiences, beliefs, and instructional decisions within context (Cumhur and Guven, 2022; Yilmaz and Koştur, 2025). Four high school mathematics teachers from a large public school district in central Florida participated. Purposive sampling was used to select teachers who could provide rich information and represented varied course levels, including Algebra I, Geometry, Advanced Algebra, and Precalculus (Lee, 2025; Yildizli and Günaydin, 2022; Hsu et al., 2023). Participation was voluntary and identifying details about the district or teachers were not disclosed.

Data were collected through a structured questionnaire and individual semi-structured interviews. The questionnaire gathered background information on teaching experience, training, and course assignments, along with open-ended items addressing beliefs and planning practices. Semi-structured interviews were conducted remotely through WhatsApp or Microsoft Teams, with a few completed in person during weekend visits to Florida. These interviews allowed teachers to explain their planning processes, intentions, and instructional decisions in their own words (Haiduc et al., 2023; Roberts, 2021).

The questionnaire and interview questions were developed based on the study's conceptual framework and prior literature on teacher questioning. Items focused on teachers' beliefs about questioning, how they planned questions before lessons, and how they adjusted questions during instruction. The questionnaire was administered electronically, and the interviews followed a semi-structured format to ensure consistency across participants while also allowing for probing questions. Trustworthiness was addressed through the use of the same instruments across cases (dependability), systematic inductive coding and cross-case comparison (confirmability), and a detailed description of participants and instructional contexts to support transferability.

Ethical procedures included informed consent, the use of pseudonyms, and the secure handling of all materials. No classroom observations or student data were collected, and the study adhered to established ethical guidelines for voluntary participation and confidentiality (Fletcher, 2023; Roberts, 2021). Data were analysed using Braun and Clarke’s (2006) thematic analysis. An inductive approach guided the coding, allowing themes to emerge from teachers’ descriptions (Cumhur and Guven, 2022; Yilmaz and Koştur, 2025).

The codes focused on teacher beliefs, planning decisions, instructional strategies, and challenges. A cross-case comparison was then conducted to identify patterns across the four teachers (Hsu et al., 2023; Nolan, 2025). Credibility was strengthened through triangulation of questionnaires and interviews (Faria et al., 2024; Haiduc et al., 2023) and member checking, wherein teachers reviewed summaries of their cases to confirm accuracy. Figure 2 provides an overview of the methodological process.

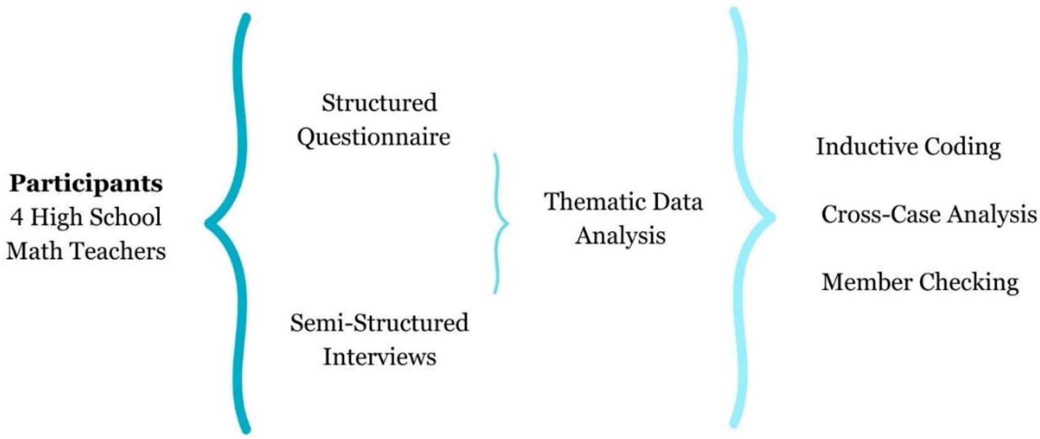

Figure 2: Methodological process overview.

5. Results

Inductive thematic analysis yielded two primary themes: (1) question planning to support procedural understanding and mathematical reasoning, and (2) question utilisation and adaptation during instruction. These themes structure the presentation of findings in Sections 5.1 and 5.2, which explore how mathematics teachers planned questions and how they employed and adapted them during instruction to engage students and respond to their thinking.

5.1. Question Planning

Mathematics teachers explained that they planned their questions during regular lesson preparation and aimed to align each question with the mathematical goals of the lesson. When planning questions for procedural understanding, teachers prepared items involving simple symbolic manipulation or step-by-step skills, for example solving linear equations like $2x + 5 = 19$ or rewriting expressions like $3(x - 4) - 2x$. These questions helped them quickly assess whether students remembered algebraic rules before moving on to deeper reasoning tasks.

Several teachers noted that they occasionally planned questions together during professional learning community (PLC) meetings, where they shared example questions and discussed how to align them with the learning targets for the unit. Teachers described this planning process in their own words. Teacher 1 explained, "When I plan, I always begin with the learning standard. That tells me what type of question I need to ask." Teacher 2 added, "Procedural questions help me see if they remember the mathematical rules, but the next question must require them to explain how to solve the problem."

When teachers planned for mathematical reasoning, they selected or designed questions that asked students to justify steps, compare methods, or explain why a solution made sense. Several teachers shared that they intentionally added questions, for instance, "Why does the slope of $y = -3x + 7$ equal -3?" or "How do you know the triangles are congruent?", to prompt students to articulate conceptual ideas. The mathematics teachers felt that procedural questions alone did not reveal what students truly understood, so they planned at least one reasoning question for each lesson, even when time constraints made this challenging. In some PLC conversations, mathematics teachers brought sample reasoning questions to refine together, which helped them think about how to move from short answers toward explanation and justification. Teacher 3 illustrated this reasoning focus, stating, “I want them to tell me how and why one problem-solving method works, not just to tell me which method they used to solve a mathematics question.”

Teachers also relied heavily on district-approved curriculum materials when planning. Many began with the textbook or digital resources, which provided standard questions covering topics such as quadratic functions, geometric relationships, and basic probability. They then modified these questions to make them more open-ended. For example, instead of only asking students to solve $x^2 - 9 = 0$, mathematics teachers prepared follow-up questions that required explanation: “Why does this factor into $(x - 3)(x + 3)$?” or “What does each solution represent on the graph?” In geometry lessons, teachers rewrote prompts such as “Find the missing angle” to include justification, asking students to explain why angles on a straight-line sum to180°.

Teachers planned questions with anticipated errors in mind. In Algebra I, they prepared prompts that targeted misconceptions about distributing negatives, such as identifying errors in simplification. $-2(x - 5)$. In statistics, some mathematics teachers devised questions to clarify misunderstandings about sampling, such as distinguishing between a population and a sample in a data investigation. Since student thinking is often unpredictable, teachers stated that they planned “anchor questions” to guide the lesson, while also relying on spontaneous follow-up questions during instruction.

A few teachers mentioned that these anchor questions were sometimes developed or improved during PLC planning, where colleagues shared common student misconceptions and brainstormed questions to address them. They believed that this combination of planned and flexible questioning helped them address both procedural skills and reasoning throughout their lessons. Teacher 4 described this flexibility, saying, “I plan my big mathematics questions ahead of time, but I change them once I see what the students are thinking. The anchors guide me, but the follow-ups come from the moment.”

To visually summarise the different elements teachers considered when preparing their questions, Figure 3 presents a concept map of the main components of teacher question planning. The diagram highlights how mathematics teachers balanced procedural tasks, reasoning-focused prompts, curriculum-based questions, and anticipated student errors during the planning process.

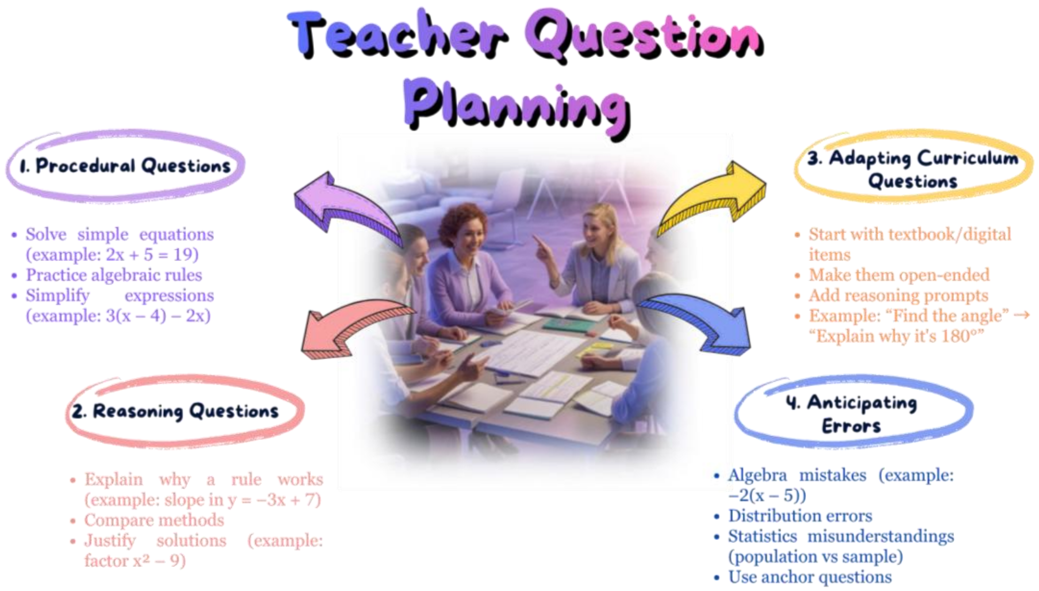

Figure 3: Four-component concept map of teacher question planning.

5.2. Question Use During Instruction

The study revealed that the mathematics teachers used a wide range of strategies to pose questions and involve students during instruction. Figure 4 shows a summary of the four main types of questioning practices teachers used during instruction: student selection methods, think-time structures, response tools, and adaptive questioning moves.

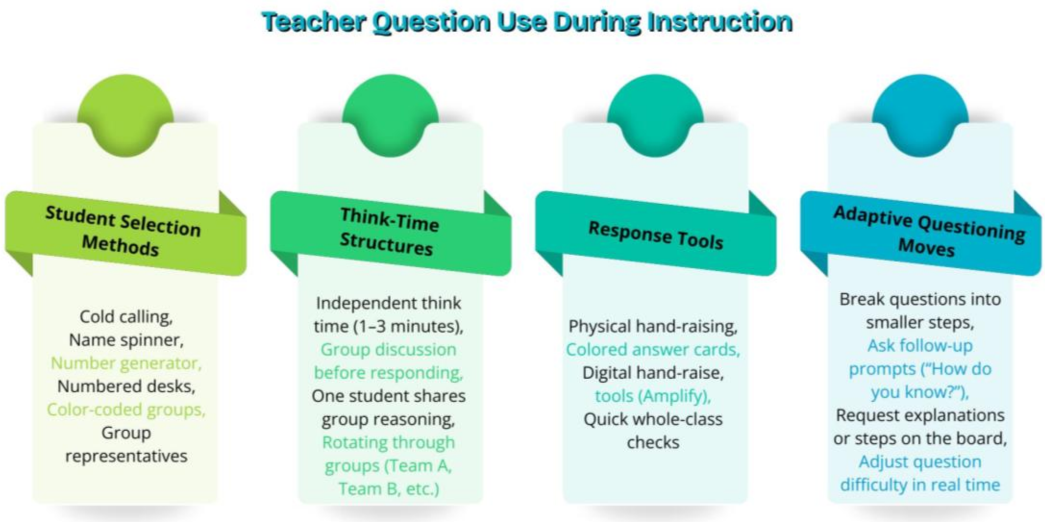

Figure 4: Overview of the main questioning strategies teachers used during instruction

Cold calling was routinely used as it encouraged students to stay attentive and prepared. To distribute questions fairly, mathematics teachers employed name spinners, number generators, numbered desks, and colour-coded group systems. Teacher 2 explained this routine by stating, "The colour spinner keeps everyone alert. They know anyone can be picked at any moment." Figure 5 illustrates how mathematics teachers marked desks with colour dots to identify group members, enabling the teacher to select a responding student by calling out a colour rather than a name.

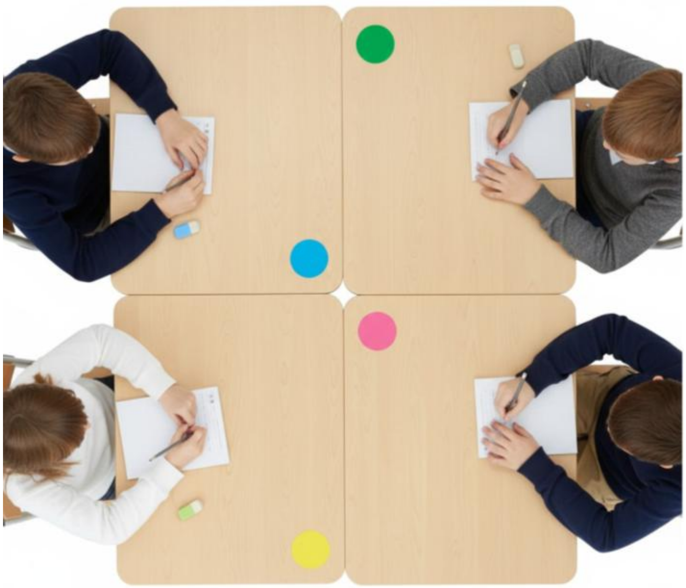

Figure 5: Color-coded desk arrangement used to select student respondents during questioning

Teachers reported that this method increased participation because students waited to see if their chosen colour would be selected. To support this system, many mathematics teachers utilised a digital colour-selection spinner, which randomly generated the responding colour. Students were more engaged when their chosen colour appeared, and mathematics teachers noted that this method reduced the likelihood of calling on the same students repeatedly. Figure 6 illustrates a sample spinner used to quickly and fairly choose a student from each group.

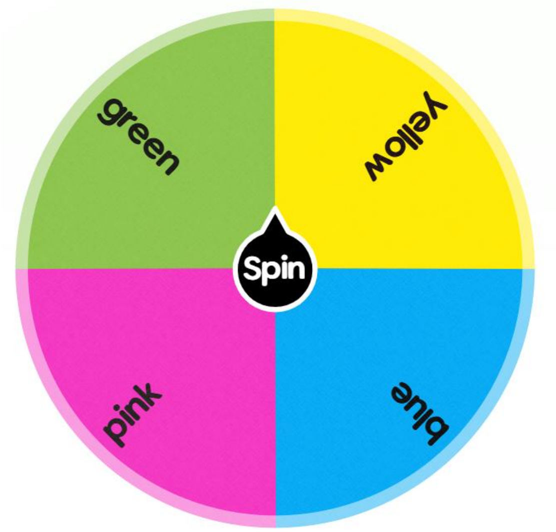

Figure 6: Digital spinner used to select students by color group during questioning

Teachers also described how they structured time before questioning. Many allowed students a few minutes to work independently or discuss a problem in their groups before selecting someone to respond. This structure allowed students to think carefully about questions that involved solving a system of equations ($y = 2x + 1, y = -x + 7$) or explaining geometric ideas, including why vertical angles are always equal. When students worked in groups, teachers often called on one representative to share the group's reasoning. Groups were labelled numerically or thematically (for example, "Team Tiger" or "Team Mustang"), and teachers rotated through them to ensure broad participation. Teacher 1 explained this routine, noting, "If I call on them right away, some panic. Giving them think time first makes the answers stronger."

Digital and physical response tools also played a role in questioning. Students raised their hands, showed coloured response cards, or used digital hand-raising tools on platforms like Amplify. To respond to questions, students also used coloured answer cards, which helped teachers quickly see their responses and check for understanding. Teachers said these tools helped them check understanding quickly, especially when asking conceptual questions such as, "Is the function $f(x) = \sqrt{x-3}$ defined for all real numbers?" or "What does a residual of -3 mean in a regression model?"

Several teachers used math-question spinners during instruction. These spinners contained actual mathematical prompts rather than student names. The questions on the spinner covered a range of content, ranging from computing the probability of rolling a 2 on a fair six-sided die to identifying the slope of a line $y = -7x - 11$ or evaluating an angle relationship in geometry. For more advanced classes, teachers included questions that required evaluating limits such as: $\lim_{x-2} \frac{x^2-4}{x-2}$, or taking simple derivatives like $f'(x) = 6x$ when $f(x) = 3x^2$.

During the interviews, several teachers explained that they used digital spinners containing actual mathematics questions as a method to randomly select problems and keep students engaged. Teacher 4 noted, "The mathematics spinner keeps them curious. They do not know what question will come next, so everyone pays attention." This spinner enabled teachers to pose both procedural and reasoning questions in a game-like format, which reduced anxiety for shy students and introduced an element of surprise during questioning. A sample mathematics question spinner used by teachers is shown in Figure 7.

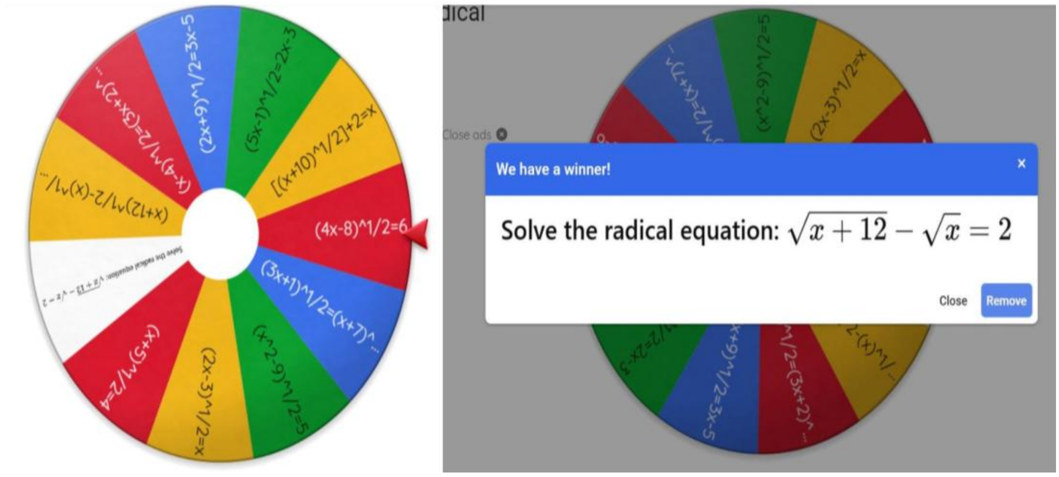

Figure 7: Example of a digital math-question spinner used by teachers to select radical equation problems during instruction.

Teachers frequently adjusted their questions based on student responses. When students appeared unsure, teachers shifted to more guided questions that broke down the problem. If students gave correct answers without explanation, teachers followed up with questions such as "How do you know?" or "Can you show your steps on the board?" Teachers believed that these adaptive moves helped them better understand student thinking and encouraged students to explain their reasoning clearly. They described flexibility as essential, noting that the quality of student responses often shaped the direction of the lesson. Teacher 3 described this adaptive approach, saying, "If their answers are short, I immediately ask them to explain. The follow-up question shows me what they truly understand."

In addition to using spinners, several teachers described using dice as part of their questioning routines. One approach involved a six-sided die labelled with different mathematics questions. A student rolled the die and responded to whichever question appeared on top. Another method used a blank die with student numbers written on each face, allowing the teacher to combine randomness and student selection. Some teachers also threw a soft foam die into the class; the student who caught it was expected to answer the next question. Teachers explained that dice made questioning more playful and reduced anxiety because the selection felt fair and unpredictable. Figure 8 shows an example of the large six-sided mathematics die used by teachers to randomly select algebra questions for students to solve during instruction.

Figure 8: Sample six-sided mathematics die displaying algebra questions used for random student response.

Teachers also reported incorporating digital gamified tools to increase student participation. Platforms like Wayground (formerly Quizizz) were used to pose questions, check understanding, and prompt students to discuss why certain answers were correct or incorrect. These tools helped engage quieter students who might not volunteer to speak in whole-class settings. The use of gamified questioning aligns with previous findings showing that platforms like Quizizz can support engagement, confidence, and mathematical explanation (Muchuweni, Jojo, & Kariyana, 2025).

Some teachers also mentioned using game-like structures, with Math Maze serving as an example, to encourage student thinking. Math Maze activities required students to navigate a pathway of questions, solving each prompt before advancing. Teachers found that these activities provided natural opportunities for questioning individual students or groups and were especially supportive for shy students who preferred solving problems quietly before sharing their reasoning. To summarise the full range of questioning practices described by teachers during instruction, Table 1 presents the main strategies they used along with brief explanations of each.

Table 1: Summary of Teachers' Questioning Strategies Used During Instruction

Category	Strategy Used	Description / Examples
Student Selection Methods	Cold calling	Teachers select students without volunteers to widen participation.
	Name spinner	Random students selected using a digital or physical spinner.
	Number generator	Teacher calls the student whose number is generated.
	Numbered desks	Teacher selects a desk number rather than a student's name.
	Color-coded groups	Teacher spins a color wheel to choose a student from that color group.

	Group representatives	Groups solve a task; one member shares the group's reasoning.
Response Tools	Hand-raise (physical/digital)	Students respond physically or via platform tools (e.g., Amplify).
	Colored answer cards	Students show color cards to indicate answers or confidence.
Think-Time Structures	Independent think time	Students think or work individually before answering.
	Group problem-solving	Students discuss the prompt before a representative respond.
Math-Question Tools	Math-question spinners	Spinner selects a mathematics question for the class.
	Dice with mathematics questions	Students roll to answer mathematics question.
	Gamified platforms	Tools such as Wayground/Quizizz used for questioning and feedback.
	Math Maze	Game-like pathway of questions that guide reasoning.
Adaptive Questioning Moves	Guided questioning	Teacher breaks complex questions into manageable steps.
	Reasoning follow-ups	Prompts including "How do you know?" or "Explain your thinking."
	Real-time adjustment	Teacher changes or extends questions based on student responses.

6. Discussion

This section interprets the findings through the lens of Dialogic Teaching Theory, which informed the analysis. It elucidates how the cognitive, interactional, and belief-based dimensions influenced teachers' questioning repertoires and facilitated opportunities for mathematical reasoning.

6.1. Question Planning

The findings show that mathematics teachers planned their questions intentionally, using planning time to decide which prompts would assess basic skills and which would support explanation and reasoning. This aligns with research indicating that careful planning is a key component of effective questioning (Nolan, 2025; Purdum-Cassidy et al., 2015). Teachers designed numerous procedural questions to confirm that students remembered rules and steps, a pattern that is also linked to pacing and assessment pressures in secondary classrooms (Alhayyan, 2023; Dong et al., 2015).

Teachers also worked to plan questions that asked students to explain, justify, or compare ideas. This supports earlier studies showing that open-ended questions deepen mathematical thinking (Aziza, 2021; Roberts, 2021; Zhuang & Conner, 2022). However, teachers noted that these reasoning questions require more time to prepare, especially when curriculum coverage is tight (Hansel, 2022; Murray, 2019). Teachers commonly used district curriculum materials as a starting point and adapted textbook questions so that students had to explain why a solution works, rather than just providing an answer. This reflects research indicating that teachers often revise curriculum tasks to promote reasoning (Remillard & Heck, 2014; Yenmez et al., 2018). Planning also focused on common student errors, notably difficulties with distributing negatives and distinguishing populations from samples, which aligns with findings showing that anticipating errors strengthens understanding (Cumhur & Matteson, 2017; Heng & Sudarshan, 2013). Professional learning communities (PLCs) supported this planning. Teachers shared example questions, identified likely misconceptions, and refined reasoning prompts during PLC discussions. This aligns with research suggesting that collaborative planning enhances questioning practices (Cumhur & Guven, 2022; Kabar & Tasdan, 2020).

Teachers also planned "anchor questions" to guide the lesson but expected to adjust their questions once they observed students' thinking. This balance between planned structure and real-time flexibility reflects evidence that teachers must make ongoing instructional decisions during questioning (Dong et al., 2015; Walkoe & Levin, 2018). The findings indicate that teachers balanced procedural and reasoning goals, adapted curriculum materials, anticipated errors, and used collaboration to improve questioning. These practices align with the cognitive, interactional, and belief-based dimensions of Dialogic Teaching Theory, which explains how teachers design and refine questions to support meaningful mathematical reasoning.

6.2. Question Use During Instruction

The findings show that questioning during instruction was an interactive and flexible process. Teachers did not follow fixed scripts; instead, they adjusted how they posed questions, selected students, and responded to student ideas as the lesson unfolded. This reflects the Dialogic Teaching Theory, which views classroom talk as co-constructed in real time and shaped by teacher responsiveness (Alexander, 2020; Kim & Wilkinson, 2019). Teachers employed structured routines, including name spinners, colour-coded groups, and digital selection tools, to involve more students. These predictable systems helped reduce bias and supported equitable participation, consistent with studies highlighting the importance of a fair distribution of questions (Zhu & Edwards, 2019). Teachers also incorporated think-time by allowing students to work individually or in groups before answering. This improved the quality of explanations and supported deeper reasoning, aligning with evidence on the value of wait time (Faria et al., 2024; Walter, 2018).

Different response tools, including coloured cards, digital hand-raise features, and gamified platforms, enabled teachers to check understanding quickly and provided quieter students with a safer way to participate. This finding supports research highlighting the role of technology in promoting confidence and inclusive participation (Yilmaz & Cakiroglu, 2024). Teachers frequently adapted their questions in the moment, simplifying them when students were confused, adding follow-up prompts when answers lacked explanation, and breaking problems into smaller steps when necessary. These responsive moves reflect the belief-based dimension of the Dialogic Teaching Theory and support prior evidence on adaptive questioning in mathematics classrooms (Paoletti et al., 2018).

Math spinners and Math Maze also contributed to participation. These tools reduced anxiety and made questioning feel more playful while maintaining high cognitive expectations, consistent with research on gamified engagement (Akkoç, 2015; Muchuweni et al., 2025). The findings demonstrate that teachers' use of questions during instruction was shaped by concerns about equity, student confidence, lesson pacing, and responsiveness to emerging thinking. Effective questioning involved not only selecting the right prompts but also creating supportive conditions that helped students explain, justify, and engage meaningfully with mathematical ideas.

7. Limitations

This study has several limitations. All data were derived from teacher self-reports gathered through questionnaires and interviews, meaning the findings reflect what teachers described rather than what was directly observed in classrooms. Self-reported information may be influenced by memory or personal beliefs (Roberts, 2021; Fletcher, 2023). Most interviews were conducted remotely, which limited the opportunity for follow-up questions and non-verbal cues; however, a few in-person interviews were conducted during visits to Florida. The study also involved only four teachers from one district in central Florida, which restricts the transferability of the findings to other contexts with different curricula or professional learning structures (Hansel, 2022; Murray, 2019). Despite these limitations, the study offers valuable insights into how mathematics teachers conceptualise questioning and the factors that shape their questioning repertoire.

8. Conclusion

This study examined how high school mathematics teachers plan and use questions to support both procedural understanding and mathematical reasoning. The findings show that teachers planned questions with clear intentions, drawing on curriculum materials and adapting them to create opportunities for explanation and justification. They also balanced planning with the need to remain flexible, adjusting their questions in response to students' ideas during instruction. During lessons, teachers used a variety of routines to involve more students and support equitable participation. They provided students with time to think, encouraged group discussion, and used follow-up prompts to clarify reasoning. Their adaptive moves were central to supporting mathematical sense-making, especially when students needed guidance or when answers lacked explanation. The study illustrates that questioning in secondary mathematics classrooms is both deliberate and dynamic.

Effective questioning requires thoughtful planning as well as responsive decisions in the moment. The results highlight the need for continued professional support that helps teachers design reasoning-focused questions, anticipate common student errors, and strengthen their confidence in using adaptive questioning strategies. These practices can help create classroom environments where students explain, justify, and engage deeply with mathematical ideas. Figure 9 shows the flow of questioning in this study, from planning questions to using them in class and creating student learning opportunities.

Figure 9: Flow diagram of teacher questioning from planning to student opportunities

9. Implications and Recommendations

Strengthening reasoning-based questioning necessitates targeted professional development. Teachers benefit from practical examples of high-quality questions and opportunities to practise follow-up prompts that extend student thinking (Zhuang & Conner, 2022; Faria et al., 2024). Training that models dialogic questioning, provides sample questioning sequences, and allows for rehearsal of probing techniques can help teachers build confidence in engaging in reasoning-focused dialogue. Schools and districts can also play a significant role. Tools such as spinners, colour-coded groups, numbered desks, and digital response features are most effective when used intentionally.

Administrators can support this by disseminating effective routines across departments, creating time for collaborative planning, and encouraging teachers to bring examples of planned questions to PLC meetings (Roberts, 2021; Fletcher, 2023; Haiduc et al., 2023). Given that teachers often adjust questions in real time, they require opportunities to practise flexible and adaptive questioning. Professional development that incorporates video reflection, peer coaching, or rehearsal of alternative questioning pathways can enhance teachers' ability to respond confidently and support students' reasoning as ideas emerge (Lee, 2025; Yildizli & Günaydin, 2022; Nolan, 2025).

At the policy level, schools and districts should regard questioning as a core component of equitable instruction. Allocating time for collaboration, supporting discourse-focused coaching, and promoting reflective practice can help embed reasoning-based questioning as a routine aspect of mathematics teaching (Yilmaz & Koştur, 2025; Roberts, 2021). These supports can foster classrooms where students regularly explain, justify, and make sense of mathematical ideas.

Conflict of Interest

The authors declare that they have no conflict of interest.

10. Acknowledgements

All aspects of the research, including the analysis, interpretation, and scholarly contributions, were carried out solely by the authors. This manuscript is an

original and accurate reflection of their work. ChatGPT (OpenAI) was used only in a limited way to support minor grammar and language refinement.

11. References

Akkoç, H. (2015). Formative questioning in computer learning environments: A course for pre-service mathematics teachers. *International Journal of Mathematical Education in Science and Technology, 46*(8), 1224–1240. https://doi.org/10.1080/0020739x.2015.1031835

Alexander, R. J. (2020). *A dialogic teaching companion.* Routledge.

Alhayyan, A. (2023). *Teacher questioning: Examining question types, depths, and factors influencing what teachers ask* [Doctoral dissertation, University of Maryland, College Park]. ProQuest Dissertations Publishing.

Aziza, M. (2021). A teacher questioning activity: The use of oral open-ended questions in the mathematics classroom. *Qualitative Research in Education, 10*(1), 66–98. https://doi.org/10.17583/qre.2021.6475

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

Clivaz, S., Daina, A., Batteau, V., Presutti, S., & Bünzli, L.-O. (2023). How do dialogic interactions contribute to the construction of teachers' mathematical problem-solving knowledge? Construction of a conceptual framework. *International Journal for Lesson & Learning Studies, 12*(1), 1–18. https://doi.org/10.1108/ijlls-03-2022-0031

Cumhur, F., & Guven, B. (2022). The effect of lesson study on questioning skills: Improving students' answers. *International Journal of Mathematical Education in Science and Technology, 53*(8), 2091–2111. https://doi.org/10.1080/0020739x.2021.2022227

Cumhur, F., & Matteson, S. M. (2017). Mathematics and science teacher candidates' beliefs of developing questioning skills in Turkey. *Journal of Teacher Education and Educators, 6*(3), 263–281. https://dergipark.org.tr/en/pub/jtee

Dahal, N., Luitel, B. C., & Pant, B. P. (2025). Understanding the use of questioning by mathematics teachers: A revelation. *SSRN Electronic Journal.* https://doi.org/10.2139/ssrn.5102389

Di Teodoro, S., Donders, S., Kemp-Davidson, J., Robertson, P., & Schuyler, L. (2011). Asking good questions: Promoting greater understanding of mathematics through purposeful teacher and student questioning. *The Canadian Journal of Action Research, 12*(2), 18–30. https://doi.org/10.33524/cjar.v12i2.16

Dong, L., Seah, W. T., & Clarke, D. (2015). A case study of the pedagogical tensions in teachers' questioning practices when implementing reform-based mathematics curriculum in China. In *Proceedings of the 38th Annual Conference of the Mathematics Education Research Group of Australasia (MERGA 38)* (pp. 197–204). Mathematics Education Research Group of Australasia. ERIC.

Eddy, C. M., & Kuehnert, E. A. (2018). The advancement of teacher questions in mathematics education. *American Educational History Journal, 45*(1–2), 83–97.

Faria, F. A. B., da Ponte, J. P., & Rodrigues, M. (2024). Teachers' leading whole-class discussions in a mathematics lesson study: From initial understanding to orchestration in practice. *European Journal of Science and Mathematics Education, 12*(1), 44–59. https://doi.org/10.30935/scimath/14149

Fletcher, S. (2023). The influence of teacher–student discourse on students' mathematics identity development in rural, secondary mathematics classrooms [Doctoral dissertation, University of Tennessee]. ProQuest Dissertations Publishing.

Haiduc, A. M., Suazo-Flores, E., Kastberg, S. E., Kenney, R., Leach, S. E., & Barber-Dansby, A. F. (2023). Mathematics teacher questioning: Cognitive and affective domains to nurture students' mathematical identity formation. In *Proceedings of the 45th*

Annual Meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education (PME-NA). ERIC.

Hansel, K. S. (2022). An interpretive multi-case study to understand what influences the usage and creation of open-ended questions in secondary mathematics [Doctoral dissertation, Indiana University of Pennsylvania]. ProQuest Dissertations Publishing.

Heng, M. A., & Sudarshan, A. (2013). "Bigger number means you plus!"—Teachers learning to use clinical interviews to understand students' mathematical thinking. *Educational Studies in Mathematics*, *83*(3), 395–408. https://doi.org/10.1007/s10649-013-9469-3

Hsu, H.-Y., Yao, C.-Y., & Lu, B. (2023). Examination of Taiwanese mathematics teacher questioning. *International Journal of Science and Mathematics Education*, *21*(6), 2287–2307. https://doi.org/10.1007/s10763-022-10313-2

Kabar, M. G. D., & Tasdan, B. T. (2020). Examining the change of pre-service middle school mathematics teachers' questioning approaches through clinical interviews. *Mathematics Teacher Education and Development*, *22*(2), 95–115. ERIC.

Kaya, S., & Ceviz, A. E. (2017). Pre-service teachers' use of dynamic discourse variables during classroom teaching. *Journal of Education and Practice*, *8*(33), 56–67. ERIC.

Kim, M.-Y., & Wilkinson, I. A. G. (2019). What is dialogic teaching? Constructing, deconstructing, and reconstructing a pedagogy of classroom talk. *Learning, Culture and Social Interaction*, *21*, 70–86. https://doi.org/10.1016/j.lcsi.2019.02.003

Lee, Y.-J. (2025). The effects of functional moves in teacher questioning on students' contextualization of mathematical word problem solving. *Journal of Mathematics Teacher Education*, *28*(1), 45–67. https://doi.org/10.1007/s10857-023-09616-0

Liang, S. (2024). *Classroom communication practices with young English learners in mathematics* [Doctoral dissertation, University of California, Santa Barbara]. ProQuest Dissertations Publishing.

Martin, C., Polly, D., McGee, J., Wang, C., Lambert, R., & Pugalee, D. (2015). Exploring the relationship between questioning, enacted mathematical tasks, and mathematical discourse in elementary school mathematics. *The Mathematics Educator*, *24*(2), 3–23. https://doi.org/10.63301/tme.v24i2.2000

McCarthy, P., Sithole, A., McCarthy, P., Cho, J., & Gyan, E. (2016). Teacher questioning strategies in mathematical classroom discourse: A case study of two grade eight teachers in Tennessee, USA. *Journal of Education and Practice*, *7*(30), 80–89. ERIC.

Mosvold, R., & Thente, N. (2025). Investigating natural differences in mathematics teacher questioning over time. *International Journal for Mathematics Teaching and Learning*, *26*(1), 1–25.

Moyer, P. S., & Milewicz, E. (2002). Learning to question: Categories of questioning used by preservice teachers during diagnostic mathematics interviews. *Journal of Mathematics Teacher Education, 5(4), 293–315.* https://doi.org/10.1023/a:1021251912775

Muchuweni, T., Jojo, Z., & Kariyana, I. (2025). Enhancing mathematics instruction through Quizizz: A systematic literature review. *International Journal of Learning, Teaching and Educational Research, 24*(10), 106–124. https://doi.org/10.26803/ijlter.24.10.5

Murray, S. A. (2019). *The impact of teacher questioning techniques on student achievement in mathematics* [Doctoral dissertation, University of Phoenix]. ProQuest Dissertations Publishing.

Nolan, E. C. (2025). Planning and implementing effective questioning. *Mathematics Teacher: Learning and Teaching PK–12, 118*(2), 127–132. https://doi.org/10.5951/mtlt.2024.0063

Paoletti, T., Krupnik, V., Papadopoulos, D., Olsen, J., Fukawa-Connelly, T., & Weber, K. (2018). Teacher questioning and invitations to participate in advanced mathematics lectures. *Educational Studies in Mathematics, 98*(3), 253–270. https://doi.org/10.1007/s10649-018-9807-6

Purdum-Cassidy, B., Nesmith, S., Meyer, R. D., & Cooper, S. (2015). What are they asking? An analysis of the questions planned by prospective teachers when integrating literature in mathematics. *Journal of Mathematics Teacher Education, 18*(1), 79–99. https://doi.org/10.1007/s10857-014-9274-7

Remillard, J. T., & Heck, D. J. (2014). Conceptualising the curriculum enactment process in mathematics education. *ZDM Mathematics Education, 46*(5), 705–718. https://doi.org/10.1007/s11858-014-0600-4

Roberts, S. A. (2021). Learning and unlearning through questioning practices: Middle grades mathematics teachers' transformations to support English learners. *Mathematics Teacher Education and Development, 23*(3), 48–66. ERIC.

Walkoe, J., & Levin, D. M. (2018). Using technology in representing practice to support preservice teachers' quality questioning: The roles of noticing in improving practice. *Journal of Technology and Teacher Education, 26*(3), 357–385.

Walter, H. A. (2018). Beyond turn and talk: Creating discourse. *Teaching Children Mathematics, 25*(3), 180–187. https://doi.org/10.5951/teacchilmath.25.3.0180

Yenmez, A. A., Erbas, A. K., Cakiroglu, E., Cetinkaya, B., & Alacaci, C. (2018). Mathematics teachers' knowledge and skills about questioning in the context of modelling activities. *Teacher Development, 22*(4), 496–514. https://doi.org/10.1080/13664530.2017.1338198

Yildizli, H., & Günaydin, G. (2022). An investigation of elementary mathematics teachers' questioning skills. *i.e.: Inquiry in Education, 14*(1), Article 6. ERIC.

Yilmaz, A., & Cakiroglu, E. (2024). Questioning channels of mathematics teachers in technology and non-technology supported mathematics classrooms. *International Journal of Technology in Education and Science, 8*(3), 392–411. https://doi.org/10.12345/ijtes.v8i3.12345

Yilmaz, A., & Koştur, M. (2025). Investigating prospective mathematics teachers' questioning purposes and intentions through their lesson plans. *Turkish Journal of Education, 14*(3), 185–202. https://doi.org/10.19128/turje.1368765

Zhu, Y., & Edwards, F. (2019). Teacher questioning in a Chinese context: Implications for New Zealand classrooms. *Teachers and Curriculum, 19*(1), 19–28. https://doi.org/10.15663/tandc.v19i1.340

Zhuang, Y., & Conner, A. (2022). Teachers' use of rational questioning strategies to promote student participation in collective argumentation. *Educational Studies in Mathematics, 111*(2), 205–225.https://doi.org/10.1007/s10649-022-10160-6