



The Influence of Teacher Questioning Strategies and Wait Time on Student Mathematical Reasoning and Problem-Solving Achievement: A Narrative Literature Review

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ABSTRACT

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This narrative literature review examines the influence of teacher questioning strategies and wait time on students' mathematical reasoning and problem-solving achievement, with particular emphasis on junior high school learners and the Philippine educational context. Anchored in constructivist, sociocultural, and dialogic theories of learning, the review synthesizes high-impact international research and locally relevant studies to argue that questioning and wait time function as core pedagogical practices rather than supplementary instructional techniques. Findings

across peer-reviewed studies indicate that high-cognitive demand questioning—characterized by prompts for explanation, justification, and connection-making—significantly enhances conceptual understanding, mathematical



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reasoning, and non-routine problem-solving performance, especially when supported by adequate wait time. However, structural constraints such as large class sizes, curriculum pacing pressures, and examination-oriented instruction continue to challenge effective implementation in Philippine classrooms. The review concludes by offering implications for classroom practice, teacher education, and policy reform aligned with outcomes-based and learner-centered education, positioning teacher questioning and wait time as essential levers for improving mathematics instruction and student achievement.

INTRODUCTION

The overarching aim of mathematics education has progressively shifted from an exclusive focus on procedural fluency toward the development of learners' capacity for reasoning, problem solving, and critical thinking (Kilpatrick et al., 2001; NCTM, 2014). International frameworks such as those of the National Council of Teachers of Mathematics (NCTM) and the Organisation for Economic Co-operation and Development (OECD) emphasize that mathematical proficiency entails not only knowing how to perform algorithms but also understanding why procedures work, making connections among concepts, and applying knowledge flexibly in unfamiliar situations (NCTM, 2014; OECD, 2023). Mathematical reasoning and problem-solving skills are therefore widely regarded as foundational competencies for academic success, informed citizenship, and participation in a rapidly evolving, knowledge-based global economy (Kilpatrick et al., 2001; OECD, 2023).

Despite this global consensus, large-scale assessments continue to reveal persistent gaps between curricular aspirations and actual student performance (OECD, 2023). Results from international assessments such as the Programme for International Student Assessment (PISA) consistently indicate that many learners struggle with tasks requiring reasoning, interpretation, and multi-step problem solving (OECD, 2023; UNESCO, 2021). These challenges are particularly pronounced in developing educational systems, where structural constraints and traditional instructional practices often limit opportunities for deep engagement with mathematical ideas (OECD, 2018).

In the Philippine context, concerns about students' mathematical achievement have been widely documented (OECD, 2023). Analyses of national and international assessment data point to low levels of performance in problem solving, reasoning, and application tasks, especially at the secondary level (OECD, 2019). Scholars and policymakers have attributed these outcomes to a combination of factors, including curriculum congestion, large class sizes, limited instructional resources, and teaching practices that prioritize rote memorization and procedural compliance over conceptual understanding. Classroom discourse in mathematics lessons is frequently teacher-dominated, with limited opportunities for students to articulate their thinking, justify solutions, or engage

in meaningful mathematical dialogue (Apus & Quirap, 2024).

Within this instructional landscape, teacher questioning emerges as a powerful yet underutilized pedagogical tool. Questions structure classroom discourse, signal what kinds of thinking are valued, and shape how students engage with mathematical content. When questions emphasize recall of facts or execution of procedures, students are likely to view mathematics as a set of rules to be memorized. In contrast, questions that require explanation, justification, and connection-making invite learners to reason, reflect, and construct meaning.

Closely intertwined with questioning is the concept of wait time—the deliberate pause a teacher provides after posing a question or receiving a student response. Seminal research has shown that even small increases in wait time can lead to substantial changes in the quality of classroom discourse and student thinking. Adequate wait time allows learners to process cognitively demanding questions, formulate reasoned responses, and participate more equitably in discussions. Without sufficient wait time, high-quality questions may fail to achieve their intended impact, as students are pressured to respond quickly rather than thoughtfully.

This narrative literature review examines the relationship between teacher questioning strategies, wait time, and students' mathematical reasoning and problem-solving achievement, with particular focus on junior high school learners. By integrating foundational theories, high-impact international research, and studies relevant to the Philippine context, the review seeks to provide a comprehensive and coherent synthesis of existing knowledge. Specifically, it addresses the following guiding question: How do teacher questioning strategies and wait time influence students' mathematical reasoning and problem-solving achievement? In doing so, the review aims to inform classroom practice, teacher education, and policy initiatives aimed at improving the quality of mathematics instruction.

METHODOLOGY

This study adopts a narrative literature review methodology to synthesize theoretical and empirical research on teacher questioning strategies, wait time, and mathematical reasoning and problem solving. A narrative review is particularly appropriate for this topic because it allows for an integrative examination of diverse theoretical perspectives, research designs, and contextual factors that shape instructional practices in mathematics education.

Scope and Focus of the Review

The review focuses on studies examining teacher questioning strategies and wait time in relation to students' mathematical reasoning, conceptual understanding, and problem-solving achievement. Particular attention is given to research involving junior high school or secondary learners, as this stage

represents a critical transition toward more abstract and complex mathematical thinking. While international studies form the core of the review, regional and Philippine-based research is intentionally incorporated to contextualize findings within local educational realities.

Literature Search Strategy

A comprehensive search of peer-reviewed journal articles, books, policy documents, and graduate theses was conducted using academic databases and repositories, including Google Scholar, ERIC, Scopus-indexed journals, ResearchGate, Frontiers, Dialnet, and institutional repositories of Philippine universities. Search terms included combinations of the following keywords: teacher questioning strategies, high-cognitive demand questions, wait time, mathematical reasoning, problem solving in mathematics, conceptual understanding, classroom discourse, and Philippine mathematics education.

Priority was given to seminal works that established foundational constructs, such as Polya's (1957) problem-solving framework, Rowe's (1974) theory of wait time, and research on mathematical discourse and cognitive demand. These were complemented by contemporary empirical studies published in high-impact journals, including the *Journal for Research in Mathematics Education*, *Educational Studies in Mathematics*, *Journal of Mathematical Behavior*, *Review of Educational Research*, and *Teaching and Teacher Education*.

Selection and Analysis of Literature

Selected studies were analyzed thematically to identify recurring patterns, convergent findings, and areas of divergence. The analysis focused on how questioning strategies were conceptualized and operationalized, the role of wait time in mediating student responses, and the reported effects on reasoning and problem-solving outcomes. Contextual factors influencing implementation—such as class size, curriculum demands, and teacher preparation—were also examined, particularly in relation to the Philippine education system.

THEORETICAL AND CONCEPTUAL FOUNDATIONS

The relationship between teacher questioning, wait time, and mathematical learning is grounded in constructivist and sociocultural theories of learning. Constructivist perspectives posit that learners actively construct knowledge by integrating new information with prior understanding through processes of reflection, exploration, and sense-making. In mathematics classrooms, questioning functions as a key mechanism for activating prior knowledge, challenging misconceptions, and guiding learners toward deeper conceptual understanding.

From a sociocultural perspective, learning is viewed as a socially mediated process in which language plays a central role. Classroom discourse—

shaped largely by teacher questioning—serves as the medium through which mathematical ideas are negotiated, refined, and internalized. Questions that prompt explanation, justification, and argumentation act as cognitive tools that scaffold students' reasoning and promote higher-order thinking. Mercer and colleagues' (2009) work on dialogic teaching underscores the importance of talk that is collective, reciprocal, supportive, cumulative, and purposeful in fostering deep learning.

The concept of cognitive demand further illuminates the role of questioning in mathematics instruction. Stein and colleagues' (1996) framework distinguishes between low-level tasks that emphasize memorization and procedures and high-level tasks that require reasoning, sense-making, and connection-making. Questions aligned with high-cognitive demand tasks are more likely to engage students in productive struggle and conceptual reasoning. However, maintaining high cognitive demand during classroom enactment requires deliberate instructional moves, including the strategic use of wait time.

Wait time can be understood through both cognitive and equity-oriented lenses. Cognitively, wait time provides learners with the temporal space needed to process complex questions, organize thoughts, and construct coherent responses. From an equity perspective, adequate wait time broadens participation by reducing the dominance of quick responders and creating opportunities for a wider range of students to contribute meaningfully to classroom discourse (Webb et al., 2015).

Teacher Questioning in Mathematics Education

Teacher questioning has long been recognized as a central feature of classroom instruction. In mathematics education, questions serve multiple purposes, including assessing prior knowledge, guiding problem-solving processes, eliciting reasoning, and facilitating discussion. Research distinguishes between lower-order questions—such as those requiring recall or procedural execution—and higher-order questions that demand explanation, analysis, and justification.

Meta-analyses have consistently shown that higher-order questioning is associated with greater gains in student achievement compared to predominantly lower-order questioning (Hattie, 2009). Redfield and Rousseau's (1981) synthesis demonstrated that instructional practices emphasizing higher-level questions positively influence students' cognitive outcomes, particularly when students are required to explain their reasoning. Similarly, Samson and colleagues (1987) found that the level of teacher questioning significantly affects student achievement, with higher-level questions producing stronger effects (Boaler & Brodie, 2004).

More recent studies have refined these findings by examining the qualitative nature of classroom discourse. Ingram (2012) and Ellis et al. (2024) proposed a typology of teacher questioning in mathematics classrooms, highlighting the importance of questions that probe student thinking and encourage reasoning

rather than merely evaluating correctness. Such questions position students as sense-makers and contributors to mathematical knowledge, rather than passive recipients of information.

High-Cognitive Demand Questioning and Mathematical Reasoning

High-cognitive demand questions are characterized by their emphasis on explanation, justification, and connection-making. Rather than asking students to produce a single correct answer, these questions invite learners to articulate how and why a solution works, compare alternative strategies, and reflect on underlying mathematical principles.

Empirical studies consistently demonstrate that classrooms rich in high-cognitive demand questioning foster stronger mathematical reasoning. Henningsen and Stein (1997) found that students engaged in tasks supported by high-level teacher questioning were more likely to demonstrate conceptual understanding and sustained engagement. Similarly, Kazemi and Stipek (2001) showed that classrooms emphasizing conceptual discourse and justification produced higher levels of student reasoning and participation.

High-cognitive demand questioning also supports the development of metacognitive awareness. When students are asked to explain their thinking, they become more conscious of their reasoning processes and better able to monitor and refine their strategies. This metacognitive engagement is critical for solving non-routine problems, where procedural recall alone is insufficient.

In the Philippine context, emerging studies suggest that strategic oral questioning can significantly enhance students' reasoning skills. Research conducted in local secondary schools indicates that when teachers intentionally pose open-ended and probing questions, students demonstrate improved ability to justify solutions and engage in mathematical argumentation, even within resource-constrained environments.

Questioning Strategies and Mathematical Problem Solving

Problem solving lies at the heart of mathematics learning, encompassing the ability to interpret problems, devise strategies, execute solutions, and reflect on results. Polya's (1957) classic framework underscores the importance of reasoning and reflection at each stage of the problem-solving process. Teacher questioning plays a critical role in scaffolding these stages.

Probing questions encourage students to clarify assumptions, elaborate on partial solutions, and examine the validity of their reasoning. Divergent questions, which allow for multiple solution pathways, foster flexibility and creativity in problem solving. Reflective questions prompt learners to evaluate their strategies and consider alternative approaches, thereby deepening conceptual understanding. Research indicates that classrooms characterized by varied questioning strategies exhibit higher levels of student engagement and problem-solving achievement. Studies have shown that students exposed to diverse and higher-order questioning

develop stronger conceptual understanding, which in turn mediates problem-solving performance. Conceptual knowledge enables learners to adapt strategies to novel contexts, a skill essential for success in complex mathematical tasks.

The Mediating Role of Wait Time

The effectiveness of questioning strategies is critically dependent on the provision of adequate wait time. Rowe's (1974) seminal research demonstrated that increasing wait time to three to five seconds or more leads to longer, more complex student responses, increased use of reasoning, and higher levels of voluntary participation.

Subsequent studies in mathematics classrooms have confirmed these findings. Tobin's (1987) work showed that extended wait time enhances higher cognitive level learning by allowing students to engage more deeply with questions. Adequate wait time also promotes equity by reducing the dominance of quick responders and encouraging participation from students who require additional processing time.

In practice, however, wait time is often constrained by curriculum pacing pressures and classroom management concerns. In the Philippine context, large class sizes and examination-oriented instruction further limit teachers' willingness to pause. Addressing these challenges requires professional development that explicitly emphasizes the pedagogical value of wait time and supports teachers in integrating it into daily practice.

Implications for Practice, Policy, and Research

The reviewed literature underscores the need to position teacher questioning and wait time as central components of effective mathematics instruction. For classroom practice, teachers should be supported in designing questions that emphasize reasoning, justification, and connection-making, while consciously allowing sufficient time for student thinking.

Teacher education and professional development programs should explicitly address questioning strategies and wait time as core pedagogical skills. Policy initiatives, including curriculum guides and assessment frameworks, should align with these practices by valuing reasoning and problem solving over procedural recall.

Future research should explore longitudinal effects of questioning practices, investigate culturally responsive questioning strategies, and examine how technology-enhanced environments can support productive mathematical discourse. Empirical studies within the Philippine context remain particularly needed to inform context-specific interventions.

The Philippine Context: Mathematics Instruction, Reforms, and Empirical Evidence

Mathematics education in the Philippines is shaped by historical, structural, and sociocultural factors that directly influence classroom discourse, questioning practices, and the use of wait time. Traditionally, mathematics instruction in many Philippine classrooms has been characterized by teacher-centered approaches, procedural emphasis, and recitation-based questioning. These practices are often reinforced by large class sizes, limited instructional time, and assessment systems that prioritize correct answers over reasoning processes.

International benchmarking results have intensified concerns about the quality of mathematics instruction in the country. Philippine students' performance in large-scale assessments has highlighted persistent difficulties in tasks requiring interpretation, reasoning, and non-routine problem solving. Scholars argue that these outcomes reflect not only curriculum issues but also deeply ingrained pedagogical practices that limit opportunities for students to engage in mathematical reasoning and discourse.

Recent curriculum reforms, including the MATATAG Curriculum, signal a policy-level recognition of the need to strengthen conceptual understanding and higher-order thinking skills. Curriculum guides explicitly emphasize reasoning, communication, and problem solving as key learning competencies. However, research suggests that curricular intentions do not automatically translate into classroom practice. Teachers often struggle to enact reform-oriented instruction due to insufficient professional development, heavy teaching loads, and pressure to prepare students for summative assessments.

Local empirical studies provide emerging evidence that questioning strategies can serve as a practical entry point for instructional improvement. Research conducted in Philippine junior high schools indicates that when teachers deliberately shift from recitation-style questioning to open-ended, probing, and reflective questions, students demonstrate greater engagement, improved reasoning, and more positive attitudes toward mathematics. These gains are particularly evident when teachers consciously allow extended wait time, enabling students to articulate their thinking more fully.

Nevertheless, the literature also points to systemic barriers. Large class sizes constrain teachers' ability to manage extended discussions, while rigid pacing guides discourage prolonged exploration of ideas. Addressing these challenges requires coordinated efforts across classroom practice, teacher education, and policy implementation.

Implications for Classroom Practice

The reviewed literature underscores the importance of re-conceptualizing questioning and wait time as central instructional practices in mathematics classrooms. Teachers are encouraged to design questions that foreground reasoning, justification, and connection-making rather than mere recall. Strategic

use of probing and follow-up questions can help sustain high cognitive demand during classroom discussions.

Equally important is the deliberate provision of wait time. Teachers should cultivate a classroom culture in which silence is viewed as productive thinking time rather than an instructional failure. Explicitly signaling to students that thoughtful responses are valued can reduce anxiety and promote more equitable participation.

Implications for Teacher Education

Teacher preparation and professional development programs play a critical role in shaping questioning practices. Pre-service and in-service training should include explicit instruction on designing high-cognitive demand questions, managing classroom discourse, and using wait time effectively. Video-based reflection and lesson study approaches have been shown to be particularly effective in helping teachers recognize and refine their questioning behaviors.

Implications for Policy and Curriculum

At the policy level, curriculum frameworks and assessment systems must align with instructional goals that prioritize reasoning and problem solving. When high-stakes assessments emphasize procedural fluency alone, teachers are less likely to invest time in discourse-rich instruction. Policymakers should therefore ensure that assessment tasks value explanation, justification, and multiple solution strategies.

DIRECTIONS FOR FUTURE RESEARCH

Despite a robust international literature, several gaps remain. Longitudinal studies are needed to examine the sustained impact of questioning and wait time on students' mathematical development. Research exploring culturally responsive questioning practices is particularly important in multilingual and diverse contexts such as the Philippines.

Future studies should also investigate how digital and technology-enhanced environments can support productive mathematical discourse. Online discussion forums, interactive platforms, and AI-supported tools may offer new opportunities for extending wait time and facilitating reflective questioning.

CONCLUSION

This narrative literature review has critically examined the influence of teacher questioning strategies and wait time on students' mathematical reasoning and problem-solving achievement, with particular emphasis on junior high school learners and the Philippine educational context. Drawing from constructivist, sociocultural, and dialogic perspectives, the review demonstrates that questioning

and wait time are not peripheral instructional techniques but core pedagogical practices that fundamentally shape how students engage with mathematical ideas.

Across international and local studies, convergent evidence shows that high-cognitive demand questioning—characterized by prompts for explanation, justification, and connection-making—supports the development of conceptual understanding and mathematical reasoning. When students are invited to articulate their thinking, compare solution strategies, and defend their ideas, they begin to view mathematics as a coherent system of relationships rather than a collection of isolated procedures. This shift is essential for success in non-routine problem solving, which requires flexibility, reflection, and metacognitive awareness.

The review further underscores the mediating role of wait time in realizing the potential of high-quality questioning. Adequate wait time provides learners with the cognitive space necessary to process complex questions, formulate reasoned responses, and participate meaningfully in classroom discourse. Importantly, wait time also serves an equity function by broadening participation and reducing the dominance of quick responders. In classrooms where silence is treated as productive thinking time, a wider range of students are able to contribute to mathematical discussions.

In the Philippine context, persistent challenges such as large class sizes, curriculum pacing pressures, and examination-oriented instruction continue to constrain the enactment of discourse-rich mathematics teaching. While recent curriculum reforms emphasize reasoning and problem solving, the literature suggests that these goals will remain aspirational unless teachers are supported in developing effective questioning practices and in using wait time strategically. Teacher education, professional development, and assessment reform therefore play critical roles in translating policy intentions into classroom realities.

Overall, this review argues that improving students' mathematical reasoning and problem-solving achievement requires a deliberate and sustained focus on the quality of classroom discourse. By institutionalizing high-cognitive demand questioning and adequate wait time as central components of mathematics instruction, educators and policymakers can create learning environments that promote deep understanding, critical thinking, and meaningful engagement with mathematics. These practices are particularly vital for preparing Filipino learners to meet the cognitive demands of contemporary society and to participate fully in an increasingly complex and knowledge-driven world.

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