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Do Mathematics Anxiety and Metacognitive Insight Impact Decision Making in Problem Solving? Systematical Literature Review

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ABSTRACT

Mathematics anxiety is one of the significant psychological challenges in the process of learning mathematics, especially because of its impact on cognitive abilities and decision-making in problem solving. Previous studies have shown that this anxiety not only decreases academic performance but also affects the efficiency and accuracy of metacognitive monitoring and control. This study aims to examine the relationship between math anxiety, metacognitive insight, and decision-making in solving mathematical problems. The method used is a systematic literature review of 10 scientific articles published in 2021–2025, which includes quantitative, qualitative data, and meta-analysis, focusing on the variables of mathematics anxiety, metacognition, self-efficacy, self-regulation, and problem-solving performance. The results of the review show that math anxiety is negatively related to metacognitive self-confidence and problem-solving performance, but this relationship can be mediated by factors such as self-efficacy, self-regulation, and cognitive activation. The decline in performance is also reinforced by disruption to working memory caused by emotional stress. This study emphasizes the importance of a comprehensive pedagogical approach in building metacognitive abilities while managing emotional factors to improve the effectiveness of mathematics learning.

Keywords**:** *Mathematics Anxiety; Metacognition; Problem Solving; Self-Regulation; Working Memory.*

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INTRODUCTION

In the world of modern education, the ability to think critically and solve problems independently is one of the main competencies that students must have. One area that requires this ability is mathematics. Mathematics is not just a collection of numbers and formulas but is an important logical and systematic thinking tool in facing real-life challenges. However, not all individuals are able to go through the mathematics learning process smoothly (Chen et al.,

2025). Many students experience difficulties, even excessive anxiety when faced with mathematics problems. This phenomenon is known as mathematics anxiety, which is a negative emotional condition characterized by fear, nervousness, or psychological pressure when having to complete mathematics assignments. This condition can appear from elementary school age and continue until higher education, even affecting a person's career decisions and mental well-being (Lau et al., 2024).

Math anxiety not only affects the emotional aspect but also affects a person's cognitive processes. Individuals who experience math anxiety tend to experience disturbances in working memory, decreased learning motivation, and decreased academic performance. In situations that require problem solving, they are more likely to feel insecure, make hasty decisions, or even avoid math tasks altogether. This is certainly a major challenge in the world of education, given the importance of mathematics in forming the basis of scientific, technological, and logical thinking (Harahap et al., 2025).

Advances in educational psychology have introduced the concept of metacognition as one of the important factors in successful mathematics learning. Metacognition is the ability to understand and control one's own thinking processes, including planning, monitoring, and evaluating problem-solving strategies. Individuals who have good metacognitive skills are able to recognize weaknesses and strengths in their thinking processes and make appropriate strategic adjustments when faced with difficulties (Muncer et al., 2022). In mathematics, metacognition plays a central role in improving conceptual understanding, work efficiency, and accuracy in decision making when solving problems (Asare et al., 2025).

The interaction between mathematics anxiety and metacognition has become the focus of attention of many researchers in recent years. Both are believed to have a complex relationship and influence each other in decision-making when solving mathematical problems. For example, anxiety can hinder accurate metacognitive monitoring, while lack of metacognitive skills can worsen the perception of mathematical difficulty (Pan et al., 2024). Therefore, it is important to examine this relationship in depth in order to find effective learning strategies, both in the classroom and in the development of educational policies. A more comprehensive understanding of these dynamics is expected to help design interventions that not only reduce mathematics anxiety but also strengthen students' reflective and strategic thinking skills in solving mathematical problems optimally (Gorman et al., 2023).

Problems in the world of education, especially in mathematics learning, are not only related to cognitive aspects such as mastery of concepts or logical abilities but also involve affective and metacognitive dimensions that are often overlooked. One important issue that continues to be a concern for researchers is mathematics anxiety, a negative emotional condition characterized by fear, anxiety, or stress when individuals face mathematical tasks (Bellon et al., 2021). Mathematics anxiety not only interferes with the learning process but also has a direct impact on decision -making abilities in problem solving. In certain situations, individuals who experience mathematics anxiety tend to avoid activities related to numbers, experience decreased working memory capacity and tend to make suboptimal decisions due to emotional influences that distort cognitive processes (Doz et al., 2023).

Developments in cognitive psychology have shown that metacognitive insight, an individual's ability to be aware of, monitor, and reflect on their own thinking processes, plays an important role in improving the quality of decision-making (Musa & Maat, 2021). Individuals with high metacognitive awareness tend to be better able to choose effective problem-solving strategies, critically evaluate progress, and avoid repeating mistakes. In other words, metacognitive regulation functions as an internal control mechanism that can stabilize the thinking process, even in less than ideal emotional conditions (Güner & Erbay, 2021).

The purpose of this literature review is to systematically explore and synthesize current scientific findings on how mathematics anxiety and metacognitive insight interact and influence decision-making in mathematical problem solving. By collecting and analyzing research results from various fields such as educational psychology, cognitive science, and learning theory, this article aims to provide a more holistic understanding of the dynamics between affective and metacognitive factors in complex cognitive processes such as problem solving.

Although there have been many studies that discuss each variable separately, there is a significant research gap in terms of understanding the causal or correlational relationship between mathematics anxiety and metacognitive insight in mathematical decision making. Most studies are still fragmentary and not many have explicitly examined the interactive or mediating effects between the two variables in mathematical tasks that require higher-order thinking skills. The lack of integration between affective and metacognitive dimensions in the design of educational interventions also poses a challenge in applying research results to classroom teaching practices.

The urgency of this research becomes increasingly relevant considering the challenges of 21st-century education that demand critical thinking skills, rational decision-making, and emotional resilience in dealing with complex situations. Students' inability to manage mathematics anxiety and weak metacognitive monitoring can result in failure to understand problems, choose the right strategy, and draw valid conclusions. Furthermore, this not only impacts academic performance, but also students' self-efficacy and confidence in their logical thinking abilities in the future.

Therefore, a systematic study that explores the dual role of mathematics anxiety and metacognitive insight in decision-making is not only theoretically important, but also has enormous practical implications in curriculum design, psycho-pedagogical interventions, and the development of self-regulation-based learning models. By synthesizing empirical evidence from relevant literature, this review is expected to fill the gap in current scientific knowledge and serve as a basis for further, more focused research. Future research should consider an integrative approach that combines metacognitive training with anxiety-reducing strategies to enhance decision-making effectiveness in complex and challenging mathematics learning.

RESEARCH METHODS

The research method used in this study is a literature review with a systematic approach to ten relevant scientific articles that have been published in the period 2021 to 2025. The articles analyzed were selected based on certain criteria, namely they must be the results of empirical research that discuss topics related to mathematics anxiety, metacognitive insight, and decision-making in mathematical problem solving. The literature search process was carried out through trusted academic databases such as Scopus, ERIC, PsycINFO, and Google Scholar using a combination of keywords such as "mathematics anxiety," "metacognition," "problem solving," and "decision-making." All selected articles have been peer-reviewed and used both quantitative and qualitative approaches. Data analysis was carried out thematically by identifying patterns of findings, similarities, and differences between studies which were then synthesized to answer the main research questions. This approach not only allows mapping of current research trends but also reveals knowledge gaps that still need to be explored in future studies.

The literature review process followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework. This framework guided the identification, screening, eligibility assessment, and inclusion of studies to ensure a rigorous and transparent review process. The detailed flow of article selection is illustrated in Figure 1.

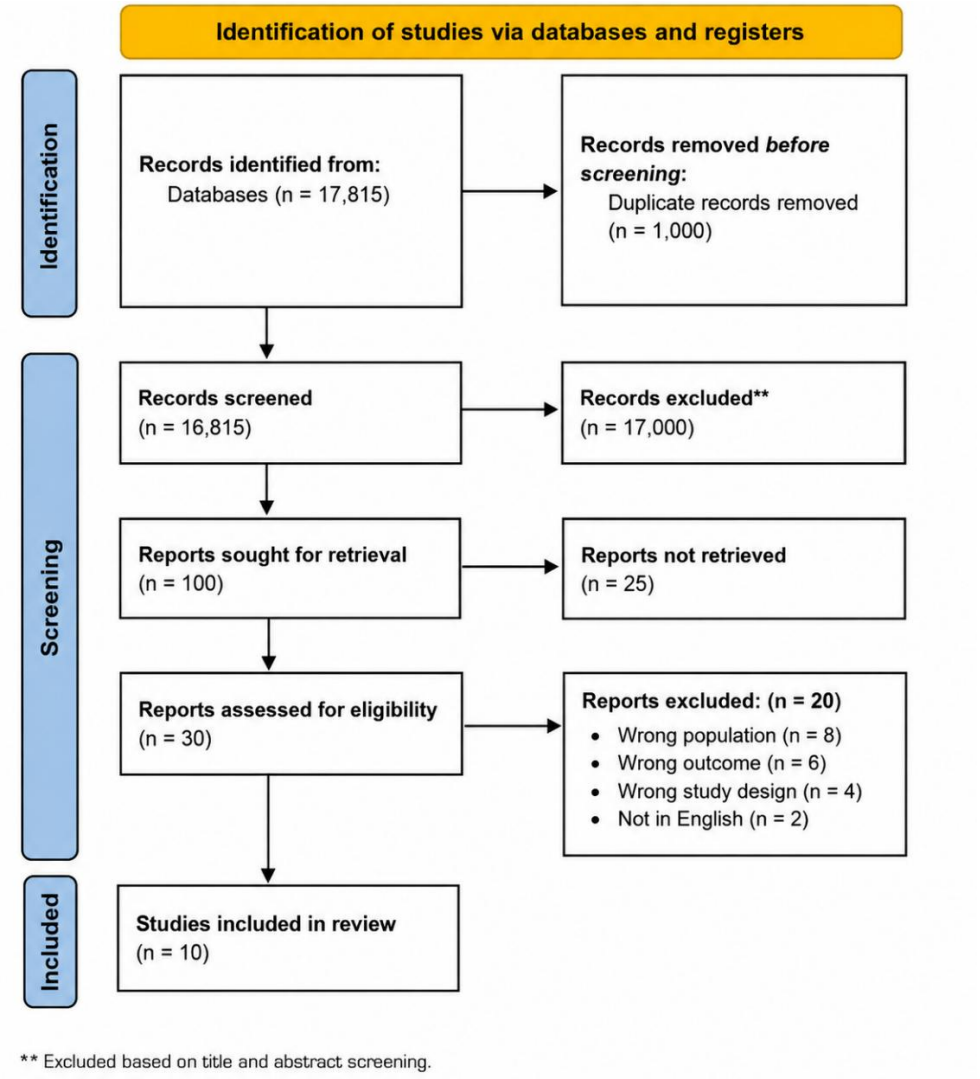

Figure 1. PRISMA Flow Diagram

RESULTS AND DISCUSSION

Based on the review results of several reputable articles in Scopus, ERIC, PsycINFO, and Google Scholar using a combination of keywords such as "mathematics anxiety," "metacognition," "problem solving," and "decision-making." It was found that there is a relationship between Mathematics Anxiety and Metacognitive Insight Impacting Decision Making in Problem Solving. The results of the research review can be seen in Table 1.

Table 1. Literature Review Results

Reference	The Problem	Objective	Result
(Desender & Sasanguie, 2022)	Reliance on self-report measures in studies of the relationships between math anxiety, metacognition, and mathematical decision making.	Provides new experimental evidence on the relationship between math anxiety, metacognitive efficiency, and decision accuracy.	Math anxiety decreases self-confidence levels but increases metacognitive efficiency prospectively.

Table 1. Literature Review Results

Reference	The Problem	Objective	Result
(Scheibe, Was, Dunlosky, & Thompson, 2023)	Inefficiency of metacognitive experiences due to math anxiety.	Developing the RAMPS framework to explain the role of attention regulation in mathematical problem solving.	Math anxiety interferes with metacognition and task control, affecting mathematical decision making.
(Zhu, Liu, Xiao, & Sindakis, 2024)	The complexity of the relationship between math anxiety and problem-solving abilities of high school students.	Analyzing the impact of math anxiety on problem solving performance in a knowledge-based economy.	Significant negative correlation between math anxiety and problem solving ability.
(Guntur & Purnomo, 2024)	The role of self-efficacy, self-regulation, and metacognition in reducing math anxiety	Analyzing the relationship and mediating role of metacognition on math anxiety at elementary school level.	Self-efficacy reduces math anxiety through the mediation of self-regulation and metacognition.
Bellon et al. (2021)	Empirical uncertainty of the relationship between math anxiety and metacognitive monitoring on arithmetic achievement.	Examining longitudinal relationships between math anxiety, metacognitive monitoring, and arithmetic achievement.	Arithmetic achievement mediates the relationship between math anxiety and metacognition.
(Kusuma, Rahmawati, Murtianto, & Baldemor, 2024)	There is a lack of studies linking emotional intelligence and metacognition in solving mathematical problems.	Reviewing the role of emotional intelligence on metacognition in solving mathematical problems.	Metacognition and emotional intelligence support focus and consistency in problem solving.
(Scheibe et al., 2022)	Lack of understanding of predictors of metacognitive judgments during real-world mathematics tasks.	Examining factors influencing item-level metacognitive judgments before and after an educational intervention.	Intervention improved confidence ratings; math anxiety continued to affect accuracy perceptions.
Tay et al. (2024)	Limited research simultaneously examines metacognitive knowledge, regulation, and experiences in mathematics learning	To investigate the relationships among the three metacognitive components and their association with mathematics achievement	Metacognitive components are strongly interrelated; high-achieving students rely more on cognitive strategies, while low-achieving students rely more on affective approaches.
(Muncer et al., 2022)	There is a lack of quantitative synthesis of the relationship between metacognition and adolescent mathematics performance.	Conducting a meta-analysis on the relationship between metacognition and mathematics performance.	Conducting a meta-analysis on the relationship between metacognition and mathematics performance.
(Zuo, Huang, & Qi, 2024)	Lack of understanding of the mediating role of math anxiety and self-efficacy in mathematics achievement.	Testing the relationship between cognitive activation and mathematics achievement through self-efficacy and math anxiety.	Cognitive activation, self-efficacy, math anxiety, math achievement.

The Relationship Between Mathematics Anxiety and Metacognition

Mathematics anxiety has consistently been found to have a significant relationship with metacognitive aspects in the mathematics learning process. Based on findings from various articles, such as those presented by Desender & Sasanguie (2021), Scheibe et al. (2023), and Bellon et al. (2021), it appears that mathematics anxiety not only impacts cognitive performance but also affects the accuracy and efficiency of metacognitive monitoring. Individuals with high levels of anxiety tend to show lower self-confidence in completing mathematics tasks, both prospectively and retrospectively, as found in Desender's study. This anxiety interferes with metacognitive experiences that should help students evaluate and control their thinking processes when solving mathematics problems. Furthermore, Bellon's longitudinal study revealed that high anxiety at the beginning of the school year has an impact on metacognitive monitoring abilities later, and in turn affects arithmetic achievement. This means that the relationship between anxiety and metacognition is reciprocal but can be mediated by factors such as previous academic achievement. These findings reinforce the importance of paying attention to the emotional aspects of mathematics education, as ineffectiveness in managing emotions can hinder the full utilization of students' metacognitive potential.

The Role of Self-Efficacy, Self-Regulation, and Working Memory as Mediators

Several studies have shown that the relationship between math anxiety and metacognitive ability is not direct but rather mediated by other psychological variables such as self-efficacy, self-regulation, and working memory capacity. In a study by Guntur & Purnomo (2024), it was found that self-efficacy has a negative relationship with math anxiety, where students who feel confident in their abilities tend to have lower levels of anxiety. This self-efficacy contributes to self-regulation and the use of metacognitive strategies effectively, which ultimately reduces anxiety and improves academic performance. Meanwhile, an article by Scheibe et al. (2023) proposed the RAMPS framework that integrates working memory and metacognitive experiences as important parts of solving mathematical problems. They revealed that emotional stress such as anxiety can interfere with working memory capacity, which in turn worsens the quality of metacognitive decisions and control strategies used by students. These findings emphasize the importance of strengthening students' internal components, such as self-confidence and the ability to regulate thoughts and emotions, in order to build resilience to the stress that arises when facing mathematical challenges.

Intervention Strategies to Reduce Math Anxiety

The results of the reviewed studies provide important insights into designing effective educational interventions to address mathematics anxiety and improve students' metacognitive skills. For example, the results of studies by Zhu et al. (2024) and Zuo et al. (2024) emphasize the importance of the role of parents and the education system in forming healthy expectations of students' performance. Excessive pressure from the social environment can trigger anxiety, which ultimately hinders the use of effective problem-solving strategies. In addition, studies by Tay et al. (2023) and Kusuma et al. (2024) emphasize the importance of an approach that integrates emotional intelligence in mathematics learning. Effective metacognition requires not only cognitive skills but also the ability to understand and manage emotions, such as frustration or embarrassment when failing to answer a problem. Therefore, a holistic educational approach that combines metacognitive training, increasing self-efficacy, and managing anxiety emotionally becomes very relevant. Teachers and policy makers are advised to design curricula and teacher training that can foster students' metacognitive awareness from an early age, as well as create an emotionally supportive learning environment.

CONCLUSION

Based on the results of the literature review that has been analyzed, it can be concluded that there is a close and complex relationship between mathematics anxiety and students' metacognitive abilities, which mutually influence and are mediated by various other psychological factors such as self-efficacy, self-regulation, and working memory capacity. Mathematics anxiety has been shown to not only inhibit cognitive performance but also reduce accuracy and confidence in metacognitive monitoring and control. This decrease in metacognitive effectiveness can occur both prospectively (when preparing to complete a task) and retrospectively (when evaluating results). Meanwhile, factors such as self-efficacy and self-regulation abilities play an important role in reducing the negative effects of anxiety on metacognitive thinking processes. Emotional stress due to high expectations, both from oneself and the environment, is also known to worsen working memory capacity, which ultimately inhibits decision making in the mathematics learning process. Therefore, efforts to improve students' metacognition cannot be separated from managing their emotional aspects. The educational implications that can be taken are the importance of a holistic approach in mathematics learning that not only focuses on cognitive aspects, but also actively fosters students' emotional and social competencies. Educational interventions that integrate metacognitive training, self-efficacy enhancement, and stress and anxiety management need to be developed and implemented systematically so that students can learn optimally and build psychological resilience in facing academic challenges, especially in mathematics.

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