Metacognitive Strategies, Math Self Efficacy and Achievement of Grade 10 Learners: A Literature Review

[1]Sheny O. Sumalinog,[2]Galilee Ortega,[3]James Samillano,[4]Shiela Tirol ,[5]Ariel Tinapay

[1,2,3,4,5]Graduate School of Education, Cebu Roosevelt Memorial Colleges, Inc., Bogo City, Cebu, Philippines

DOI: https://doi.org/10.47772/IJRISS.2026.100900298

Received: 16 September 2026; Accepted: 21 September 2026; Published: 09 October 2026

ABSTRACT

The purpose of this study was to determine if mathematics self-efficacy and mathematics achievement are associated the use of metacognitive strategies, including self-monitoring, self-questioning, and reflective thinking among tenth graders. After reviewing articles related to this topic, it was found that success in mathematics is affected by more than students' cognitive ability to learn mathematics. Students' confidence, drive to learn mathematics, emotional state, surrounding environment, and past teaching experiences also impact their success in mathematics. Mathematics self-efficacy can help students feel confident to attempt complex mathematical problems, persist when faced with challenges, and use appropriate problem-solving strategies when working on mathematical tasks. Learners who utilize metacognitive strategies such as planning, self-monitoring, and self-reflection can also accurately plan how to approach learning tasks, keep track of their performance and understanding, and make adjustments to their learning strategies if they are not working. Other articles reviewed mentioned that the use of metacognitive strategies could help students feel more confident and independent, use problem-solving strategies, feel more motivated, and increase student achievement. There are various instructional strategies that can help students develop self-efficacy and metacognitive skills. These strategies include scaffolding, providing students with formative feedback, group work, differentiation, mastery experiences, and real-world mathematical problem-solving. Other articles discussed the importance of maintaining a comfortable classroom environment that is open to all learners and decreases mathematics anxiety. The literature reviewed proved that self-efficacy in mathematics and metacognitive strategies are linked and may have an effect on students' mathematics achievement and well-being. Therefore, this study seeks to help students better learn mathematics by implementing specific metacognitive strategies into mathematics instruction to help students feel confident and better understand how to learn mathematics. This study will help contribute to Sustainable Development Goals number 3, 4, and 10.

Keywords: Metacognitive Strategies, Mathematics Self-efficacy, Academic Achievement, Problem-Solving skills

INTRODUCTION

Math instruction is more than just about remembering formulas or following steps. There is a lot more going on. Both empirical research and classroom teaching demonstrate that well-performing mathematics students require a convergence of variables; the way they think, the way they feel, the social context, and teachers' teaching (OECD, 2020; Hattie, 2023). Here two concepts particularly leap out: self-efficacy, which is essentially how much students believe they can handle math, and metacognitive strategies, or how effectively they plan, keep track of, and reflect on their own learning. Those are critical details, too, for Grade 10 students. The math gets harder and more abstract, and it's not only about knowing how to do it; it's also about thinking big and thinking strategically, which is more than knowing the steps; it helps to stay tough when the going gets tough. Developing these skills not only enables students to score higher on tests, but also supports Sustainable Development Goal 4 (Quality Education), by making math classrooms more engaging, student-centered, and effective.

This article section delves into what research says about mathematics self-efficacy, achievement and metacognitive strategies and how these all come together to form how students learn. Research has repeatedly noted that when students have faith in their math abilities, and know how to control their thought processes, they are more engaged, able to carry through with a challenging problem and, typically, perform better (Dunlosky et al., 2020; Schraw, Crippen, & Hartley, 2021). Here, the emphasis is on three metacognitive strategies – self-monitoring, self-questioning, and reflective thinking. These tools are designed to help students

self-regulate, solve problems with more confidence and boost their self-assurance when doing math. They also lower anxiety and can affect more positive attitudes in students to study, corresponding to SDG 3 (Good Health and Well-Being). On top of that, giving students these metacognitive strategies, help level the playing field for kids from different backgrounds, supporting SDG 10 (Reduced Inequalities) by making math education more equitable and opportunities available to all.

Objectives

The purpose of this scoping review was to identify and summarize literature related to metacognitive strategies, mathematics self-efficacy and mathematics achievement for secondary learners, specifically grade 10 students. It also helped us find the differences between direct and indirect evidence across various populations, grades, subject areas and context. Find factors that may relate to instruction or the context. Identify any gaps that can be further explored.

METHODS

Design

A structured scoping review was used to help identify and summarize literature relating to metacognition, math self-efficacy and math achievement in relation to Grade 10 learners. By using this type of review, it was possible to find studies that included Grade 10 learners studying mathematics as well as other studies that did not. These studies were separated and classified based on if they dealt with Grade 10 learners specifically studying mathematics. The steps taken during the review are outlined below. Some of the information regarding the steps taken during the review could not be found so no search results or screening results have been made up.

Search Strategy

The literature search covered ERIC, Scopus, Web of Science, and Google Scholar for studies published from January 2015 to December 2025, with particular attention to foundational studies published during 2015–2017. The search focused on metacognitive strategies, mathematics self-efficacy, mathematics achievement, and secondary or Grade 10 learners using combinations of these key terms. Retrieved studies were screened by title, abstract, and full text, while reference lists of relevant studies were also examined. Studies meeting the inclusion criteria were retained for synthesis, with evidence involving Grade 10 mathematics learners classified as direct evidence and studies involving other grade levels, subjects, or poulations classified as indirect evidence.

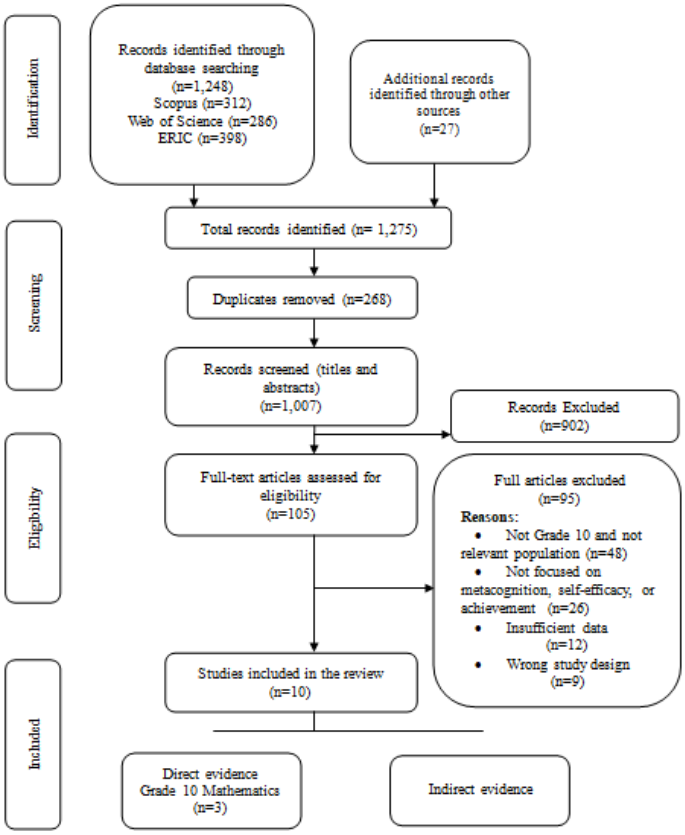


Figure 1. PRISMA-Style Flow Diagram of the Study Selection Process

Eligibility Criteria

Included studies needed to cover at least one of the review topics. Contained learners from an education environment or similar setting. Had meaningful results that could help answer the questions. Could be accessed in its entirety. And fulfilled any criteria set by the author for publication, language and time period. Evidence that directly relates to learners in Grade 10 mathematics will be considered direct evidence. Any studies that contain learners of different subjects/grades/environments will be deemed indirect evidence.

Screening and Reviewer Roles

Records should be screened in stages: duplicate removal; title/abstract screening; full-text assessment; and final inclusion. The authors should report the actual number of reviewers, their roles, how disagreements were resolved, and the reasons for full-text exclusions. These details must be completed from the actual review process.

Table 1. Studies with Direct Evidence Involving Grade 10 Mathematics Learners

Authors (Year)	Population	Context/Subject	Design	Measures	Key Findings
Dela Cruz, R. M., Jr., & Castillo, A. A. (2024)	120 Grade 10 students	Mathematics (urban high school)	Quasi-experimental	Metacognitive strategy questionnaire; mathematics achievement test	Metacognitive strategy instruction significantly improved mathematics achievement.
Bustoba, A. M., & Dela Cruz, M. C. A. (2022)	98 Grade 10 learners	Mathematics (public high school)	Correlational	Mathematics self-efficacy scale; mathematics achievement record	Mathematics self-efficacy was positively related to mathematics achievement.

Quality Appraisal

Because this is framed as a scoping review, quality appraisal is not used to exclude studies unless the authors' actual protocol specified such a procedure. If quality appraisal was conducted, the tool, reviewer roles, scoring procedure, and use of appraisal results should be reported explicitly.

Data Extraction

The evidence table should extract author/year, population, educational level, subject/context, design, sample, measures, intervention or exposure where applicable, direct/indirect classification, principal findings, and limitations.

Synthesis Method

Findings are synthesized narratively and thematically. Evidence directly concerning Grade 10 mathematics is separated from indirect evidence. Associations are described using evidence-calibrated language, and causal or universal claims are avoided unless directly supported by appropriate study designs.

Table 2. Studies with Indirect Evidence from Other Populations, Levels, Subjects, or Contexts

Author (Year)	Population	Context/Subject	Design	Measures	Key Findings
Gaylo & Dales (2017)	Grade 9 students	Mathematics	Intervention/ comparative	Metacognitive strategy instruction; mathematics achievement test	Metacognitive strategy instruction was associated with higher mathematics achievement.
Causapin (2016)	Rural high school students	Mathematics	Correlational	Mathematics self-efficacy scale; mathematics grades	Self-efficacy was significantly related to mathematics achievement, with contextual factors influencing outcomes.
Kaya & Bozdag (2016)	Secondary students	Mathematics	Correlational	Mathematics self-efficacy scale; academic achievement	Self-efficacy was positively related to academic achievement in mathematics.
Toraman et al. (2020)	Students (grade level not specified)	Mathematics	Empirical	Reflective thinking scale; mathematics scores	Reflective thinking was associated with higher mathematics performance.
Negara et al. (2021)	Learners (grade level not specified)	Mathematics learning	Empirical	Metacognitive and self-efficacy measures	Metacognitive support was associated with mathematics learning outcomes.
Özcan & Kültür (2021)	Learners (grade level not specified)	Mathematics	Empirical	Instructional and self-efficacy measures	Instructional support was associated with mathematics-related outcomes.
Fadillah, Budiyono, & Nurhasanah (2021)	Learners (grade level not specified)	Learning/ Metacognition	Empirical	Self-efficacy and metacognitive measures	Self-efficacy was associated with metacognitive strategy use.

Guntur & Purnomo (2024)	Learners (grade level not specified)	Learning/ Metacognition	Empirical	Self-efficacy and metacognitive measures	Significant relationships were reported between self-efficacy and metacognitive strategy use.
Arianto & Hanif (2024)	Learners (grade level not specified)	Learning/Self-regulation	Empirical	Metacognitive/self-regulation measures	Planning, monitoring, and reflection were linked to improved learning outcomes.
Clemente (2025)	Learners (grade level not specified)	Mathematics	Empirical	Instructional and self-efficacy measures	Instructional and metacognitive support was associated with mathematics learning and confidence.

LITERARTURE REVIEW

Mathematics Self – Efficacy

Math self-efficacy is all about how much students believe they can handle math problems, especially the tough or unfamiliar ones. Lately, researchers keep pointing out just how much this belief shapes the way students tackle math — how hard they try, how long they stick with a problem, and whether they keep going after hitting a wall (Schunk & DiBenedetto, 2020; OECD, 2020). When students truly believe they can succeed, they're a lot more likely to take on hard problems, keep working when they mess up, and actually try different approaches instead of just giving up. This confidence spills over, too; it affects not just grades, but how students feel about math in general. Building up this kind of self-efficacy isn't just a nice idea it's key if we want to reach Sustainable Development Goal 4 (Quality Education). It helps students learn in a deeper way, do better in school, and pick up the skills they'll need to keep learning for life.

Strategies for Enhancing Mathematics Self-Efficacy.

Methods to Improve Mathematics Self-Efficacy Studies indicate some robust strategies. Such, Zakariya (2022)

says, is the greatest benefit, which comes from mastery experiences: essentially, allowing students to work through problems that get harder over time, so they get used to success. Witnessing classmates or teachers solve problems out loud is also helpful. When students notice how others struggle, try different things, and finally figure it out, they learn to believe they can do it well too. Teachers can have a strong influence as well by giving students direct support, delivering feedback that is concrete and useful, and having lessons so they become "active" and understand what's being taught. And there is more: goal-setting, planning, checking your own work, and thinking about what you've learned all contribute to allowing students to see their progress and control their own learning (Arianto & Hanif, 2024). As with other strategies, these measures in turn help all students to perform better in math or school. They also meet SDG 4 (Quality Education) and SDG 10 (Reduced Inequalities), for they work on students from all walks of life and abilities of every kind.

Relationship Between Self-Efficacy, Motivation, and Self-Regulated Learning.

Self-efficacy, motivation, and self-regulated learning all work together at the heart of success in math. Schunk and DiBenedetto (2020) point out that when students believe in themselves, they're more likely to dive in, stick with tough problems, and actually put in the effort. If you see students with strong self-efficacy, you'll notice they set real goals, plan ahead, check their progress as they go, and figure out what's working or not. Zimmerman (2020) adds that these habits don't just keep motivation alive—they also help students stay engaged, even when the work gets harder. Building up self-efficacy doesn't just boost perseverance and smart

learning habits; it actually helps cut down on academic stress and keeps students emotionally balanced. That lines up with Sustainable Development Goal 3, which focuses on good health and well-being.

Emotional and Cognitive Influences on Mathematics Self-Efficacy.

Math self-efficacy really comes down to how students feel and think during learning. Research from Tahmassian, Jalali-Moghadam, and Ghasemi (2020) shows that self-efficacy shapes performance by influencing things like anxiety, stress, motivation, and how students use their own thinking strategies. When students feel confident, they don't get as anxious about math, so they can actually focus on figuring things out instead of worrying. Arens, Frenzel, and Goetz (2020) found that having a positive view of yourself as a math student makes you even more confident for specific tasks, which keeps the cycle of engagement and achievement going. Clear teaching, quick feedback, and step-by-step support—these all-help students feel less confused and overwhelmed, and that boosts self-efficacy too (Liu & Wang, 2022). All of this connects right back to SDG 3, since emotional strength and less stress mean better health and well-being for students.

Social, Instructional, and Learning Environment Factors.

The way students interact with each other and their teachers shapes how confident they feel about math. When teachers build supportive relationships, give honest feedback, and create classrooms where it's okay to ask questions or make mistakes, students' math anxiety drops. Their confidence grows (Sides & Cuevas, 2020). Teachers who adjust lessons to match students' needs—changing up the pace, the content, or the kind of help they offer—give everyone a real shot at success. When kids experience success at the right level for them, their belief in themselves gets stronger (Lai, Zhang, & Chang, 2020). These kinds of inclusive approaches make sure every student gets a fair chance, no matter their background or ability. And really, that's what SDG 10 (Reduced Inequalities) and SDG 4 (Quality Education) are all about.

Self-Efficacy in Online and Technology-Enhanced Learning.

Even when learning goes digital, self-efficacy still matters—a lot. Huang, Hidayat, and Ayub (2025) found that students who believe in their math abilities stick with online courses longer, get involved more, and do better overall. Good online teaching—think interactive assignments, feedback that comes when you need it, and clear instructions—keeps students motivated and confident. Making sure everyone has access to helpful digital resources opens doors for all kinds of learners, which lines up perfectly with SDG 4 (Quality Education) and SDG 10 (Reduced Inequalities).

Sociocultural Influences on Mathematics Self-Efficacy.

What students believe about themselves in math isn't just about what happens in the classroom. Gender norms, cultural expectations, and how society talks about math all play a big part. Iraola-Real and Carvalho (2025) pointed out that negative stereotypes and low expectations can really shake students' confidence—especially for those in marginalized groups. The fix? Teachers need to bring in culturally aware teaching, fair practices, and strong role models. That's what helps every student feel like they belong in math, and it pushes SDG 10 (Reduced Inequalities) forward.

Instructional Interventions and Metacognitive Support.

When teachers blend metacognitive support into their lessons, students' confidence in math really grows. The research backs this up — students do better when they get to work on mastery-focused tasks, see peers model solutions, get helpful feedback, and use technology as part of their learning (Negara et al., 2021; Özcan & Kültür, 2021; Clemente, 2025). It helps even more when students actively plan, keep track of, and reflect on how they learn, especially when they're stuck on tough problems (Arianto & Hanif, 2024). Newer ideas, like scaffolded flipped classrooms and well-structured learning spaces, give students more independence and help them really understand the material. All of this supports the goals of quality education (SDG 4) and good health and well-being (SDG 3).

Everything points to this: math self-efficacy isn't just about what happens in the classroom. It stems from a blend of the way learners think, feel, learn, and interact with their environment. The most successful interventions put these pieces together and are that unique blend—they're a hybrid of metacognitive practices, good teaching, real mastery experiences, and welcoming, inclusive environments. It boosts academic results and builds emotional strength while promoting fairness — all in line with the SDGs 4, 3, and 10. So moving forward, researchers will have to keep probing into how these strategies function over time and how they work with various schools and cultures (Dela Cruz & Castillo, 2024)

Mathematics Achievement

A lot goes into how well students do in math. Sure, things like their own motivation and natural ability matter,

but that's only part of the story. The way teachers teach, how confident and skilled they are, the support students get at home, and even how they feel emotionally—all of these shape math achievement (OECD, 2020; Harefa, 2023). When students really get involved in their math work and know what's expected, they tend to do better. Teachers who pay attention to what their students need and give steady, clear guidance really make a difference. Having a family that backs you up and feeling emotionally steady also help a lot. When these pieces come together, students have a better shot at success—and that's exactly what Sustainable Development Goal 4 (Quality Education) is all about: making sure everyone gets a fair chance to learn math well (Bustoba, & Dela Cruz, 2022).

Cognitive Engagement and Instructional Approaches in Mathematics Achievement.

Students learn math better when lessons push them to think, not just memorize. Research keeps showing that problem-solving, asking questions, and staying actively involved help students grasp big ideas instead of just picking up facts (Salam et al., 2020; Bakar & Ismail, 2020). Even in tough times, like during the COVID-19 pandemic, structured lessons and thoughtful interventions kept kids on track (Lewis, Kuhfeld, & Ruzek, 2021). It's not just about what teachers do, though. Students who set goals, pay attention to how they're learning, and take time to reflect usually end up doing better. This kind of teaching gives everyone a fair shot and helps close achievement gaps, which lines up with SDG 10 (Reduced Inequalities).

Role of Self-Efficacy in Mathematics Achievement.

Self-efficacy really shapes how well students do in math. When students believe they can handle the work, they tend to jump in, stick with tough problems, and actually use strategies that help them solve things (Zakariya, 2022; Arens, Frenzel, & Goetz, 2020). You see this confidence growing in places where the learning environment feels supportive, the teaching connects, and classmates encourage each other. Programs that focus on real feedback, strong role models, and steady encouragement push students' confidence and performance up (Ryan & Bowman, 2022; Clemente, 2025; Negara et al., 2021; Özcan & Kültür, 2021). Getting kids started early with strategies that help them think about their own thinking—metacognition—and learning how to manage themselves really boosts their confidence and problem-solving skills (Arianto & Hanif, 2024). When students feel less anxious and more willing to persevere, they just do better. That ties right back into SDG 3, supporting good health and well-being.

Metacognitive Strategies and Mathematics Achievement.

Metacognitive strategies—like planning, checking your work as you go, and reflecting on how you solved a problem—change the game in math. Planning helps students set clear goals and figure out the best way to tackle a problem. Monitoring means they're checking in with themselves as they work, making sure they actually get what's happening. Evaluation is all about looking back and judging if their approach worked or if there's a better way. Research keeps showing that students who use these strategies don't just memorize steps—they actually understand what they're doing, work independently, and solve problems better than those who just memorize (Salam et al., 2020; Bakar & Ismail, 2020; Zhang & Lian, 2023; Halmo, Yamini, & Stanton, 2024). There's also a back-and-forth here: when students feel confident, they use more metacognitive

strategies, which then builds even more confidence and success (Fadillah, Budiyono, & Nurhasanah, 2021; Guntur & Purnomo, 2024). All of this backs up SDG 4 by highlighting the importance of deeper thinking and learning how to learn.

Instructional Quality, Teacher Competence, and Collaborative Learning.

Great teaching really boosts how self-efficacy and metacognition impact students' success in math. When teachers use things like scaffolding, differentiated instruction, formative feedback, and get students working together, kids don't just understand more — they actually care more about learning, too. Take scaffolded flipped classrooms, for example. Students get the structure they need, but also the freedom to learn on their own. That mix leads to better understanding and more confidence (Awi Dassa et al., 2024). When students team up to solve problems or talk through their ideas, they plan, monitor, and tweak strategies together, which builds stronger metacognitive skills (Krüger, Vorhölter, & Kaiser, 2020). Letting students create their own math problems does even more — it pushes them to be independent, builds their confidence, and gets them thinking about their own thinking (Pietrocola, Malaspina, & Villani, 2020).

Teacher Expertise, Learning Environment, and Real-World Applications.

A teacher who really knows their stuff can turn tough math ideas into lessons that actually stick. Research shows that when teachers have strong knowledge and clear teaching methods, students not only understand more — they feel more confident, too (Yang & Kaiser, 2020; Liu & Wang, 2022). Well-structured approaches — like those inspired by Montessori — set clear expectations and offer steady challenges, so students steadily grow in confidence and skill (Basargekar & Lillard, 2021). Bringing in real-world, STEM-based projects gives students a reason to care and shows them how math fits into real life (Wahono, Lin, & Chang, 2020). These strategies make learning both inclusive and meaningful, lining up with goals like SDG 4 (Quality Education) and SDG 10 (Reduced Inequalities).

Motivation, Emotional Factors, and Learning Contexts.

Motivation and interest really shape how students do in math. When kids actually like math, they stick with it, manage their own learning better, and end up doing well (Harefa, 2023; Zakariya, 2022). A positive classroom vibe and strong connections with teachers go a long way in lowering math anxiety and getting students involved (Daucourt et al., 2021). Programs that work in self-regulation, reflection, scaffolding, and tailored instruction tackle not just the thinking side, but also the emotional and motivational parts of learning (Hone, Weldemeskel, & Worku, 2023; Santosa et al., 2023; Dassa et al., 2024). Flexible teaching strategies are especially important for remote or blended learning. They help keep students engaged and independent (Lewis, Kuhfeld, & Ruzek, 2021), and they support SDG 3 (Good Health and Well-Being).

The research makes it pretty clear: if students are going to do well in math, a few key things need to work together—stuff like confidence in their own abilities, good study habits, solid teaching, motivation, and a classroom that actually supports them. For Grade 10 students, what really works are approaches that build their confidence, get them thinking about how they learn, and use smart teaching methods. Think scaffolding, group work, giving students a chance to pose their own problems, and encouraging them to reflect on their thinking. Even with plenty of evidence showing these strategies help, we don't know which mix works best for different types of learners, or how much these methods improve more advanced math skills over time. Figuring that out matters. If we want to create lessons that help students keep succeeding, become more independent, and have equal chances at a good math education—while also supporting bigger goals like quality education, health, and reducing inequality—we need to close those gaps.

Metacognitive Strategies

Metacognitive strategies are all about taking control of how you learn. They help you plan, keep track of, and make sense of your own thinking, so you actually get better results. When you use these strategies, you start steering your own learning journey. You're not just memorizing stuff—you're figuring out how you think,

what works, and how you can do better next time. This kind of self-awareness builds real skills: critical thinking, adaptability, and a mindset for lifelong learning (Anthonysamy, 2021; Rivas, Saiz, & Ossa, 2022). Students who use metacognitive strategies don't just cram and forget. Instead, they become strategic thinkers who know how to analyze what they understand, switch up their study tactics, and genuinely improve. That's exactly what Sustainable Development Goal 4 – Quality Education is all about: making education meaningful and centered around the learner.

People talk about a lot of different things when they discuss metacognition, but three strategies come up again and again: self-monitoring, self-questioning, and reflective thinking. Research points to these as real game-changers—they boost academic results, help with problem-solving, and build independence and emotional strength. That's not just good for learning; it ties into big-picture goals like SDG 3 (Good Health and Well-Being) and SDG 10 (Reduced Inequalities), too. When people know how to manage their own learning, they're better equipped to handle challenges in all kinds of situations.

Self-Monitoring as a Metacognitive Strategy.

Self-monitoring is all about learners keeping tabs on how well they understand, how much progress they're making, and how they're actually performing as they go. They spot their own mistakes, check if they really get what they're studying, and tweak how they're working when things aren't clicking. Sabaliauskas and colleagues (2025) point out that self-monitoring helps people stay aware of what's happening in their own heads, which makes it easier to self-regulate and remember things over time.

Study after study backs this up. Muhid et al. (2020) found that students using self-monitoring strategies made big jumps in comprehension—especially when they focused their attention and checked their work as they went. In online learning, Zhu and Doo (2022) saw that students who kept a close eye on their learning in MOOCs stuck with it longer, felt more motivated, and managed themselves better. Maftoon and Fakhri Alamdari (2020) noticed the same effect in listening: when learners were taught to plan out and review their own progress, their listening skills improved.

Feedback makes a big difference here. Zhang and Zhang (2024) found that when students got clear, timely feedback, they got better at using self-monitoring in their writing—and their writing made more sense and felt better organized. Athami (2020) showed that structured self-monitoring programs really boosted comprehension and critical thinking. It doesn't stop at academics, either. Bürgler and Hoyle (2021) showed that self-monitoring helps people manage their behavior and make smarter choices. So, self-monitoring isn't just for grades—it builds independence and personal growth, supporting SDG 3 (Good Health and Well-Being) and SDG 4 (Quality Education).

Self-Questioning as a Metacognitive Strategy.

Self-questioning is about learners asking themselves thoughtful questions as they learn—checking if they really understand, connecting what's new to what they already know, and figuring out if their learning tactics are actually working. This keeps them active and thinking deeply, instead of just soaking up facts without much thought (Pereles, 2024). When students get in the habit of questioning themselves, they actually comprehend more, reason better, and pull ideas together more effectively.

The research here is pretty clear. Saxena (2020) found that students who regularly practiced self-questioning had more motivation from within and took better charge of their learning. Vosniadou and her team (2021) noticed that learners with strong beliefs in their own abilities used self-questioning more—and got better academic results. Lumpkin (2020) saw that self-questioning sharpens problem-solving and helps information stick for the long haul.

In language and writing, Teng (2020) found that prompts built around self-questioning helped students organize their thoughts, make their writing flow, and improve their revisions. Efklides and Schwartz (2024) stressed that self-questioning is a key part of self-regulated learning—it helps learners set goals, track how

they're doing, and change up their approach when needed. At the classroom level, Muijs and Bokhove (2020) showed that lessons focused on explaining and questioning boosted metacognitive awareness and adaptability. All of this supports SDG 4 (Quality Education) by fostering critical thinking, and SDG 10 (Reduced Inequalities) by giving students tools that work in any subject or setting.

Reflective Thinking as a Metacognitive Strategy.

Reflective thinking is all about looking back on how you learn—what worked, what didn't, and what you can do better next time. Instead of just checking off tasks, it pushes you to really dig into your own thought process. Ho (2025) points out that people who practice reflective thinking usually have stronger metacognitive awareness and do better academically.

Plenty of studies back this up. Shahrakipour (2021) noticed that students who mixed reflective thinking with other metacognitive strategies scored higher and solved problems more easily. Antonio (2020) found that when learners tried structured reflection activities, they got better at managing themselves—they started to question and fine-tune their own strategies. Nobutoshi (2023) adds another layer, saying teachers who model reflective thinking help students get better at judging their own learning, which boosts independence and critical thinking.

It's not just general skills—reflection matters in specific subjects, too. Toraman and colleagues (2020) saw a clear link between reflective thinking and better math scores. Ramadhanti et al. (2020) found that students who kept reflective journals became more aware of how they think and wrote better essays. Kholid and colleagues (2020, 2022) showed that activities like think-alouds help students plan, monitor, and evaluate their work more effectively. Ossa et al. (2023) and Aydoğmuş and Şentürk (2023) both found that reflective practices boost motivation, keep students going when things get tough, and make them better at managing their own learning. All of this connects with SDG 3 (Good Health and Well-Being), since reflection builds emotional resilience, and SDG 4 (Quality Education), because it drives deeper, more meaningful learning.

The research shows that when people use self-monitoring, self-questioning, and reflective thinking together, they get better at learning. These strategies help learners plan what they're going to do, keep track of how it's going, and figure out how well they did. That builds up confidence, independence, and achievement. Metacognitive strategies don't just boost grades—they also help people adapt, bounce back from setbacks, and think more deeply. When teachers weave these approaches into their lessons, they create classrooms where everyone feels supported, no matter their background. This kind of teaching moves us closer to quality education, better well-being, and less inequality—right in line with SDG 4, SDG 3, and SDG 10.

The reviewed literature collectively underscores that mathematics learning among in Grade 10 isn't just about crunching numbers or memorizing formulas. It's a mix of what students know, how they think about their thinking, what drives them, how they feel, the way teachers teach, and even the culture they're in. Over and over, studies point to one thing that really matters—math self-efficacy. If students believe they can do math, they're more likely to stick with tough problems, try new strategies, and actually do better. Confidence makes a difference. On the flip side, without that belief, students get anxious, avoid challenges, and tend to struggle. That's why building confidence in math class isn't just nice to have—it's essential.

But there's more to it than just believing in yourself. Success in math also depends on great teaching, solid relationships with teachers, a positive classroom vibe, and students' emotional health. When teachers push students to think deeply, guide them step by step, give real feedback, and actually care about their progress, students learn more and feel better about it. These kinds of teaching don't just close achievement gaps—they help everyone feel included and set up for success, which ties right into what SDG 4 and SDG 10 are all about: quality education and reduced inequalities.

Another big piece of the puzzle is metacognition. That's just a fancy way of saying "thinking about your own thinking." Students who plan their approach, check their understanding, and reflect on what's working (or not) end up with a stronger grasp of math and more independence. They spot mistakes, try new tactics, and see

setbacks as chances to learn, not reasons to give up. There's a kind of feedback loop here—when students feel more confident, they use these strategies more, and when they use them successfully, their confidence grows even more.What's really interesting is how these strategies help with the emotional side of learning, too. Teaching students to be aware of their learning and reflect helps them stress less and bounce back when things get tough. It builds resilience and keeps motivation going, all of which support SDG 3: good health and well-being. Students who feel better emotionally engage more and keep at it, even when math gets tricky.

All in all, the research says one thing loud and clear: using metacognitive strategies to boost math confidence and achievement isn't just effective—it's necessary for Grade 10 students. Blending these strategies into everyday teaching doesn't just help with test scores; it supports emotional health and makes learning fairer for everyone. Still, there are some gaps. We don't know enough about how well these approaches work over the long haul or in every type of classroom. That's what this study aims to figure out—how targeted metacognitive strategies can help Grade 10 students build math confidence and achieve more, while pushing forward the goals of Sustainable Development Goal SDG 4 (Quality Education), SDG 3 (Good Health and Well-Being), and SDG 10 (Reduced Inequalities).

CONCLUSION

The reviewed literature indicates that learning mathematics goes beyond knowledge and procedural skill development as mathematics self-efficacy, metacognitive strategies, motivation, emotional well-being, instruction, and environment intersect to influence students' learning opportunities and achievement. Students with higher mathematics self-efficacy generally tend to stick with difficult tasks and use learning strategies whereas self-monitoring, self-questioning, and reflection encourage students to notice how they learn and discover when they don't understand something, judge if they are using appropriate strategies, and correct course if needed. The literature showed that students can benefit from metacognitive strategies and mathematics self-efficacy can be mutually beneficial. When learners see that using a strategy helps them learn, they may develop greater confidence in mathematics and when students feel confident, they are more likely to use efficient metacognitive strategies. Mathematics instruction should explicitly give students opportunities to plan, monitor, question, evaluate, and reflect on their learning and provide scaffolding, meaningful feedback, activities that promote mastery and self-regulation, and a supportive classroom environment. With few exceptions, the literature validates the inclusion of metacognitive strategies to help support students' mathematics self-efficacy and possibly mathematics achievement. Unclear or insufficient information was found regarding the long-term effectiveness of metacognitive strategies and if the strategies can be applied in multiple learning contexts. These gaps create justification for further research with Grade 10 students and the development of an evidence-based intervention supporting Sustainable Development Goals 3, 4, and 10.

REFERENCES

1. Ablian, J. D., & Parangat, K. B. (2022). Mathematics anxiety and mathematics self-efficacy among senior high school students in public secondary schools. International Journal of Computer, Electrical, Automation, Control and Information Engineering, 16(5), 213–220.
2. Al Umairi, K. S. (2024). Role of mathematics motivation in the relationship between mathematics self-efficacy and achievement. Journal of Pedagogical Research, 8(1), 45–60.
3. Amal, M. F., & Mahmudi, A. (2020). Enhancing students' self-efficacy through metacognitive strategies in learning mathematics. Journal of Physics: Conference Series, 1567, 042061.
4. Amir, M. Z., Nurdin, E., Azmi, M. P., & Andrian, D. (2021). The increasing of math adversity quotient in mathematics cooperative learning through metacognitive strategies. International Journal of Instruction, 14(3), 789–804.
5. Anthonysamy, L. (2021). The use of metacognitive strategies for undisrupted online learning: Preparing university students in the age of pandemic. Education and Information Technologies, 26(6), 6975–6995.
6. Antonio, R. P. (2020). Developing students' reflective thinking skills in a metacognitive and argument-driven learning environment. International Journal of Research in Education and Science, 6(4), 789–805.

7. Arifin, S., & Herman, T. (2021). The effect of students' mathematics self-efficacy on mathematical understanding performance. Ilkogretim Online, 20(4), 123–134.
8. Arianto, F., & Hanif, M. (2024). Evaluating metacognitive strategies and self-regulated learning to predict primary school students' self-efficacy and problem-solving skills in science learning. Journal of Pedagogical Research, 8(3), 301–319. https://doi.org/10.33902/JPR.202428575
9. Athami, S. (2020). The effectiveness of using Self-Monitoring Approach to Reading and Thinking (SMART) strategy in students' reading comprehension. CORE Open Access.
10. Awofala, A. O. A. (2023). Examining sources of mathematics self-efficacy beliefs of senior secondary school students. ASEAN Journal of Science and Engineering Education, 4(2), 101–115.
11. Aydoğmuş, M., & Şentürk, C. (2023). An investigation into the predictive power of reflective thinking on learning strategies. Reflective Practice, 24(3), 456–472.
12. Bakar, M. A. A., & Ismail, N. (2020). Mathematical instructional: A conceptual redesign of active learning with metacognitive regulation strategy. International Journal of Instruction, 13(2), 45–62.
13. Bouknify, M. (2023). Importance of metacognitive strategies in enhancing reading comprehension skills. Journal of Education in Black Sea Region.
14. Bürgler, S., & Hoyle, R. H. (2021). Flexibility in using self-regulatory strategies to manage self-control conflicts: The role of metacognitive knowledge, strategy repertoire, and feedback monitoring. European Journal of Psychological Assessment, 37(5), 345–356.
15. Causapin, M. (2016). Contextualising mathematics self-efficacy and performance among rural high school students in the Philippines. Journal of Science and Mathematics Education in Southeast Asia.
16. Clemente, J. M., Kilag, O. K. T., Ypon, A. Q., Groenewald, E. S., Groenewald, C. A., & Ubay, R. G. (2023). Enhancing mathematics self-efficacy: Intervention strategies and effectiveness—A systematic review.
17. Craig, K., Hale, D., Grainger, C., & Stewart, M. E. (2020). Evaluating metacognitive self-reports: Systematic reviews of the value of self-report in metacognitive research. Metacognition and Learning, 15(3), 307–334.
18. Cribbs, J., & Huang, X. (2021). Relations of mathematics mindset, mathematics anxiety, mathematics identity, and mathematics self-efficacy to STEM career choice: A structural equation modeling study. School Science and Mathematics.
19. Czocher, J. A., Melhuish, K., et al. (2020). Building mathematics self-efficacy of STEM undergraduates through mathematical modelling. International Journal of Mathematical Education in Science and Technology, 51(7), 1045–1062.
20. Ding, Y., Klapp, A., & Yang Hansen, K. (2024). The importance of mathematics self-concept and self-efficacy for mathematics achievement: A comparison between public and independent schools in Sweden. Educational Psychology, 44(2), 145–162.
21. Divrik, R., Pilten, P., & Tas, A. M. (2020). Effect of inquiry-based learning method supported by metacognitive strategies on fourth-grade students' problem-solving and problem-posing skills: A mixed-method study. International Electronic Journal of Elementary Education.
22. Efklides, A., & Metallidou, P. (2020). Applying metacognition and self-regulated learning in the classroom.
23. Efklides, A., & Schwartz, B. L. (2024). Revisiting the metacognitive and affective model of self-regulated learning: Origins, development, and future directions. Educational Psychology Review, 36(2), 345–371.
24. Falco, L. D. (2020). An intervention to support mathematics self-efficacy in middle school. In Integrative and interdisciplinary curriculum in the middle school.
25. Fadillah, R. R., Budiyono, & Nurhasanah, F. (2021). The analysis of students' metacognition in solving math problems based on self-efficacy. Journal of Physics: Conference Series, 1808(1), 012062. https://doi.org/10.1088/1742-6596/1808/1/012062
26. Gao, J. (2020). Sources of mathematics self-efficacy in Chinese students: A mixed-method study with Q-sorting procedure. International Journal of Science and Mathematics.
27. Gaylo, D. N., & Dales, Z. I. (2017). Metacognitive strategies: Their effects on students' academic achievement and engagement in mathematics. World Review of Business Research, 7(2), 33–55. https://doi.org/10.5281/zenodo.3951851

28. Guntur, M., & Purnomo, Y. W. (2024). Unravelling the interplay of self-efficacy, self-regulation, metacognition in alleviating math anxiety among primary school student: A conditional process analysis. Education 3–13. https://doi.org/10.1080/03004279.2024.2396096
29. Güner, P., & Erbay, H. N. (2021). Metacognitive skills and problem-solving. International Journal of Research in Education and Science, 7(4), 987–1002.
30. Hennecke, M., & Bürgler, S. (2023). Metacognition and self-control: An integrative framework. Psychological Review, 130(5), 879–901.
31. Ho. (2025). Thinking more wisely: Using the Socratic method to develop critical thinking skills amongst healthcare students. BMC Medical Education.
32. Jones, J. S., Milton, F., Mostazir, M., et al. (2020). The academic outcomes of working memory and metacognitive strategy training in children: A double-blind randomized controlled trial. Developmental Science.
33. Kaya, D., & Bozdağ, H. C. (2016). Resources of mathematics self-efficacy and perception of science self-efficacy as predictors of academic achievement. European Journal of Contemporary Education, 18(4), 438–451. https://doi.org/10.13187/ejced.2016.18.438
34. Khanal, B., Panthi, R. K., Kshetree, M. P., & Acharya, B. R. (2021). Mathematics learning strategies of high school students in Nepal. SN Social Sciences.
35. Kholid, M. N., Sa'dijah, C., & Hidayanto, E. (2022). Students' reflective thinking pattern changes and characteristics of problem solving. Reflective Practice, 23(4), 567–584.
36. Kholid, M., Sa'dijah, C., & Hidayanto, E. (2020). How are students' reflective thinking for problem solving? Journal for the Education of Gifted Young Scientists, 8(3), 123–138.
37. Kusaka, S., & Ndihokubwayo, K. (2022). Metacognitive strategies in solving mathematical word problems.
38. Lumpkin, A. (2020). Metacognition and its contribution to student learning. College Student Journal, 54(2), 123–132.
39. Maftoon, P., & Fakhri Alamdari, E. (2020). Exploring the effect of metacognitive strategy instruction on metacognitive awareness and listening performance through a process-based approach. International Journal of Listening.
40. Marasabessy, R. (2021). Study of mathematical reasoning ability for mathematics learning in schools: A literature review. Indonesian Journal of Teaching in Science.
41. Mohseni, F., Seifoori, Z., & Ahangari, S. (2020). The impact of metacognitive strategy training and critical thinking awareness-raising on reading comprehension.
42. Muhid, A., Amalia, E. R., Hilaliyah, H., Budiana, N., & Wajdi, M. B. N. (2020). The effect of metacognitive strategies implementation on students' reading comprehension achievement. International Journal of Instruction, 13(2), 847–862.
43. Muijs, D., & Bokhove, C. (2020). Metacognition and self-regulation: Evidence review. Education Endowment Foundation.
44. Negara, H. R. P., Nurlaelah, E., Wahyudin, T., Herman, T., & Tamur, M. (2021). Mathematics self-efficacy and mathematics performance in online learning. Journal of Physics: Conference Series, 1882(1), 012050.
45. Nobutoshi, M. (2023). Metacognition and reflective teaching: A synergistic approach to fostering critical thinking skills. Research and Advances in Education, 5(2), 101–118.
46. Ossa, C. J., Rivas, S. F., & Saiz, C. (2023). Relation between metacognitive strategies, motivation to think, and critical thinking skills. Frontiers in Psychology, 14, 112345.
47. Özcan, B., & Kültür, Y. Z. (2021). The relationship between sources of mathematics self-efficacy and mathematics test and course achievement in high school seniors. SAGE Open, 11(4), 1–14.
48. Özkubat, U., & Özmen, E. R. (2021). Investigation of effects of cognitive strategies and metacognitive functions on mathematical problem-solving performance of students with or without learning difficulties. International Electronic Journal of Elementary Education.
49. Öztürk, M., Akkan, Y., & Kaplan, A. (2019). Reading comprehension, mathematics self-efficacy perception, and mathematics attitude as correlates of students' non-routine mathematics problem-solving skills in Turkey. International Journal of Mathematical Education in Science and Technology, 50(7), 1042–1058.

50. Pintrich, P. R. (2004). A conceptual framework for assessing motivation and self-regulated learning in college students. Educational Psychology Review, 16(4), 385–407.
51. Presto, A., & Menorca, E. L. (2023). Students' metacognitive strategies in solving mathematics problems in distance learning: A phenomenological study. International Journal of Multidisciplinary Studies, 10(2), 45–60.
52. Ramadhanti, D., Ghazali, A., & Hasanah, M. (2020). The use of reflective journal as a tool for monitoring of metacognition growth in writing. Journal of Emerging Technologies in Learning, 15(12), 45–58.
53. Rao, I. S., Jeevan, S., & Ahmad, A. (2023). Impact of metacognitive strategies on creative writing of ESL students at college level in District Lahore. Global Language Review.
54. Rivas, S. F., Saiz, C., & Ossa, C. (2022). Metacognitive strategies and development of critical thinking in higher education. Frontiers in Psychology, 13, 913219.
55. Rozgonjuk, D., Kraav, T., & Mikkor, K. (2020). Mathematics anxiety among STEM and social sciences students: The roles of mathematics self-efficacy, and deep and surface approach to learning. International Journal of STEM Education, 7, Article 46.
56. Rusyid, H. K., & Juandi, D. (2023). Students' mathematics learning difficulties in terms of metacognitive ability: A systematic literature review. Pedagogy: Jurnal Pendidikan Matematika.
57. Ryan, J., & Bowman, J. (2022). Teach cognitive and metacognitive strategies to support learning and independence. In High leverage practices and students with disabilities (pp. 115–134). Taylor & Francis.
58. Salam, M., Misu, L., Rahim, U., & Hindaryatiningsih, N. (2020). Strategies of metacognition based on behavioural learning to improve metacognition awareness and mathematics ability of students. International Journal of Instruction, 13(4), 221–240.
59. Saxena, A. S. (2020). Impact of metacognitive strategies on self-regulated learning and intrinsic motivation. Journal of Psychosocial Research, 15(2), 235–247.
60. Schunk, D. H., & DiBenedetto, M. K. (2020). Motivation and social-emotional factors in mathematics learning: How self-efficacy and goal-setting influence achievement. Contemporary Educational Psychology, 60, 101823.
61. Schuster, C., Stebner, F., Leutner, D., & Wirth, J. (2020). Transfer of metacognitive skills in self-regulated learning: An experimental training study. Metacognition and Learning, 15(4), 601–627.
62. Sercenia, J. C., & Prudente, M. S. (2023). Effectiveness of the metacognitive-based pedagogical intervention on mathematics achievement: A meta-analysis. International Journal of Instruction, 16(1), 55–78.
63. Sethares, K. A., & Asselin, M. E. (2022). Use of exam wrapper metacognitive strategy to promote student self-assessment of learning: An integrative review. Nurse Educator, 47(3).
64. Sevgi, S., & Arslan, K. (2020). Exploring middle school students' mathematics self-efficacy and mathematics anxiety. Online Submission, 6(4), 55–68.
65. Shahrakipour, H. (2021). Predicting the role of learning approaches, studying strategies, metacognitive strategies, and reflective thinking with students' academic achievements.
66. Street, K. E. S., Malmberg, L. E., & Schukajlow, S. (2024). Students' mathematics self-efficacy: A scoping review. ZDM Mathematics Education, 56, 265–280.
67. Tay, L. Y., Chan, M., Chong, S. K., & Tan, J. Y. (2024). Learning of mathematics: A metacognitive experiences perspective. International Journal of Science and Mathematics Education, 22(1), 101–119.
68. Teng, F. (2020). Tertiary-level students' English writing performance and metacognitive awareness: A group metacognitive support perspective. Scandinavian Journal of Educational Research, 64(5), 783–799.
69. Toraman, C., Orakci, S., & Aktan, O. (2020). Analysis of the relationships between mathematics achievement, reflective thinking of problem solving and metacognitive awareness. International Journal of Progressive Education, 16(5), 123–140.
70. Trigueros, R., Aguilar-Parra, J. M., Lopez-Liria, R., & Cangas, A. J. (2020). Perceived support in the classroom on the students' motivation and emotions: The impact on metacognition strategies and academic performance in math and English classes. Frontiers in Psychology.

71. Vorhoelter, K. (2023). Metacognition in mathematical modeling: The connection between metacognitive individual strategies, metacognitive group strategies and modeling competencies. Mathematical Thinking and Learning, 25(2), 102–124.
72. Vosniadou, S., Darmawan, I., & Lawson, M. J. (2021). Beliefs about the self-regulation of learning predict cognitive and metacognitive strategies and academic performance in pre-service teachers. Metacognition and Learning, 16(3), 511–534.
73. Yang, Y., Maeda, Y., & Gentry, M. (2024). The relationship between mathematics self-efficacy and mathematics achievement: Multilevel analysis with NAEP 2019. Large-Scale Assessments in Education, 12(1), Article 16.
74. Zakariya, Y. F. (2022). Improving students' mathematics self-efficacy: A systematic review of intervention studies. International Journal of Mathematical Education in Science and Technology.
75. Zhang, J., & Zhang, L. J. (2024). The effect of feedback on metacognitive strategy uses in EFL writing. Computer Assisted Language Learning.
76. Zhang, W., & Lian, R. (2024). The impact of reading metacognitive strategies on mathematics learning efficiency and performance: An analysis using PISA 2018 data in China. Acta Psychologica, 236, 103894.
77. Zhu, M., & Doo, M. Y. (2022). The relationship among motivation, self-monitoring, self-management, and learning strategies of MOOC learners. Journal of Computing in Higher Education, 34(3), 533–554.
78. Zhu, M., Bonk, C. J., & Doo, M. Y. (2020). Self-directed learning in MOOCs: Exploring the relationships among motivation, self-monitoring, and self-management. Educational Technology Research and Development, 68(4), 2067–2089.
79. Zhu, Y., & Kaiser, G. (2022). Impacts of classroom teaching practices on students' mathematics learning interest, mathematics self-efficacy and mathematics test achievements: A secondary school study. ZDM–Mathematics Education, 54(3), 567–584.