Role of Metacognitive Skills and Student Engagement in Enhancing Mathematics Performance among High School Learners: A Systematic Literature Review

Cherry Mae L. Valdez, Allan Jay S. Cajandig (Professor)

College of Graduate School, Sultan Kudarat State University, Philippines

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ABSTRACT

Metacognitive skills and student engagement play crucial roles in enhancing mathematics performance among high school learners. This systematic review examines the metacognitive skills, student engagement, and mathematics performance of high school learners. Using the PRISMA methodology, a comprehensive search of the ERIC database with relevant keywords yielded 363 studies, which were screened and assessed for eligibility without duplicates. After full-text appraisal, 12 studies were included. The findings demonstrate that metacognitive regulation (planning, monitoring, evaluation) combined with multidimensional student engagement drives significant improvements in math achievement, with quantitative studies (10/12) showing consistent positive correlations. The review highlights the global relevance of these factors despite limited Philippine evidence (2/12 studies), emphasizing strategic self-regulation and behavioral/emotional/cognitive engagement as key mechanisms. These results provide evidence-based recommendations for educators to integrate metacognitive training and engagement strategies, particularly needed in under-researched local contexts like the Philippines. This review underscores the interplay of metacognitive and engagement factors as essential for high school math success and advocates for targeted interventions, including explicit strategy instruction and Philippine-specific research to bridge evidence gaps.

Keywords*:* Metacognitive Skills, Student Engagement, Mathematics Performance, Mathematics Achievement, High School Learners

INTRODUCTION

Cognitive and metacognitive skills are central to academic success and lifelong learning, enabling learners to effectively process information, solve problems, and regulate their own learning processes (Sheffler et al., 2022; Stanton et al., 2021). Cognitive skills refer to the internal mental processes through which individuals perceive, understand, and remember information, while metacognitive skills involve awareness and regulation of these processes, often described as "thinking about thinking" (Tatiana et al., 2022). The study of Catador Jr., J. A. (2024). highlighted that high-performing students in mathematics were those who effectively utilized and managed their metacognitive awareness. Moreover, it was found that greater awareness of metacognitive thinking correlated with better performance in mathematics.

Some studies like Zhu et al. (2019) have examined metacognitive knowledge alongside self-efficacy and motivation among junior high students, most existing research examines these factors individually, uses limited engagement dimensions, or focuses on university-level students, leaving a gap in comprehensively understanding how multiple aspects of metacognitive skills (knowledge, regulation, experience) interact with behavioral, emotional, and cognitive engagement dimensions to predict mathematics performance specifically among high school learners.

This systematic literature review addresses this gap by investigating the joint influence of comprehensive metacognitive skills and multidimensional student engagement on mathematics performance among high school learners. The findings will provide evidence-based implications for classroom practices that integrate explicit metacognitive strategy instruction with sustained engagement strategies to optimize mathematics achievement at the high school level.

Purpose of the Study

The purpose of this study is to systematically review and synthesize empirical research conducted between 2015 and 2025 on the role of metacognitive skills and student engagement in enhancing mathematics performance among high school learners. This review aims to evaluate how these cognitive and behavioral factors contribute to improved math achievement across diverse educational contexts. By employing the PRISMA framework, the study ensures a transparent and replicable process of literature identification, screening, and analysis, ultimately identifying key mechanisms, effective strategies, and research gaps. The findings intend to provide educators and policymakers with evidence-based insights to integrate metacognitive training and engagement interventions that elevate mathematics performance among high school learners, fostering deeper problem-solving and lifelong learning competencies. This literature review aims to answer the question:

a. Among high school learners, how do metacognitive skills (e.g., planning, monitoring, evaluation) and student engagement (e.g., behavioral, emotional, cognitive dimensions) affect mathematics performance, according to empirical studies published between 2015 and 2025?

METHODOLOGY

This study employs a systematic review approach to synthesize existing literature on the impact of metacognition on learning outcomes and educational efficiency. The review adheres to the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines, ensuring methodological rigor and transparency.

Inclusion and Exclusion Criteria

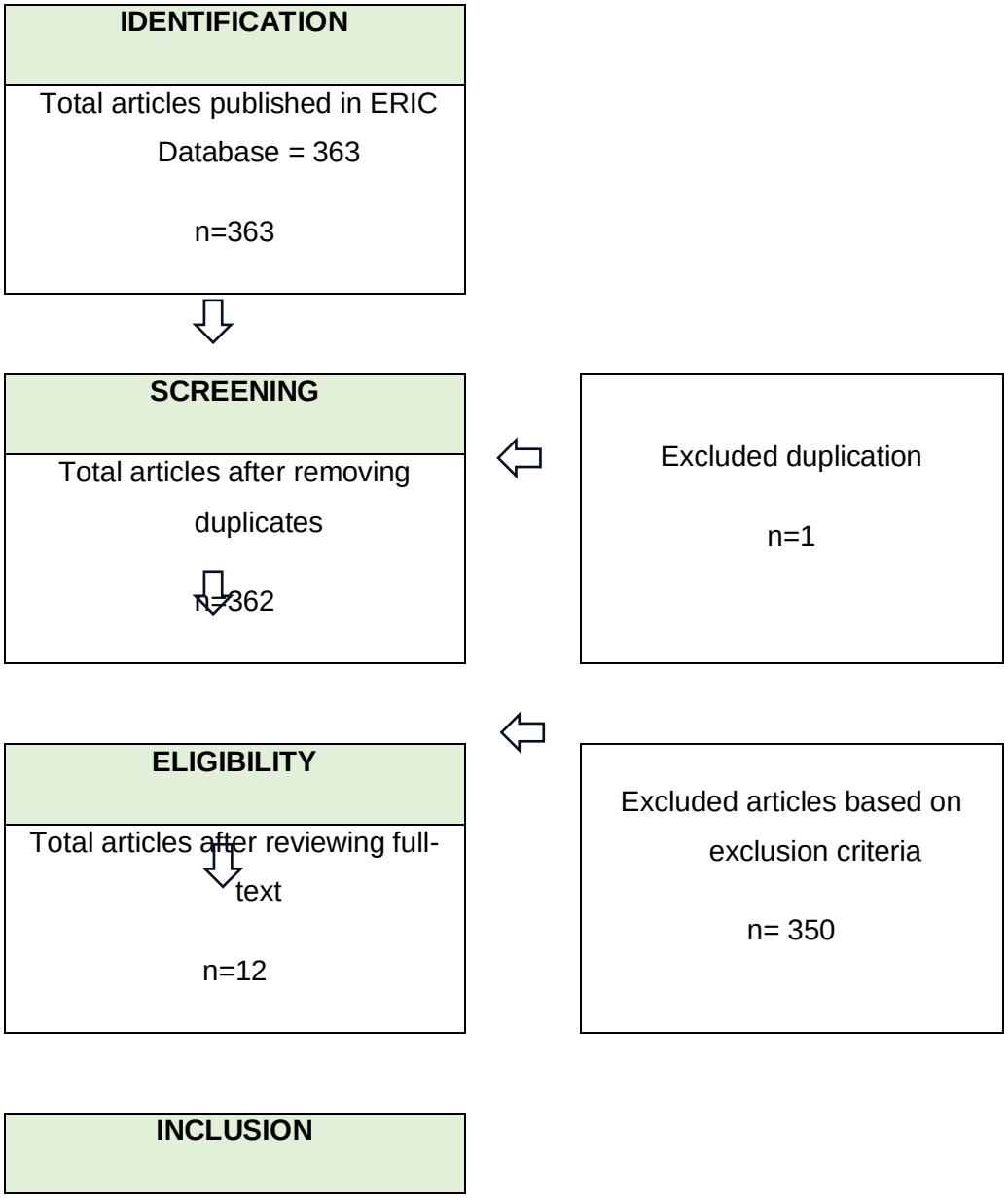
Studies included in this review were published between 2019 and 2025, focused on the role of metacognitive skills and student engagement in enhancing mathematics performance among high school learners.

Indicator	Inclusion Criteria	Exclusion Criteria
Date	Studies published between 2015 and 2025	Studies published before 2015 or after 2025
Exposure of interest	Role of Metacognitive Skills, Student Engagement, Mathematics Performance, and High School Learners	Studies unrelated to mathematics performance, metacognitive skills, and the role of metacognitive to high school learners.
Language	Studies published in English	Studies published in languages other than English
Participants and Geographic Location of the Study	Secondary school students, including those from other countries with comparable educational contexts.	Studies focused exclusively on primary (elementary) or tertiary education levels.
Indicator	**Inclusion Criteria**	**Exclusion Criteria**
Peer review	Peer-reviewed journal articles, conference papers, theses/dissertations	Unpublished reports, opinion pieces, and nonpeer-reviewed materials

Reported outcomes	Student performance in mathematics related to metacognitive skills and engagement	Studies not reporting mathematics performance or not measuring metacognitive/engagement
Setting	Formal educational settings (secondary schools)	Informal education settings or adult education
Study design	Empirical studies, including qualitative, quantitative, and mixed methods research.	Editorials, opinion pieces, book reviews, or articles without empirical data. without primary data
Type of publication	Peer-reviewed journal articles, conference proceedings, theses, dissertations, and credible academic reports.	Non-academic publications such as magazine articles, newsletters

Table 1. Inclusion and Exclusion Criteria Search Strategy

This systematic literature review was conducted following the PRISMA or Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines to ensure a transparent and replicable study selection process.



Total articles included in the systematic literature review n=12

Figure 1. Data Selection Process Using PRISMA

The PRISMA methodology involves four key phases: Identification, Screening, Eligibility, and

Inclusion. A comprehensive search was performed across ERIC and databases using the search terms ("Metacognitive Skills" OR "Student Engagement" AND "Mathematics Performance of High School Learners" with filters open-access journal articles, yielding 363 studies from ERIC.

Titles and abstracts of the 363 studies were screened against the inclusion and exclusion criteria, focusing on relevance to high school learners, metacognitive skills, student engagement, and mathematics performance. Full-text versions of screened studies were retrieved and thoroughly evaluated for eligibility based on the preestablished inclusion criteria. This process involved critical appraisal to verify methodological rigor, relevance to research questions, and data quality. Following full-text review, 12 studies met all eligibility criteria and were included in the final synthesis for this systematic review.

RESULTS AND DISCUSSION

General Study Characteristics

Table 2 presents the summarized characteristics of the 12 studies included in the systematic literature review. The studies span from 2019 to 2025 and collectively represent diverse educational contexts across the Philippines, Turkey, South Africa, Pakistan, Indonesia, Malaysia, and Saudi Arabia.

Table 2. Summarized characteristics of the Studies Included in the Study

Author	Year	Methodology	Grade Levels	Countries	Respondents /Participants
Cerrado & Limjap	2025	Mixed methods	Grade 9	Philippines	30 Students
Sercenia, Ibañez, & Pentang	2023	Quantitative (Descriptive-correlational)	Grade 7	Turkey	303 Students
Ncube & Luneta	2025	Sequential explanatory (mixed methods: quantitative t-test, qualitative themes from questionnaires/interviews)	Grade 11	South Africa	35 Students
Habib, Amjad, Aslam, Saleem, & Saleem	2024	Quasi-experimental non-equivalent control group (pre/post Jr. MAI assessments over 18 weeks)	Grade 8	Pakistan	80 Students
Agusman, Purwanto, & Rahardi	2025	Qualitative descriptive (tests, interviews)	Grade 8	Indonesia	90 Students
Bircan & Akman	2023	Quantitative relational survey (ANOVA, correlation, regression)	Grade 9	Turkey	596 Students
Oren Ozdemir, Dandil Sert, & Yildirim	2024	Quantitative SEM (scales)	Grade 7 & 8	Turkey	650 Students

Tee, Leong, & Rahim	2019	Quantitative PLS-SEM (path analysis on affective/metacognitive scales)	Grade 11	Malaysia	86 Students
Alzahrani	2022	Qualitative case study (semi-structured interviews)	Grade 8	Saudi Arabia	13 Students
Aslan & Sahin	2020	Quantitative correlational (self-confidence/metacognition scales; SPSS stats)	Grade 11 & 12	Turkey	420 Students
Peteros, Gamboa, Etcuban, Dinauanao, Sitoy, & Arcadio	2020	Quantitative descriptive correlational (self-concept survey; math grades; t-test, Pearson r)	Grade 10	Philippines	183 Students
Wawan & Retnawati	2022	Quantitative correlational (scales on teacher competence, anxiety, motivation, problem-solving, connections; path analysis)	Grade 11	Indonesia	171 Students

Quantitative methodologies dominate (10/12 studies), followed by qualitative (2/12), enabling robust statistical and interpretive insights into metacognitive skills and student engagement in mathematics performance. All 12 studies focus explicitly on high school learners, with participants primarily consisting of students (all 12 studies, ranging from 13-650 per study), countries represented include the Philippines (2 studies), Turkey (4), South Africa (1), Pakistan (1), Indonesia (2), Malaysia (1), and Saudi Arabia (1). Only 2 studies are Philippine-specific, justifying inclusion of international comparators from similar K-12 contexts like Turkey and Indonesia for broader relevance. This distribution underscores the global interplay of metacognitive regulation and engagement factors, supporting thematic synthesis while highlighting limited local evidence.

CONCLUSION

This systematic literature review demonstrates that metacognitive skills and student engagement positively influence mathematics performance among high school learners. The included studies consistently show that metacognitive regulation (e.g., planning, monitoring, evaluation) combined with multidimensional engagement drives improved math achievement across diverse contexts.

The evidence suggests that:

- Metacognitive awareness and self-regulation skills enable strategic problem-solving and persistence in mathematics tasks

- Student engagement (behavioral, emotional, and cognitive dimensions) amplifies metacognitive effects through motivation and active participation

- The reviewed quantitative studies (10/12) conclusively establish consistent positive correlations between metacognitive skills, student engagement, and mathematics grades or outcomes.

- International studies from contexts like Turkey and Indonesia provide conclusive, transferable evidence for enhancing Philippine mathematics performance through metacognitive skills and engagement, overriding the limitations of sparse local data (2/12 studies).

Educators and policymakers should consider these evidence-based findings when designing interventions to foster metacognitive training and engagement strategies that enhance high school mathematics performance.

Recommendations for Future Studies

Based on the synthesis of findings, several actionable recommendations are proposed:

- Integrate explicit metacognitive strategy instruction (planning/monitoring) into high school math curricula
- Develop engagement-focused interventions combining behavioral prompts, emotional support, and cognitive activation
- Conduct Philippine-specific empirical studies to address the evident local research gap
- Employ mixed-methods designs to capture both statistical correlations and qualitative mechanisms
- Scale up interventions in Grades 7-11, where most evidence concentrates, using larger samples for generalizability

These themes indicate that optimal mathematics performance requires integrated metacognitive and engagement approaches, with each reinforcing the other to promote deeper understanding and sustained achievement.

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