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Understanding How Students Learn Mathematics: A Systematic Literature Review of Contemporary Learning Strategies in Mathematics Education Post-2020

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Abstract In the post-pandemic context, current learning strategies are crucial for improving educational outcomes and equipping students to navigate modern learning challenges. This study aims to conduct a systematic literature review on mathematics learning strategies employed by secondary students post-2020. This study rigorously defined the inclusion criteria to ensure the analysis's relevance and quality and considered only peer-reviewed articles from January 2021 onward, incorporating the latest research developments in mathematics education. The review focuses on understanding how students learn mathematics by exploring effective cognitive and metacognitive learning strategies they employ. As revealed in this review, cognitive strategies such as connecting to prior knowledge and real-life experience, visual representation, deep learning, and mobile technology significantly enhance understanding and application of mathematical concepts. In addition, students effectively develop their analytical skills and procedural flexibility by breaking down complex problems through differentiated activities and heuristic problem-solving. Furthermore, students use learning strategies to engage in mathematical communication and collaboration. Metacognitive strategies such as creating a supportive learning environment among peers, exercising self-regulated learning, practicing reflective thinking, elaboration, organization, and orientation strategies, enhancing problem-solving skills through enrichment activities, and actively listening to teacher discussions, significantly improved students' ability to monitor, evaluate, and adapt their learning processes. This study concludes that cognitive and metacognitive strategies are crucial in enhancing academic performance in mathematics and fostering critical thinking and lifelong learning skills. This review will guide future researchers to explore the long-term impacts of integrating these strategies into mathematics education, specifically in designing a scale that accurately measures the effectiveness and frequency of learning strategies employed by students in mathematics education, ultimately supporting the modification of instructional methods and increasing learning performance.

Keywords: *mathematics learning strategies, systematic review, secondary education, cognitive strategies, metacognitive strategies, technology integration, literature review*

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1. Introduction

Recognizing how students learn mathematics is crucial for several reasons. Mathematics learning strategies may influence or are influenced by how students engage in their mathematics learning process [1], how they appreciate or/and perceive its relevance [2], and how they apply the concept learned in their daily activities [3]. Students' engagement in mathematics to solve issues and understand the subject is meaningful and applicable to their daily lives rather than as the only means of preparing for the future [4].

However, poor mathematics performance is one of the most significant issues impeding learning achievement, as it has grave consequences for the community and the school. This issue is evident almost every semester, as manifested by the promotion and failing percentages in some mathematics courses. For instance, 10% of students in mathematics classes are determined to be below the recommended level and not competent enough to move on to the next grade. According to the most recent National Assessment of Educational Progress, just 26% of eighth graders are proficient in math. Every year, a certain proportion of students fall behind the rest of the class due to difficulty in remembering the content learned, rapid forgetting of the learned material, and struggle with understanding mathematics concepts [5].

The COVID-19 pandemic has significantly affected students' learning experiences, particularly in mathematics, which relies heavily on cognitive and metacognitive strategies for effective concept assimilation [6]. Before 2020, published studies on learning strategies were primarily focused on traditional classroom settings where students might benefit from direct support from teachers and peer collaboration [6,7,8]. Research shows that cognitive and metacognitive strategies are essential for understanding mathematical concepts [7,9]. Cognitive strategies enable students to approach problem-solving systematically [8,10], while metacognitive strategies foster self-regulation, allowing students to adapt their learning approaches based on their understanding [7,8]. However, post-pandemic disruptions have impacted students' ability to apply these strategies effectively, creating a need for targeted interventions.

Despite several studies conducted on the implementation of innovative teaching strategies [11,12,13,14,15,16], instructional materials design and development [17,18,19,20], integration of educational technology tools [21,22,23], and teaching modality [24,25,26,27], there is still a decline in students' mathematics performance. Recent research has predominantly focused on the implementation of innovative teaching strategies and the development of instructional materials rather than on understanding how students themselves learn mathematics. While previous studies provide insights into enhancing teaching approaches, most are designed from the teacher's viewpoint, focusing on better ways to impart knowledge rather than exploring how students naturally learn and understand mathematical concepts. This teacher-centered approach may overlook the significance of tailoring methods to students' cognitive processes. Given the dynamic nature of the modern learning environment, it is crucial to explore some cognitive and metacognitive strategies critical for achieving academic success in mathematics [6,7,9].

Cognitive and metacognitive strategies developed before 2020 may no longer be fully effective due to the shift in learning environments following COVID-19 [6]. The transition to remote learning introduced challenges in understanding mathematical concepts, as reduced face-to-face interaction led to increased student disengagement. Furthermore, exploring current learning strategies in the post-pandemic context is crucial for improving educational outcomes and helping students navigate modern learning challenges. By focusing on how students engage with and apply mathematical concepts, educators can develop strategies that better resonate with learners and address their specific needs.

This study aims to conduct a systematic literature review of contemporary learning strategies in mathematics education after 2020. The following research question guides this systematic review: What are the effective cognitive and metacognitive learning strategies employed by students in mathematics learning after 2020?

2. Methodology

This study employed a systematic literature review approach, as outlined by Tahiru (2021) [28]. This study adopted a rigorous, evidence-focused review model proposed by Hagen-Zanker & Mallett (2013) [29] to ensure a comprehensive and objective synthesis of the literature on learning strategies in mathematics education post-2020. This model emphasizes systematic procedures for identifying, evaluating, and synthesizing research evidence, providing a robust foundation for drawing conclusions and making recommendations. The primary focus of this review was to understand how students learn mathematics through a systematic examination of learning strategies in mathematics education. The review addressed the primary question: What cognitive and metacognitive learning strategies have students employed to learn mathematics effectively?

The search strategy involved conducting a comprehensive search using Google Scholar. Keywords such as "mathematics learning strategies," "secondary education," "strategies students use to learn mathematics," "contemporary learning strategies," "mathematics education," "cognitive strategies," and "metacognitive strategies" were used to refine the search results. Initially, this study selected 27 articles for review. It strictly defined inclusion criteria to ensure the relevance and quality of the selected studies. Only peer-reviewed articles published in English from January 2021 onward were considered to incorporate the latest research developments in mathematics education. The studies needed to specifically focus on secondary education, emphasizing learning strategies in mathematics within a post-2020 context. On the other hand, this study rigorously applied exclusion criteria to filter out studies that did not meet these standards. Non-peer-reviewed materials, such as opinion pieces, editorials, or blog posts, were excluded to ensure academic rigor. Additionally, any studies that do not directly address secondary mathematics education or the specific learning strategies under investigation were also omitted from the review. After the meticulous selection, 20 articles were identified as suitable for the systematic review.

Classroom observations were integrated into the methodology, employing triangulation to ensure a comprehensive analysis. Triangulation involved combining qualitative and quantitative data from research studies with real-world classroom observations to cross-validate the results and deepen the understanding of learning strategies in mathematics. The observational data was compared with the literature to assess how the identified strategies align with classroom realities, further strengthening the study's conclusions. This study analyzed the observational data to validate the theoretical findings from the systematic review and provide a contextualized understanding of how these strategies function in actual classroom environments.

3. Discussion of the Findings

This study focused on understanding how students learn mathematics through a systematic literature review of learning strategies in mathematics education post-2020.

The content analysis of the effective cognitive learning strategies employed by the students revealed the following emerging themes: Building understanding by connecting to prior knowledge and real-life experience, utilizing visual representation, deep learning, and using mobile technology; Breaking down problems through differentiated activities and heuristic problem-solving and Engaging mathematical communication and collaboration through Think, Talk Write (TPW), Think, Pair, Share (TPS) and flipped learning.

The content analysis of the effective metacognitive learning strategies employed by the students revealed the following emerging themes: Creating a supportive learning environment among peers, exercising self-regulated learning, practicing reflective thinking, employing meta-cognition skills, and Listening to the teacher's discussion.

3.1. Effective Cognitive Learning Strategies Employed by Students in Mathematics Education

Cognitive learning strategies are methods and mental processes students use to understand and process information more effectively for better-retained learning [8]. This literature review, supported by classroom observation data, revealed that these effective cognitive strategies improve academic performance and advance critical thinking and lifelong learning skills, which are essential in contemporary times.

3.1.1. Building Understanding

Building understanding in mathematics education involves helping students develop a deep comprehension of mathematical concepts and procedures, enabling students to make connections and apply their knowledge flexibly [30]. In this literature review, students built an understanding of mathematical concepts by connecting them to prior knowledge and real-life experiences through utilizing visual representation, deep learning techniques, and mobile technology.

Connecting to prior knowledge and real-life experience. Establishing real-life connections is a key strategy that makes mathematics relevant to students, increasing their engagement and understanding of the subject [31]. It is a strategy wherein students relate mathematical concepts to previous knowledge and everyday scenarios. According to Khanal et al. (2021) [32], in their qualitative data exploration through interviews with one of their study participants, students learn mathematics by solving problems using the concepts they learned in previous classes. Students learn mathematics effectively by connecting new information to their prior knowledge and real-life concepts, enabling them to apply appropriate strategies or steps for relevant answers and conclusions [33].

The findings of this review were further validated through classroom observations, with teachers actively incorporating strategies to encourage students to recall previous lessons and apply them to practical, real-world scenarios. For instance, in a general mathematics class, students were tasked with calculating the simple and compound interest on principal amounts borrowed and invested. The effectiveness of these strategies was further enhanced when teachers used examples grounded in real-life situations, allowing students to make stronger connections between mathematical concepts and everyday financial decisions [33]. Hence, as noted during the observation, students responded positively, increasing engagement and comprehension, with almost 82% of the student population getting the desired result and validating the theoretical claims. This triangulation between literature, classroom practice, and student engagement demonstrates the practical effectiveness of connecting prior knowledge and real-life contexts in mathematics education.

Utilizing visual representation. Visual aids are also highlighted to help students learn more effectively since they enhance understanding by providing precise and intuitive representations of mathematical concepts. Students must use charts, graphs, and diagrams with bright visuals to attract attention and improve memory retention [31]. Hence, students learned through hands-on activities using tangible objects and physical models to illustrate abstract concepts. It is also supported by Attard and Holmes' (2022) [6] case study analysis, which investigates students' perceptions of blended learning in secondary mathematics classrooms, noting that cognitive learning strategies promoted by visual aids and dynamic software help students effectively understand and manipulate mathematical concepts.

According to Sekaryanti et al. (2022) [33], students with high emotional intelligence can understand the context of the problem and represent the problem with pictures. In addition, students with medium emotional intelligence are rewriting information on the problems using mathematical models and their language. When building an understanding of mathematical concepts, students first focus on understanding the problem before selecting the relevant formula and organizing the information. Therefore, students read the problem carefully and use visual aids like drawing pictures and math expressions to understand and use appropriate formulas [34].

This finding was confirmed in classroom observations, where teachers employed visualizations, specifically printed graphic organizers, as supplementary tools to guide students' learning activities. As noted in the classroom observation, students who actively engaged with the provided graphic organizers made significant efforts to visually arrange the given information before applying correct formulas and were notably more successful in solving problems. However, Sekaryanti et al. (2022) [33] revealed that students with high emotional intelligence can better understand the context of a problem and represent it visually through pictures. As claimed by Irshad (2024) [31], exploring interactive learning, visual aids, and real-world applications is a pathway toward a more profound understanding of basic math concepts, from increased engagement to improved retention of the students. Hence, this triangulation of theoretical insights, observed classroom practices, and student responses highlights the crucial role of visual representations in fostering comprehension and engagement in mathematics learning.

Deep learning. In this literature review, students also build mathematical understanding by employing deep learning approaches. The deep learning strategy is a set of methods that the learner uses to deeply understand the learning material by interpreting and reflecting on it and rephrasing it in his vocabulary [35]. Hammadi et al. (2023)

[35] revealed that students who adopted the deep learning strategy raised their level of academic achievement with a mean percentage score of 70% compared to the control group of 59%. Moreover, the student who learns according to these strategies has many characteristics. These learners actively seek to understand the subject and material of learning. They give meaning to what they have learned and increase the school's connection to society and daily practical life [36]. Hence, deep learning, which fosters critical thinking and problem-solving, leads to better academic outcomes than traditional teaching methods [35]. Furthermore, Majeed, Jawad, and ALRikabi (2022) [37] cited that deep learning strategies typically involve approaches that promote understanding and integrate into what they learn, allowing individuals to retain information rather than rote memorization. These cognitive processes improve mathematics learning, including problem-solving, analysis, and synthesis.

This result was further validated through classroom observations, where students employed deep learning strategies while reflecting on a handout provided by the teacher. In a mathematics class, students evaluated investment schemes and compared simple and compound interest rates for each option. In this case, the students explore the problems, reflect on their solutions, and relate the scenarios to real-life financial decisions. Deep learning became effective because the students could freely express their ideas, such as verifying the solutions and explaining the importance of evaluating investment schemes before making sound financial decisions. However, it is significant to note that based on the observation, students' positive attitude toward this strategy is critical for it to become more effective.

Utilizing mobile technology. This refers to using mobile devices to access educational resources, interactive tools, and applications that aid in understanding and practicing mathematical concepts. Olga et al. (2023) [38] cited that students prefer using mobile phones in learning mathematics. Learning with mobile devices pushes to support students in their self-study of mathematics both in and out of the classroom. From students' perspectives, utilizing a mobile phone to learn mathematics is seamless and convenient. Moreover, mobile mathematics learning applications are among the most effective ways to integrate technology to enhance mathematics learning [38].

Mobile technologies started to play an essential role in designing seamless learning environments [39]. The prevalence of mobile devices provides a new perspective on learning mathematics and bridges classroom instruction and real-world applications [40]. In the study of Cevikbas & Kaiser (2022) [41], one of the basic requirements needed for students to learn mathematics, which the participants consider as effective, is to have at least one mobile device with a stable internet connection at home to engage in learning through watching videos, being active in the online learning platform, accessing online resources, or communicating with one another outside the class time. Thus, one of the participants in the study claimed that watching mathematical videos on the internet draws all of their attention and is more entertaining [41]. Furthermore, according to Fabian et al. (2016) [40], students' perceptions showed that mobile technology applications used in out-of-school learning environments positively affect their learning process.

The literature stresses mobile technology's growing significance in mathematics education, with studies such as Olga et al. (2023) [38] and Cevikbas & Kaiser (2022) [41] showing how students find mobile devices useful for self-study and beneficial for incorporating technology into their learning. Classroom observations supported this finding, as students used mobile applications and devices to engage with mathematical lessons inside and outside the classroom, accessing materials, videos, and online platforms to help them learn. The result was further satisfactory, where students stated that mobile technology made learning more engaging and practical. As was emphasized by most of the students in the classroom, the usefulness of mobile technology in providing more dynamic and effective mathematics learning environments has increased their academic performance in math. However, Attard & Holmes (2022) [6] revealed that students' perceptions of technology use across the four case studies they conducted yielded strong similarities, which held positive attitudes toward the general use of technology in mathematics education.

3.1.2. Breaking Down Problems

In learning mathematics, students break down problems to understand each part of the problem, making it easier to solve the overall problem step-by-step. This strategy involves dividing complex problems into smaller and more manageable parts [42]. Educational research supports the effectiveness of this strategy. According to Boonen et al. (2014) [43], breaking down problems helps students develop a deeper conceptual understanding of mathematics. The students break down problems in this review through differentiated activities and heuristic problem-solving.

Differentiated activities. These are learning activities engaged by students to solve mathematical problems at an appropriate level of challenge and support. Differentiated instructions are necessary to effectively address learning gaps in mathematics among high school students [44,6]. As revealed in the study, there is a highly significant difference between the control and differentiated groups of students performing differentiated activities. Following Cabigao (2021) [45], students effectively perform differentiated activities and strategies to learn mathematics.

These strategies are the following:

- Math hunting is when students use the mini-library to find essential mathematical words and examples related to their topic based on their prior knowledge.
- Peer learning is the practice of students learning from and with one another.
- Small group discussion wherein students discuss and exchange ideas while interacting with professors and their peers.
- Board work is where students solve on the board while studying and recalling the lesson's language during class.
- Interactive games such as bingo card games allow students to choose the types of problems they prefer to answer.

For students to be motivated and learn problem-solving in mathematics, they are also effective in interactive games and exercises for an enjoyable learning experience. Through these, students can incorporate friendly competitions or collaborative activities to foster a positive and engaging learning environment [31]. Furthermore, differentiated instruction can effectively achieve classroom goals and objectives as students engage in activities promoting critical thinking, problem-solving, and applying mathematical concepts that fit their own learning pace and style [31].

Classroom observations verified that students participated in various activities to learn more about the lessons. They frequently use peer learning, small group conversations, and visits to the library to explore mathematical problems and grasp the lesson better. Furthermore, the teacher in the math classroom incorporates board work tasks and interactive games as learning exercises before administering summative tests to the students. As a result, more than 80% of the students in the classroom received the desired outcome and demonstrated a high level of engagement in differentiated activities. This approach reinforces literature that suggests varied instructional methods contribute to a positive learning environment. The triangulation of theoretical frameworks, classroom observations, and student participation substantiates the effectiveness of diverse activities in enhancing students' understanding of mathematical concepts.

Heuristic problem-solving. Heuristic approaches, such as comparing various problem-solving methods and engaging in mathematical discussions, promote deeper understanding and analytical skills. Students frequently compare multiple strategies, participate in small group activities, and engage in mathematical discussions. As a result, they exhibit increased procedural flexibility [46]. It is further supported by Ansari et al. (2021) [34], who noted that cognitive learning strategies for solving mathematical problems include understanding questions, selecting relevant formulas, and organizing problem information.

The study of Zhang et al. (2024) [10], which explores the role of computational thinking in enhancing meta-cognition and mathematical modeling skills among high school students, discussed that effective cognitive learning strategies employed by students include solving real-world problems, developing algorithmic thinking, and using multiple representations such as graphs and equations to understand and solve problems. Furthermore, Anggo and Haryana (2021) [9] identified learning strategies for solving mathematical problems, such as building mental representations, determining solutions, performing required steps, interpreting results, and evaluating solutions. These heuristic strategies help students enhance their problem-solving skills and develop a structured approach to learning mathematics.

The literature supports the effectiveness of heuristic approaches in mathematics learning, where students compare different problem-solving methods, engage in discussions, and apply cognitive strategies such as selecting relevant formulas and organizing information [34,10]. These actions were reflected in the classroom, as students regularly worked in groups, talked about different approaches, and solved mathematics problems using a variety of representations, such as equations and graphs, resulting in the desirable outcomes in their math learning activities. As the literature indicated, these exercises promoted deeper comprehension and procedural flexibility. This triangulation of theoretical insights, observed student behaviors, and problem-solving outcomes demonstrates the value of heuristic problem-solving in promoting analytical skills and structured approaches to learning mathematics.

3.1.3. Engaging in Mathematical Communication and Collaboration

Engaging in mathematical communication and collaboration involves actively participating in discussions, sharing ideas, and working together to learn mathematics effectively. This interaction not only aids in individual comprehension but also builds a supportive learning community where students can learn from one another [47]. In this literature review, students engage in mathematical communication and collaboration through Think, Talk, Write (TPW), Think, Pair, Share (TPS), and flipped learning.

Think-Talk-Write (TTW). It is a learning model to train students' writing skills and emphasizes the need for students to communicate the results of their thoughts orally and in writing smoothly [48]. It enhances students' mathematical communication skills by integrating cognitive thinking, speaking, and writing processes. Cognitive strategies in TTW involve students thinking deeply about mathematical concepts, discussing these ideas with peers to clarify understanding, and then articulating their thoughts in writing, reinforcing learning [49].

Think-Pair-Share (TPS). It is a collaborative learning model where students think individually about a question or problem, pair up to discuss their thoughts with a partner, and finally share their ideas with the larger group to enhance understanding and engagement. In the study of Tarigan (2022) [50], there was an increase in students' mathematical communication skills when students employed the Think Pair Share (TPS) learning strategy with the students' mathematical communication ability level of 84.21% or the medium category from 60.52% or low category. Students are more likely to contribute to class activities and feel more confident in understanding the learning material. The study conducted by Alzahrani (2022) [51] explores high school students' use of metacognitive strategies in mathematics, emphasizing the importance of active communication to solve mathematical problems. Tarigan (2022) [50] cited in his study that the Think-Pair-Share (TPS) strategy improves students' mathematical communication skills. This strategy encourages students problem-solving, clear articulation of mathematical concepts, and visual representation of ideas.

Flipped learning. It is a strategy in which students learn new concepts independently outside of class, allowing up in-class time to engage in collaborative problem-solving activities that increase their understanding and application of mathematical concepts. To effectively improve mathematical communication, flipped learning strengthens students' engagement in a social environment [6,41]. The most effective elements of flip learning came from the participants' views based on their experiences, which offer a flexible learning environment that provides lecture videos and problem-solving activities that develop their cognitive engagement. [41]. Egara & Mosimege (2024). [52] cited the need to support the flipped learning approach employed by students to increase engagement by providing a flexible learning environment where students engage with lecture materials outside class and participate in interactive problem-solving activities during class. Hence, this approach significantly enhanced learners' achievement and interest in mathematics [52].

Flipped learning integrates technology so that students can engage in mathematical communication and collaboration. Mobile technology, including Augmented Reality (AR) and WhatsApp applications, enhances learning performance and motivation in mathematics education [39]. AR applications positively impact students' interest and willingness to learn by concreting abstract mathematical concepts through modeling and multiple displays, particularly in geometry [53]. Additionally, students expressed positive opinions about WhatsApp. Its benefits include increased participation from passive and introverted students, improved peer communication to clarify misunderstandings, the creation of cooperative learning environments, and the extension of learning beyond the classroom [54]. Whats App is practical and straightforward, enabling students to share worksheets and resources and receive instant feedback, which can enhance their success [55]. Thus, cognitive strategies are supported by the active learning processes encouraged by AR activities and the collaborative problem-solving facilitated by Whats App discussions.

Classroom observations further validated these findings, revealing that students actively engaged in mathematical communication and collaboration through Think-Pair-Share (TPS), Think-Talk-Write (TTW), and flipped learning. During the observation, it was noted that these strategies were instrumental in enhancing students' understanding of mathematical concepts while fostering a collaborative learning environment. Specifically, the flipped learning strategy requires students to support each other inside and outside the classroom to sustain motivation [52]. However, based on the classroom observation, the group of students who participated in collaborative activities such as Think-Pair-Share (TPS) and Think-Talk-Write (TTW) demonstrated superior learning outcomes compared to those with limited collaboration. Therefore, the triangulation of literature, classroom practices, and student engagement powerfully reflects the effectiveness of these collaborative strategies in engaging mathematical communication and cooperation.

In conclusion, this section of the literature review identifies several effective cognitive learning strategies employed by students in mathematics education, which were further corroborated through classroom observations conducted in secondary mathematics settings.

3.2. Effective Metacognitive Learning Strategies Employed by Students in Mathematics Education

Metacognitive learning strategies involve self-awareness and self-regulation during the learning process. These strategies include planning how to approach learning tasks, monitoring comprehension and progress, and evaluating the effectiveness of learning strategies [7]. Effective use of metacognitive strategies enhances students' ability to understand, retain, and apply mathematical concepts [9,51].

3.2.1. Creating A Supportive Learning Environment Among Peers

Creating a supportive learning environment among peers involves fostering a classroom culture where students feel safe, respected, and encouraged to collaborate and share ideas. Irshad (2024) [31] found that effective metacognitive learning strategies emphasize creating a supportive learning environment that encourages questions, reflection, and positive reinforcement. This approach helps students develop self-regulation skills and boosts their confidence in mathematics. It is also supported by Tarigan (2022) [50] in his study on the Think-Pair-Share (TPS) strategy, which, for instance, enhances students' mathematical communication skills. Khanal et al. (2021) [32] claimed in their study that out of 1394 students, about 25% of students used a peer learning strategy. The study's qualitative data exploration revealed that if students have been absent from class, they can copy class notes from friends, and if they have difficulty understanding the problem, they can ask their friends.

Furthermore, if friends cannot solve mathematical problems, one frequently teaches them. Participants claimed that teaching their peers would increase their knowledge. Working in pairs and sharing with peers allowed students to receive and give feedback, which helped them analyze and improve their learning practices. This is also supported in the study of Della Purba and Kohlhoff (2022) [56], wherein students work in small groups to solve problems, which helps them understand and apply mathematical concepts.

Students expressed positive perceptions of using metacognitive strategies as they worked cooperatively using materials designed by the teacher and took turns asking and answering questions to solve the given problem. Members resolve their differences through discussion and write down the agreed solution. Thus, this strategy helps capture their interest and stimulates their curiosity to learn. By engaging in metacognitive strategies, students reported increased confidence in their ability to understand and solve mathematical problems [51].

This review revealed the value of creating a supportive learning environment that fosters collaboration, peer assistance, and the development of self-regulation skills in mathematics learning [31,32,50]. Classroom observations also revealed that a supportive peer learning environment positively results in suitable learning. It was noted that mathematics classrooms where learners create a supportive environment where they work in pairs, share knowledge, and provide feedback positively enhance their communication and problem-solving abilities. Additionally, as observed by Alzahrani (2022) [51], cooperative learning practices stimulated curiosity and encouraged students to resolve disagreements through discussion, boosting confidence and engagement. This triangulation of literature observed classroom interactions and student feedback confirms that a supportive peer-based environment enhances collaborative skills and mathematical learning outcomes.

3.2.2. Exercising Self-Regulated Learning

Metacognitive strategies in learning mathematics involve promoting self-regulated learning, helping students take control of their education by setting goals, monitoring their progress, and adjusting their approaches as needed. Students engage in self-monitoring by asking themselves questions like "What am I doing?", "Did I succeed?", "Is my plan good?" and "What could I do next?". This involves planning, monitoring, and evaluating their learning process and adjusting as necessary [51]. Self-regulated learning was also promoted according to the study conducted by Khanal et al. (2021) [32]; for instance, students solve problems in a new way that is different from how the teacher does it. Students often practice all the math exercises from the textbook and some important math questions from the practice books. They used textbooks, workbooks, model questions, and the internet well.

Furthermore, students make a list and chart of the essential mathematical concepts and practice them more. Some students also practice mathematics daily for one hour at home and study in a quiet place. Then, use a short-cut method and catchy statements to remember the formula. Hence, Khanal et al. (2021) [32] concluded that when students' ideas and teachers' explanations of math solutions are similar, they learn mathematics effectively. It is also supported by the study of Della Purba and Kohlhoff (2022) [56], wherein students plan their approach to learning tasks, monitor their understanding, and evaluate their progress. This cycle of self-regulation is critical for effective learning in mathematics.

The literature highlights the importance of metacognitive strategies in promoting self-regulated learning, where students take control of their education through goal setting, self-monitoring, and adjusting their approaches [32,56]. During classroom observations, students were observed to exercise self-regulated learning. Furthermore, it confirmed that most academic achievers who showed desirable grades in mathematics engage in practices such as planning their study sessions using various resources such as textbooks and online materials. As revealed in the study by Ansari et al. (2021) [34], fast learners are more effective in practicing Self-Regulated Learning (SRL), categorized as good, with 89.3% in their test results. As noted in the observation, students monitored their progress by reflecting on their strategies and results, using catchy methods to remember formulas, and organizing key mathematical concepts. This alignment between theoretical findings, classroom behaviors, and student outcomes demonstrates that self-regulated learning fosters deeper engagement and more effective problem-solving in mathematics.

3.2.3. Practice Reflective Thinking

Reflective thinking allows students to assess their strengths and weaknesses, leading to more effective adjustments in their learning strategies [10,44]. This practice reflects on their learning experiences to understand what strategies worked, what did not, and why. This reflective process helps students to adapt and improve their learning strategies for future tasks. The participant's response highlighted that if he reflected and changed his thinking, it would benefit him in his mathematics learning and daily life [51]. In addition, Durkin et al. (2023) [46] demonstrate that the Comparison and Discussion of Multiple Strategies (CDMS) approach enhances students' learning by fostering procedural flexibility. These strategies encourage students to reflect on their problem-solving processes and evaluate the effectiveness of the different methods. Students who apply these metacognitive strategies can relate their learning to real-life situations, develop problem-solving skills beyond the classroom [35], and improve the clarity of their mathematical communication [49].

Olga et al. (2023). [38] also found that monitoring understanding enables students to become aware of their learning processes, adjust their approaches, and improve their overall mathematical proficiency. Blended learning environments, as highlighted by Attard and Holmes (2022) [6], foster these strategies by allowing students to engage in self-paced learning, plan study schedules, monitor progress, and adjust strategies based on performance.

The literature emphasizes the importance of reflective thinking, where students assess their strengths and weaknesses, leading to improved learning strategies and more profound understanding (Durkin et al., 2023; Olga et al., 2023). Classroom observations confirmed that students who engaged in reflective practices, such as comparing and discussing multiple problem-solving strategies, could adapt and refine their approaches, fostering procedural flexibility and problem-solving skills. This reflection enhanced their mathematical proficiency and connected their learning to real-life scenarios, improving their problem-solving abilities and communication skills. These observations align with theoretical insights, demonstrating that reflective thinking helps students continuously monitor, evaluate, and adjust their learning strategies for more effective mathematics learning. More importantly, this practice also develops their essential soft skills.

3.2.4. Using Elaboration, Organization, and Orientation Strategies

Elaboration strategies involve linking new mathematical concepts to real-life applications to deepen understanding and retention. In contrast, organization strategies involve structuring mathematical problems, such as diagrams or step-by-step methods. Ansari et al. (2021) [34] cited that high-performing students show a tendency towards elaboration strategies, using detailed understanding and application of concepts, while middle-performing students use organizational strategies, such as drawing and step-by-step problem-solving. Moreover, orientation strategies are typically used by learners who are less structured in their approach to problem-solving and are used mainly by lower-performing students [34]. These strategies involve setting clear goals, continuously assessing progress, and making necessary adjustments to improve understanding and performance in mathematics. Abari and Tyovenda (2021) [57] cited that our society needs to accommodate mathematical reasoning for its daily survival and advancement. Hence, learners can be more aware of their learning and have control over their success at tasks. They can also adjust their thinking strategies as they go about their tasks to ensure optimum outcomes.

The literature suggests that high-performing students often employ elaboration strategies by connecting new mathematical concepts to real-life applications, while middle-performing students rely on organization strategies, such as diagrams and step-by-step approaches [34]. Classroom observations supported this result expressly, as it was noted that lower-performing students tended to utilize orientation strategies, set goals, and adjust their approaches as they progressed.

3.2.5. Enhancing Problem-Solving Skills through Enrichment Activities

In a study by Sihotang and Fatimah (2024) [58], which focused on improving learning strategies through an enrichment stage, students developed practical metacognitive skills that significantly enhanced their ability to learn mathematics. These skills include:

- Identifying Problems, wherein students learn to thoroughly understand and articulate what is known and what is being asked about a problem, is the first step toward effective problem-solving.
- Describe the plan, wherein students can outline the plan they intend to use to solve the problem, drawing on previously acquired knowledge and skills.
- Predicting knowledge is a technique wherein students anticipate the knowledge they need to solve the problem, helping them approach the task more strategically.
- Ensuring Alignment with Objectives involves students checking that the solutions they develop align with the problem's original goals, ensuring that their approach remains focused and effective.

Furthermore, the key metacognitive strategies identified by Abari and Tyovenda (2021) [57] include reflecting on learning processes using mnemonic techniques. These strategies help students better understand and retain mathematical concepts, improving their performance. From the student's side, metacognitive strategies are essential in building a strong thinking foundation that can be applied in various conditions and levels of complexity of the problems. Students who are accustomed to applying metacognitive strategies in solving mathematical problems will be greatly helped in every problem-solving because all the steps taken to solve are always based on an awareness of what they are doing, why they are done, and how to make improvements when mistakes occur [9].

The literature emphasizes that enrichment activities are key to developing students' metacognitive skills, significantly enhancing problem-solving abilities (Sihotang & Fatimah, 2024; Abari & Tyovenda, 2021). Classroom observations showed that academic achievers who engaged in enrichment tasks could better identify problems, describe their problem-solving plans, and predict the necessary knowledge for completing tasks. As a result, students who have engaged in enrichment activities have excellent academic performance. This alignment between theoretical frameworks and classroom behaviors underscores how enrichment activities improve students' strategic thinking and problem-solving efficiency in mathematics.

3.2.6. Listening to Teachers' Discussion

Listening to teachers' discussions refers to the active process where students pay attention to and engage with the information being presented by the teacher. This practice is essential for effective learning as it helps students grasp new concepts, understand instructions, and develop critical thinking skills. When students are experiencing difficulties in their learning, they prefer to ask the teacher and listen to the discussion provided by the teacher [34]. As cited by Khanal et al. (2021) [32], students look carefully at the board when their teacher solves the problems, try to understand them, and solve other problems by following similar steps. Furthermore, students solve the exercise problems by looking at the work-out examples provided by the teacher. Based on students' perceptions, worked-out examples are beneficial. They also feel comfortable asking their teacher about complex concepts they do not understand.

The literature highlights that actively listening to teachers' discussions is crucial for effective learning, enabling students to grasp new concepts and develop critical thinking skills (Khanal et al., 2021). Classroom observations confirmed that students who attentively followed their teachers during problem-solving discussions were better equipped to understand and apply similar strategies to solve the provided mathematical problems. Hence, it was noted that this practice is particularly beneficial when students encounter difficulties, as they often feel comfortable asking questions to clarify challenging concepts.

4. Conclusion

This systematic literature review has explored students' cognitive and metacognitive learning strategies in mathematics education. The findings highlight how building connections to prior knowledge, connecting to real-life experiences, and utilizing visual representations and mobile technology can enhance student understanding. Some students prefer to break down complex problems through differentiated activities or engaging heuristic problem-solving methods, supporting their analytical skills and procedural flexibility. Hence, in mathematics education, the primary role of teachers is to understand how students learn mathematics [32]. These insights emphasize the critical role of mathematics teachers in fostering meaningful engagement by aligning instructional methods with students' cognitive and metacognitive processes. In this digital age, teachers integrating technology into teaching practices is no longer optional, it must be used to remain adequate and relevant [38]. However, this review identifies a notable gap: the lack of a standardized scale to measure the effectiveness and frequency of these learning strategies as employed by students. While existing literature contains enough evidence of various methods being used, there is a notable lack of a systematic approach to quantify and assess how students apply these strategies in their learning processes.

Developing a comprehensive and reliable scale to assess strategies would be a significant step forward in mathematics education, leading to more targeted educational interventions. This scale could improve teaching strategies and learning outcomes by helping mathematics teachers identify the most effective methods for specific settings and mathematical concepts. Moreover, the scale could serve as a diagnostic tool to identify strengths and weaknesses in students' approaches, enabling personalized education that meets individual learning needs. The results of this systematic literature review will undoubtedly be a foundation for future research, specifically in developing and validating mathematics learning strategies scale. By identifying the core cognitive and metacognitive methods effective in contemporary studies, this review highlights critical components for inclusion in such a scale. Hence, developing this scale will enable a more accurate assessment of how different strategies contribute to students' mathematical understanding, ultimately supporting the modification of instructional methods and increasing learning outcomes.

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