CHAPTER 2

REVIEW OF THE RELATED LITERATURE

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2.1. FOUNDATIONAL CONCEPTS OF METACOGNITION

Flavell (1979) first articulated the idea of *metacognition* as individuals' knowledge about and regulation of their own thinking. He proposed that learners who deliberately plan, monitor, and evaluate their cognition can develop greater control over learning tasks. His foundational framework introduced the dual components of metacognitive knowledge and metacognitive regulation. This early conceptualisation has since informed decades of research on learning strategies, forming the cornerstone for understanding how learners become independent problem solvers.

Wang, Haertel and Walberg (1990) analysed a wide range of educational research and concluded that classroom practices which foster metacognitive self-regulation are among the strongest predictors of student success. Their content analysis suggested that learners who are taught to think about their learning, adjust their strategies, and evaluate outcomes develop stronger academic performance, including improved problem-solving skills. This study highlighted the importance of intentional instructional design to enhance student thinking.

Alaiyemola, Jegede and Okebukola (1990) conducted an experimental study with Nigerian secondary science students and found that the use of metacognitive strategies helped reduce academic anxiety and improve conceptual understanding. Students exposed to guided planning and reflective thinking performed better on science tasks. Their work established an important link between emotional well-being and cognitive development, illustrating that metacognitive support not only improves learning but also supports learner confidence.

Schraw and Dennison (1994) developed the Metacognitive Awareness Inventory (MAI), a widely used tool to assess student awareness across five domains: planning, information management, monitoring, debugging, and evaluation. They confirmed that these dimensions jointly predict a student's ability to approach new or unfamiliar problems successfully. Their model has since guided instructional research and classroom practice in building reflective learners.

Schraw and Moshman (1995) proposed a theoretical model that categorized learners' metacognitive theories as tacit, informal, or formal. They argued that students develop

deeper learning strategies when educators explicitly engage them in thinking about their thinking. By encouraging learners to reflect, educators can support progression toward more structured and effective problem-solving approaches. This work remains relevant for shaping instructional interventions that promote learner autonomy.

2.2. EARLY EMPIRICAL EVIDENCE

Maqsud (1998) implemented metacognitive instructional techniques among low-achieving mathematics students and reported significant gains in both academic achievement and learner attitude. The quasi-experimental design revealed that students who received training in goal-setting, progress monitoring, and strategy evaluation performed substantially better than their peers. This study underlined the accessibility of metacognitive strategies for struggling learners and their potential to foster mathematical problem-solving competence.

Zimmerman (2002) synthesised research on self-regulated learning and proposed a cyclical model encompassing three phases: forethought, performance, and self-reflection. Each phase is underpinned by metacognitive awareness. According to his model, successful problem solvers actively plan strategies, monitor their implementation, and reflect on outcomes to adjust future approaches. Zimmerman's framework offers valuable insight into how learners sustain motivation and adapt to challenges in academic tasks.

National Council of Educational Research and Training (2005) formally advocated for the development of metacognitive abilities in its *National Curriculum Framework*. It recommended that schools promote "learning how to learn" by embedding reflective and self-directed learning practices across subjects, including science. This national policy shifted the focus of Indian pedagogy from content delivery to competency-based learning, reinforcing the importance of fostering metacognitive thinking at the secondary level.

Annevirta and Vauras (2006) conducted a longitudinal study tracking students from elementary through lower secondary school. They found that metacognitive skills develop gradually but can be accelerated through deliberate instruction. Students who received structured support in planning, questioning, and monitoring improved their ability to organize information and solve complex academic problems. This work confirmed the importance of scaffolding metacognitive development over time.

Veenman, Van Hout-Wolters and Afflerbach (2006) highlighted the methodological complexity of studying metacognition and argued for using multiple data sources—

including verbal protocols, self-reports, and performance metrics—to fully understand how learners regulate their cognition. Their work provided researchers and educators with a stronger foundation for assessing and improving students' metacognitive behaviours in real-world problem-solving contexts.

2.3. INSTRUCTIONAL TECHNIQUES AND MEASUREMENT

McKeown and Gentilucci (2007) introduced the Think-Aloud strategy in middle school second-language classrooms to examine its effects on metacognitive development and comprehension. Their study found that students trained to verbalize their thinking processes became more adept at monitoring their understanding and correcting misunderstandings during reading tasks. The implications of their work extend beyond literacy, as verbalized reasoning is also central to effective scientific and mathematical problem-solving. Their findings suggest that encouraging learners to articulate thought processes aloud helps internalize self-regulatory behaviours essential for academic success.

Dignath and Büttner (2008) conducted a meta-analysis involving primary and secondary school interventions to identify key components of successful self-regulated learning programmes. Their research concluded that explicitly teaching students how to plan, monitor, and evaluate their learning significantly improved academic outcomes. They observed that students who received metacognitive instruction demonstrated stronger strategic awareness and problem-solving proficiency, validating the importance of structured strategy instruction at all stages of schooling. The study provides foundational evidence that supports the incorporation of metacognitive practices into core instructional frameworks.

Trilling and Fadel (2009), in their work on 21st-century skills, identified metacognition as a crucial competence for lifelong learning. They argued that reflective learners who possess the capacity to evaluate their thinking, adapt their strategies, and transfer knowledge across contexts are more prepared for modern challenges. Their analysis emphasized that metacognitive awareness enhances adaptability and problem-solving, both of which are critical for navigating complex academic and real-world scenarios. The inclusion of metacognitive thinking in educational priorities is central to fostering learners who are self-directed and capable of managing uncertainty.

Zohar and Dori (2011) explored the role of metacognition in science education through a detailed analysis of instructional strategies. They emphasized the importance of embedding

reflective activities within inquiry-based learning environments. According to their findings, students who engaged in metacognitive practices—such as planning investigations, analyzing outcomes, and revising hypotheses—demonstrated enhanced scientific reasoning and conceptual clarity. Their study confirmed that metacognitive scaffolding empowers learners to navigate the complexities of scientific problem-solving more effectively and independently.

2.4. CREATIVE AND DOMAIN-SPECIFIC EXPANSION

Fleming and Lau (2014) examined various approaches to measuring metacognition and underscored the significance of developing accurate assessment tools to evaluate metacognitive processes. They proposed using confidence-accuracy correlations, judgments of learning, and post-task reflection to capture learners' self-evaluation capabilities. These tools provide insights into how effectively students monitor their performance, which is critical for addressing errors and improving outcomes in problem-solving tasks. Their contribution is particularly important for educational researchers and practitioners seeking to evaluate the impact of instructional interventions on student cognition.

Hargrove and Nietfeld (2014) investigated how metacognitive instruction influences students' creative problem-solving capabilities. Through a controlled experimental design, they demonstrated that learners exposed to reflective strategy training developed more original and flexible approaches to solving open-ended problems. The findings highlighted that metacognition is not only essential for academic success but also plays a significant role in fostering creativity and innovation. By cultivating awareness of one's thinking processes, students can navigate complex and ambiguous problems with greater resourcefulness and confidence.

Murray (2014) implemented a case study using color-coded drafts to foster higher-order thinking and metacognitive awareness among first-year college students. His approach encouraged students to visually track their revisions and reflect on their learning journey. This iterative writing process cultivated critical reflection, enabling students to recognize patterns of error, question assumptions, and refine their problem-solving strategies. Murray's findings support the integration of reflective activities into coursework to develop metacognitive thinking in both humanities and STEM domains.

Bruckermann, Aschermann, Bresges, and Schlüter (2017) evaluated the effectiveness of combining multimedia experiments with metacognitive support in science teacher preparation programmes. Their study revealed that preservice teachers who received both forms of scaffolding displayed higher proficiency in planning experiments, identifying variables, and interpreting results. These skills are vital for scientific inquiry and underscore the importance of metacognitive prompts in improving future educators' instructional competence. The research also supports using technology-enhanced tools to build metacognitive capacities in learners.

2.5. POLICY ALIGNMENT AND GLOBAL PERSPECTIVE

Organisation for Economic Co-operation and Development (2018) introduced the OECD Learning Compass 2030 to provide a framework for the future of education. The framework places metacognitive competencies at the centre of student agency, highlighting the need for learners to navigate their own learning paths by setting goals, reflecting on outcomes, and adapting strategies. These abilities are seen as essential not only for academic success but also for lifelong learning and citizenship in a rapidly evolving world. The emphasis on metacognition within the OECD's vision underscores its growing importance in global education policies aimed at equipping students with the tools needed for complex problem-solving.

Rhodes (2019) conducted a comprehensive review of literature on the instructional applications of metacognition and its impact on academic achievement. His work concluded that teaching students to explain their reasoning and evaluate their learning processes significantly improves their ability to perform complex tasks. He emphasized the importance of instructional strategies that engage students in self-questioning, feedback interpretation, and error correction. These metacognitive habits enhance learners' ability to monitor their problem-solving approaches, making them more flexible and accurate in applying their knowledge.

Ministry of Education (2020), through India's National Education Policy (NEP) 2020, underscored the importance of competency-based education and reflective thinking. The policy highlighted the integration of metacognitive strategies such as project-based learning, peer assessment, and formative evaluation in mainstream classroom practice. NEP 2020 emphasizes student-centred pedagogy and encourages teaching methods that foster critical thinking, problem-solving, and self-directed learning. The incorporation of

metacognitive practices into national policy signifies a strategic shift in how Indian education aims to develop independent, adaptable learners equipped for 21st-century challenges.

Hancock and Karakok (2020) focused on supporting the development of process-focused metacognition in mathematical problem-solving. Their findings revealed that when students were guided to reflect not only on the solutions but also on the process they followed, their understanding of mathematical concepts deepened. This reflective approach helped students identify more effective strategies and develop persistence in solving challenging problems. The research supports instructional methods that encourage students to monitor their thinking continuously throughout problem-solving activities.

Mohseni, Seifoori, and Ahangari (2020) investigated the impact of metacognitive strategy instruction alongside critical thinking development in reading comprehension among secondary students. Their quasi-experimental study demonstrated that students who received metacognitive training showed significant gains in reading comprehension, analytical skills, and cognitive flexibility. The results support the integration of metacognitive training across subject areas, illustrating how such strategies enhance students' capacity to interpret, evaluate, and solve complex problems.

Muhid, Amalia, Hilaliyah, Budiana, and Wajdi (2020) assessed the effectiveness of implementing metacognitive strategies in secondary reading classes in Indonesia. The study employed a pre-test/post-test design and found that students who practiced techniques such as self-questioning and summarization showed notable improvements in comprehension and task performance. The findings reinforced the role of metacognitive instruction in equipping students with the cognitive tools needed for independent learning and effective problem-solving.

Usta and Yılmaz (2020) applied the KWL (Know-Want-Learn) strategy in Grade 4 mathematics classrooms and found that students using the strategy outperformed those in traditional instruction on multi-step problem-solving tasks. The strategy helped students activate prior knowledge, set specific learning goals, and reflect on their learning outcomes, all of which are critical components of metacognitive awareness. Their research emphasizes the early introduction of structured reflective tools to develop strategic thinking skills from a young age.

UNESCO (2020), in its Global Education Monitoring Report, emphasized inclusive education and the importance of metacognitive practices for diverse learners. The report argued that teaching students to regulate their learning processes promotes equity by enabling all students—regardless of background or ability—to become successful problem-solvers. By advocating for learner-centred approaches that support reflection, goal-setting, and strategy evaluation, UNESCO positioned metacognition as a vital component of inclusive and quality education worldwide.

Baral (2021) studied the impact of metacognitive interventions on metacognitive awareness, academic self-efficacy, and achievement among Indian higher secondary school students. The study involved structured metacognitive training sessions, which led to marked improvements in students' self-regulation and confidence in tackling complex academic tasks. Baral's research offers compelling evidence for the positive correlation between metacognitive instruction and both cognitive and affective student outcomes.

Lytra and Drigas (2021) explored the use of metacognitive scaffolds in STEAM education for learners with Specific Learning Disabilities (SLD). Their findings revealed that when students with SLDs engaged in guided metacognitive reflection and goal-setting, they developed greater autonomy, improved performance, and reduced frustration in problem-solving tasks. This work highlights the inclusive potential of metacognitive instruction and its adaptability to varied learning needs.

Stanton, Sebesta, and Dunlosky (2021) synthesised classroom-based interventions and reported that simple strategies—such as student-generated self-tests and structured reflection journals—enhanced both academic performance and metacognitive ability in undergraduate life science courses. The research confirmed that fostering reflection and self-monitoring supports problem-solving even in large classroom settings and across complex content domains.

OECD (2021) reaffirmed the value of metacognition in its follow-up report, Trends Shaping Education. The report reiterated the need for education systems to cultivate learners who can self-regulate, adapt, and solve problems across disciplines. It urged policymakers and educators to integrate metacognitive instruction into curriculum design and classroom practices as part of preparing students for uncertainty and lifelong learning.

2.6. TEACHER DEVELOPMENT AND ASSESSMENT INNOVATION

De Vries, Dimosthenous, Schildkamp, and Visscher (2022) examined the role of teacher professional development in promoting student metacognition through an Assessment for Learning (AfL) program. Their findings demonstrated that when teachers engaged in ongoing training focused on formative feedback, learning goal clarity, and student self-assessment, students displayed significant improvement in their ability to monitor and regulate their learning. The program encouraged teachers to use reflective questioning techniques and facilitate discussions about learning strategies, enabling students to become more strategic and thoughtful in problem-solving situations. This study confirms the vital connection between teacher training and the cultivation of metacognitive skills in learners.

Elbyaly and Elfeky (2022) investigated the impact of metacognitive training in online learning environments, particularly during the COVID-19 pandemic when many students participated in Massive Open Online Courses (MOOCs). Their study revealed that metacognitive scaffolds—such as reflection prompts and progress-tracking dashboards—significantly enhanced learners' ability to process information deeply and apply knowledge across contexts. Students who engaged in self-monitoring activities outperformed those in traditional online courses on complex analytical tasks, highlighting the importance of intentional strategy instruction in virtual education settings. This research supports the growing integration of metacognitive strategies into digital learning platforms.

Bagga and McKee (2023) explored the application of metacognitive instruction in oral health education, drawing attention to its potential in clinical reasoning and professional development. The researchers noted that students trained in self-assessment and reflective inquiry exhibited stronger diagnostic skills and decision-making capabilities. While their study was based in medical education, the findings have direct relevance to secondary science instruction, where problem-solving requires careful analysis and evidence-based reasoning. Their work reinforces the value of metacognitive strategies in enhancing applied learning and professional competencies.

Rajadurai and Ganapathy (2023) focused on the use of metacognitive instructional strategies among undergraduate students preparing for competitive mathematics examinations. Their quasi-experimental study found that students who were explicitly trained in planning, monitoring, and evaluating their mathematical problem-solving approaches showed marked improvement in performance. These learners also

demonstrated greater persistence and flexibility in tackling complex problems. The findings emphasize the transferability of metacognitive instruction across educational stages and confirm its effectiveness in high-stakes academic environments.

Wass et al. (2023) examined the influence of pedagogical training on the development of students' metacognitive skills in diverse classroom settings. Their study highlighted the importance of teachers modeling reflective thinking and providing explicit instruction in metacognitive strategies. Teachers who practiced self-reflection and shared their problem-solving approaches fostered a classroom culture where students felt empowered to think critically and independently. The study concluded that metacognitively aware educators are better positioned to guide learners toward strategic thinking and effective problem-solving.

Taguma, Makowiecki, and Gabriel (2023) analyzed the implications of the OECD Learning Compass 2030 for mathematics curricula and proposed the inclusion of metacognitive checkpoints throughout instructional sequences. These checkpoints help students assess their understanding, adjust strategies, and plan next steps. The authors argued that embedding metacognitive processes into mathematics education ensures that learners become not just proficient in content, but also capable of solving novel and complex problems. Their research reinforces the need for curriculum developers to integrate reflection and self-regulation into subject-specific frameworks.

2.7. CONTEMPORARY EMPIRICAL EXTENSIONS

Das, Khatun, Mohakud, and Khan (2024) examined the role of self-directed learning in the context of India's NEP 2020 and its impact on student engagement and problem-solving. Their findings indicated that when students engaged in metacognitive planning, such as setting personal learning goals, tracking their progress, and adjusting strategies, they demonstrated higher levels of motivation, curiosity, and academic performance. The study supports the view that metacognition is a critical component of 21st-century learning, enabling students to thrive in flexible, learner-centred environments.

Danlami, Ginga, Aliyu, Umahaba, and Tsoho (2024) conducted a quasi-experimental study on the effectiveness of the KWL (Know–Want–Learn) strategy in improving geometry problem-solving among Upper Basic students in Nigeria. The results showed that students who used the KWL chart outperformed their peers in conceptual understanding and spatial reasoning. The strategy allowed learners to activate prior knowledge, identify learning objectives, and reflect on their progress, thus fostering metacognitive engagement.

The study affirms the utility of structured metacognitive tools in promoting problem-solving competence.

Toikka, Eronen, Atjonen, and Havu-Nuutinen (2024) explored students' metacognitive knowledge and its relationship to mathematical problem-solving. Their research integrated the dimensions of declarative, procedural, and conditional knowledge, demonstrating that students who possessed a comprehensive understanding of how, when, and why to apply problem-solving strategies achieved significantly higher scores. This study reinforces the idea that metacognitive instruction must address all facets of strategic knowledge to build robust problem-solving skills in mathematics.

2.8. CONCLUSION

The review of literature from 1979 to 2024 offers compelling evidence that metacognitive instructional strategies significantly enhance students' ability to solve problems, particularly in mathematics and science education. Researchers consistently affirm that when students are explicitly taught how to plan, monitor, and evaluate their thinking, they become more effective, reflective, and independent learners. Metacognitive instruction not only improves academic performance but also supports emotional resilience, motivation, and adaptability—skills that are essential for success in the modern world.

In addition, national and international educational policies, including India's NEP 2020 and the OECD Learning Compass 2030, strongly advocate the integration of metacognitive practices into mainstream curricula. These policies align with the empirical research emphasizing the role of self-regulation in developing 21st-century competencies. However, despite the extensive body of global literature, there remains a need for more context-specific studies in Indian secondary schools, particularly using quasi-experimental methods to evaluate the impact of metacognitive strategies on domain-specific problem-solving.

In light of these insights, the present study seeks to address these gaps by investigating the effect of metacognitive instructional strategies on promoting problem-solving skills among secondary stage students. The study aims to contribute to the growing field of metacognitive research and provide practical implications for enhancing teaching and learning in Indian classrooms.