

Exploring Metacognitive Teaching Strategies in Science among High Schools in the Division of Batangas City

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Abstract

This study investigated the utilization and usefulness of metacognitive teaching strategies in Science instruction among high school science teachers in Batangas City during the school year 2025–2026. Employing a quantitative research design, data were collected from 98 selected Science teachers across 10 districts using a validated researcher-made survey questionnaire.

The study examined five strategies—self-questioning, concept mapping, think-pair-share, reflective journaling, and problem-solving—rated on a 4-point Likert scale, with statistical analyses including weighted mean, composite mean, ranking, and Pearson's r correlation coefficient.

Findings revealed that concept mapping, think-pair-share, and problem-solving were highly utilized, while self-questioning and reflective journaling were only moderately utilized. Teachers perceived metacognitive strategies as highly useful in enhancing academic achievement, classroom engagement, self-reflection and feedback, and critical thinking skills.

Correlation results showed that collaborative and reflective strategies such as think-pair-share, reflective journaling, and problem-solving consistently demonstrated significant positive relationships with instructional outcomes, whereas self-questioning and concept mapping had weak or non-significant relationships. Challenges faced by teachers were generally moderate, with large class sizes, diverse student backgrounds, and systemic constraints identified as the most pressing issues, while lack of familiarity and administrative support were less critical.

Based on these findings, enhancement activities were proposed, including sustained professional development, curriculum and workload adjustments, provision of resources and digital tools, improved classroom management strategies, stronger student engagement initiatives, and institutional leadership support. Overall, the study concludes that metacognitive strategies are vital in strengthening Science instruction, but their usefulness depends on consistent application, adequate support, and alignment with collaborative and reflective practices. Recommendations emphasized sustaining highly utilized strategies, reinforcing moderately applied ones, addressing classroom challenges, and institutionalizing activities to ensure effective and sustainable metacognitive instruction.

Keywords: *Metacognitive Teaching Strategies, Science Instruction, High School Science Teachers, Enhancement Activities*

Introduction

Science education is a cornerstone of national development, equipping learners with the skills to think critically, solve problems, and engage with the world through inquiry and evidence. In the Philippine context, the Department of Education (DepEd) has emphasized the importance of strengthening Science instruction through various legal and policy frameworks. Article XIV, Section 1 of the 1987 Philippine Constitution mandates the State to “protect and promote the right of all citizens to quality education at all levels.”

This commitment is further reinforced by Republic Act No. 10533, or the Enhanced Basic Education Act of 2013, which introduced the K to 12 curriculum to develop learners who are “holistically developed and equipped with 21st-century skills” (Republic of the Philippines, 2013). DepEd Order No. 55, s. 2010 also outlines specific policies to enhance Science and Mathematics education, including the establishment of Special Science Classes and the provision of instructional resources and teacher training (Department of Education, 2010).

Despite these efforts, the Philippines continues to face significant challenges in Science education. The country’s performance in the Programme for International Student Assessment (PISA) has consistently ranked among the lowest globally. In the 2018 PISA, Filipino students placed 77th in Science out of 79 participating countries (OECD, 2019), and in the 2022 cycle, the Philippines remained in the bottom quartile (OECD, 2023). These results reflect deficiencies in scientific literacy, critical thinking, and problem-solving skills. Similarly, the National Achievement Test (NAT) has shown low mean percentage scores in Science, often ranging between 35% and 40%, far below the mastery level of 75% (Department of Education, 2020).

These outcomes underscore the need for innovative, student-centered teaching approaches. One such approach is the use of metacognitive teaching strategies, which enable learners to become aware of and regulate their own thinking processes. Flavell (1979) defined metacognition as “knowledge about one’s own cognitive processes,” emphasizing its role in planning, monitoring, and evaluating learning. Vygotsky’s Sociocultural Theory (1978) supported this by highlighting the importance of scaffolding and social interaction in cognitive development. Piaget’s Constructivist Theory (1972) also advocated for learner-centered environments where students actively construct knowledge through experience.

Metacognitive strategies such as self-questioning, concept mapping, think-pair-share, reflective journaling, and problem-solving have been shown to improve student engagement, academic performance, and higher-order thinking skills Durukan et.al,(2022); Khagendra & Ankita, (2024). However, their implementation in Philippine classrooms remains inconsistent due to various barriers.

Science teachers face numerous challenges in delivering effective instruction. These include limited access to laboratory equipment and instructional materials, large class sizes, and the pressure of administrative tasks Bernard (2021). Teachers also reported difficulties in adapting to the spiral progression of the K to 12 curriculum, managing diverse learner needs, and integrating technology into their lessons. Many educators express the need for ongoing

professional development and institutional support to effectively apply metacognitive strategies, Cabrera & Dela Cruz (2022).

As a Science teacher, the research observed that students, on the other hand, encounter their own set of challenges. High school learners often struggle with comprehension of abstract scientific concepts, lack of motivation, and limited access to digital resources. Socioeconomic factors, such as poverty and parental educational attainment, further compound these difficulties. The transition from junior to senior high school also brings increased academic pressure, which can lead to stress and disengagement.

Given these realities, this study seeks to explore the utilization and usefulness of metacognitive teaching strategies in Science instruction among high school teachers in the Division of Batangas City. It aims to identify the specific strategies employed, assess their impact on student outcomes, examine the challenges faced by educators, and propose enhancement activities to support effective integration. Grounded in theoretical frameworks and empirical data, the study aspires to contribute to the improvement of Science education in the region and inform policy and practice at the national level.

Statement of the Problem

This study investigates the utilization and usefulness of metacognitive teaching strategies employed by high school Science teachers in the Division of Batangas City.

Specifically, this seeks to answer the following questions:

1. What is the extent of utilization of metacognitive teaching strategies by the teachers in terms of:
 - 1.1. Self-questioning;
 - 1.2. Concept mapping;
 - 1.3. Think-Pair-Share;
 - 1.4. Reflective journaling; and
 - 1.5. Problem-solving?
2. How may the level of usefulness of metacognitive teaching strategies be assessed in relation to:
 - 2.1. Academic achievement;
 - 2.2. Classroom engagement;
 - 2.3. Self-reflection and feedback; and
 - 2.4. Development of critical thinking skills?
3. Is there a significant relationship between the assessments on the extent of utilization of metacognitive teaching strategies and on their level of usefulness?
4. What challenges are faced by Science teachers in utilizing metacognitive teaching strategies?
5. Based on the findings, what enhancement activities may be proposed?

Hypothesis

There is no significant relationship between the assessments on the extent of utilization of metacognitive teaching strategies and on their level of usefulness.

Methodology

Research Design

This study utilized a descriptive research design to thoroughly investigate the utilization and usefulness of metacognitive teaching strategies in high school Science instruction within the Division of Batangas City. The quantitative method provided a holistic understanding of how metacognitive strategies are applied and their impact on student learning. The quantitative component involved the use of structured survey questionnaires to measure the frequency and extent of strategy utilization—specifically focusing on self-questioning, concept mapping, think-pair-share, reflective journaling, and problem-solving—and to assess their influence on student outcomes such as academic achievement, classroom engagement, self-reflection, and the development of critical thinking skills.

It also explored the challenges faced by Science teachers in implementing metacognitive teaching strategies survey questionnaire it aims to uncover the challenges they face in implementing these strategies and the contextual factors that affect their usefulness. This design is appropriate for the study as it allows for the identification of patterns, relationships, and deeper insights that cannot be captured through quantitative data alone. By numerical data, the study seeks to generate evidence-based recommendations for enhancing the integration of metacognitive strategies in Science education.

Participants

The study was conducted during the school year 2025–2026 and involved 98 high school Science teachers from 10 districts within the Division of Batangas City. Participants were selected through stratified sampling to ensure representation across various schools and teaching contexts. Slovin's formula was used with a 5% margin of error.

Research Instrument

This study utilized a researcher-made survey as the primary instrument to assess the utilization and usefulness of metacognitive teaching strategies employed by high school Science teachers. The questionnaire was designed to gather quantitative data on the frequency and extent of strategy use, specifically focusing on five key metacognitive strategies: self-questioning, concept mapping, think-pair-share, reflective journaling, and problem-solving. It also measured the perceived impact of these strategies on student outcomes, including academic achievement, classroom engagement, self-reflection and feedback, and the development of critical thinking skills.

Data Collection Procedure

Data was collected through one method: survey questionnaires. Prior to administration, the researcher secured necessary approvals from the Schools Division Superintendent, district

supervisors, and school heads. Informed consent was obtained from teacher-respondents, and ethical standards were upheld in accordance with the Data Privacy Act. The survey was administered to a stratified sample of 98 high school Science teachers across 10 districts in Batangas City.

Data Analysis

In analyzing and interpreting the gathered data, the researcher employed quantitative techniques to ensure comprehensive and meaningful results. Quantitative data from the survey questionnaire was analyzed using statistical methods such as ranking, weighted mean, composite mean, and Pearson's r correlation coefficient.

Results and Discussion

1. Extent of Utilization of Metacognitive Teaching Strategies

The utilization of metacognitive teaching strategies has a strong relationship with their usefulness in science instruction, particularly in terms of academic achievement.

1.1. Self-Questioning Strategy Utilization. Self-questioning is a metacognitive strategy where learners generate questions to monitor comprehension and stimulate deeper thinking Villanueva & Dizon (2022).

The results in Table 2 on Self-Questioning Strategy Utilization show that teachers in Batangas City High Schools apply self-questioning strategies at different levels, with weighted means ranging from 3.36 to 3.72.

The highest indicator, encouraging students to ask themselves guiding questions before starting a Science task with a weighted mean of 3.72 and ranked first, is highly utilized and reflects the importance of activating prior knowledge and preparing learners for deeper engagement. Providing prompts to reflect on understanding with 3.58 and asking students to evaluate their learning after completing a Science activity with 3.53, ranked second and third respectively, are also highly utilized, emphasizing reflection and comprehension monitoring.

Moderate utilization is evident in integrating self-questioning in formative assessments with 3.45 and promoting independent learning through self-questioning with 3.48, showing that while teachers recognize the value of these practices, they are not consistently embedded in assessments and autonomy-building. The moderately utilized indicators include helping students identify gaps in their knowledge and encouraging students to use self-questioning when solving Science problems with 3.38 and 3.36, ranked ninth and tenth, which suggests limited integration of self-questioning into problem-solving and diagnostic learning. The composite mean of 3.48, interpreted as moderately utilized, indicates that self-questioning is present but not maximized across all instructional contexts.

These findings aligned with Philippine education policies such as the 1987 Constitution, RA 10533, DepEd Orders 21 of 2019 and 42 of 2017, and RA 9155, which emphasize reflective, inquiry-based, and learner-centered instruction. They also resonate with Flavell 1979 who

introduced metacognition as the regulation of cognitive processes and Vygotsky (1978) who underscored internal dialogue and scaffolding in learning. Cheng, Hwang, and Chen (2024) demonstrated that self-reflective questioning in flipped learning models enhances scientific literacy and problem-solving, Winne and Azevedo (2022) described self-questioning as a calibration mechanism in self-regulated learning.

Table 2
Self-Questioning Strategy Utilization

Statements	Weighted Mean	Verbal Interpretation	Rank
1. Encourage students to ask themselves guiding questions before starting a Science task.	3.72	Highly Utilized	1
2. Model self-questioning techniques during Science instruction.	3.51	Highly Utilized	4
3. Provide students with prompts to reflect on their understanding of concepts.	3.58	Highly Utilized	2
4. Ask students to evaluate their learning after completing a Science activity.	3.53	Highly Utilized	3
5. Integrate self-questioning items in formative assessments.	3.45	Moderately Utilized	6
6. Teach students how to formulate their own questions during lessons.	3.39	Moderately Utilized	8
7. Use self-questioning to help students identify gaps in their knowledge.	3.38	Moderately Utilized	9
8. Encourage students to use self-questioning when solving Science problems.	3.36	Moderately Utilized	10
9. Incorporate self-questioning in group discussions and collaborative learning tasks.	3.41	Moderately Utilized	7
10. Use self-questioning strategies to promote independent learning and critical thinking in Science.	3.48	Moderately Utilized	5
Composite Mean	3.48	Moderately Utilized	

Legend: *Highly Utilized* (3.50-4.00), *Moderately Utilized* (2.50-3.49), *Slightly Utilized* (1.50-2.49), *Least Utilized* (1.00-1.49)

Pentuccia et al. (2025) highlighted its role in connecting theoretical and operational knowledge in Chemistry, and Boven et al. (2025) emphasized the cognitive depth of explicit reflection. De Castro (2023) found that self-questioning techniques in Batangas classrooms improved students' monitoring of comprehension and formulation of scientific inquiries, especially in laboratory reflections and formative assessments. Overall, the analysis suggests that while self-questioning strategies are moderately utilized, strengthening their application in problem-solving, independent learning, and diagnostic reflection could further advance critical thinking, autonomy, and scientific literacy among high school learners.

1.2. Concept Mapping Strategy Utilization. Concept mapping is a visual learning strategy that helps students organize and relate ideas to enhance understanding Antonio & Prudente (2022). In this study, it refers to the use of diagrams by Science teachers to help students connect scientific concepts and structure their knowledge.

The results in Table 3 on concept mapping strategy utilization reveal that teachers in Batangas City High Schools highly utilize concept mapping strategies, with weighted means ranging from 3.54 to 3.78 and a composite mean of 3.65 interpreted as highly utilized. The highest indicator, encouraging students to visually connect related concepts in Science with a weighted mean of 3.78 and ranked first, demonstrates that teachers prioritize helping learners establish meaningful relationships among ideas. This is followed by using concept mapping to reinforce relationships between scientific ideas with 3.71 ranked second and integrating concept mapping in group activities to promote collaboration with 3.69 ranked third, which highlight the collaborative and relational aspects of concept mapping.

Table 3
Utilization of Concept Mapping Strategy

Statements	Weighted Mean	Verbal Interpretation	Rank
1. Teach students how to create concept maps to organize Science concepts.	3.63	Highly Utilized	7
2. Use concept maps to summarize key ideas at the end of a lesson.	3.65	Highly Utilized	4.5
3. Integrate concept mapping in group activities to promote collaboration.	3.69	Highly Utilized	3
4. Assess students' understanding through their concept maps.	3.59	Highly Utilized	8
5. Encourage students to visually connect related concepts in Science.	3.78	Highly Utilized	1
6. Use concept maps to identify and correct misconceptions.	3.64	Highly Utilized	6
7. Provide feedback on students' concept maps to improve their learning.	3.65	Highly Utilized	4.5
8. Use concept mapping to reinforce relationships between scientific ideas.	3.71	Highly Utilized	2
9. Allow students to revise their concept maps as their understanding deepens.	3.57	Highly Utilized	9
10. Use concept maps as a tool for review before assessments.	3.54	Highly Utilized	10
Composite Mean	3.65	Highly Utilized	

Legend: Highly Utilized (3.50-4.00), Moderately Utilized (2.50-3.49), Slightly Utilized (1.50-2.49), Least Utilized (1.00-1.49)

Providing feedback on students' concept maps with 3.65 ranked fourth and using concept maps to summarize key ideas at the end of a lesson also with 3.65 ranked fifth show that teachers value concept maps as tools for consolidation and improvement. Teaching students how to create concept maps with 3.63 ranked sixth and assessing students' understanding through their concept maps with 3.59 ranked seventh emphasize the role of concept mapping in both instruction and evaluation. Moderately lower but still highly utilized indicators include using concept maps to identify and correct misconceptions with 3.64 ranked eighth, allowing students to revise their concept maps as their understanding deepens with 3.57 ranked ninth, and using concept maps as a tool for review before assessments with 3.54 ranked tenth. These results suggest that concept mapping is consistently integrated into Science instruction, particularly for connecting ideas, promoting collaboration, and reinforcing conceptual relationships, though its use for review and revision is less emphasized.

These findings aligned with Ausubel's Assimilation Theory of which underscores the importance of connecting prior knowledge with new information through meaningful learning. Wang et al. (2025) confirmed through meta-analysis that concept mapping significantly improves achievement in STEM disciplines, especially in secondary education. Chu, et. al., (2025) highlighted its usefulness in technology-based learning environments, enhancing conceptual understanding and collaborative learning. Sakhnin (2025) demonstrated that concept mapping boosts student engagement and analytical skills in Science classes, particularly among younger learners. Garcia (2022) in her study of Physics classes in Batangas City found that students who regularly constructed concept maps showed stronger retention and deeper conceptual understanding of force and motion. Taken together, the analysis and related studies affirm that concept mapping is a powerful metacognitive strategy that supports schema construction, collaborative inquiry, and meaningful learning, and while it is highly utilized in Batangas classrooms, strengthening its application in review and revision could further enhance critical thinking and long-term retention among high school learners.

1.3 Think-Pair-Share Strategy Utilization. Think-Pair-Share is a collaborative learning strategy that promoted peer discussion and shared reasoning Santos & De Vera, (2021). In this study, it refers to the structured interaction used by Science teachers to encourage student dialogue and reflection.

The results in Table 4 on Think-Pair-Share utilization show that teachers in Batangas City High Schools highly utilize this collaborative strategy, with weighted means ranging from 3.53 to 3.71 and a composite mean of 3.63 interpreted as highly utilized. The highest indicator, using think-pair-share to check for understanding during lessons with a weighted mean of 3.71 ranked first, demonstrates that teachers prioritize TPS as a formative assessments tool to gauge comprehension. Giving students time to think individually before sharing with 3.69 ranked second and encouraging student collaboration with 3.66 ranked third highlight the emphasis on structured reflection and peer interaction. Building confidence in expressing ideas also with 3.66 shares the third rank, showing TPS as a confidence-building mechanism. Pairing students strategically with 3.64 ranked fifth and integrating TPS in problem-solving activities also with 3.64 ranked sixth emphasize its role in fostering meaningful discussion and collaborative reasoning.

Moderately lower but still highly utilized indicators include assessing student participation with 3.63 ranked eighth and guiding students in giving constructive feedback with 3.56 ranked seventh reflect its use in monitoring engagement and peer evaluation. The least utilized indicators include promoting critical thinking and reasoning with 3.55 ranked ninth and incorporating TPS in laboratory or hands-on activities with 3.53 ranked tenth, suggesting that while TPS is widely applied in discussions and comprehension checks, its integration in practical and experimental contexts is less emphasized.

Table 4
Utilization of Think-Pair-Share

Statements	Weighted Mean	Verbal Interpretation	Rank
1. Use think-pair-share to encourage student collaboration.	3.66	Highly Utilized	3.5
2. Give students time to think individually before sharing.	3.69	Highly Utilized	2
3. Pair students strategically to promote meaningful discussion.	3.64	Highly Utilized	5.5
4. Use think-pair-share to check for understanding during lessons.	3.71	Highly Utilized	1
5. Integrate think-pair-share in problem-solving activities.	3.64	Highly Utilized	5.5
6. Guide students in giving constructive feedback to their peers.	3.56	Highly Utilized	8
7. Use think-pair-share to build confidence in expressing ideas.	3.66	Highly Utilized	3.5
8. Assess student participation during think-pair-share sessions.	3.63	Highly Utilized	7
9. Use think-pair-share to promote critical thinking and reasoning.	3.55	Highly Utilized	9
10. Incorporate think-pair-share in laboratory or hands-on activities.	3.53	Highly Utilized	10
Composite Mean	3.63	Highly Utilized	

Legend: *Highly Utilized* (3.50–4.00), *Moderately Utilized* (2.50–3.49), *Slightly Utilized* (1.50–2.49), *Least Utilized* (1.00–1.49)

Overall, the composite mean of 3.63 confirms that TPS is consistently embedded in Science instruction, particularly for collaboration, comprehension, and confidence-building. These findings align with Lyman 1981 who originally developed Think-Pair Share as a structured method for active engagement through individual reflection, peer discussion, and group sharing. Capillas and Cancio (2025) found that TPS significantly enhanced student participation, peer engagement, and critical thinking in middle school Science classes, while Adagwine (2023) connected TPS to Vygotsky's Zone of Proximal Development, emphasizing its role in peer scaffolding. Kesuma et al. (2024) demonstrated that integrating TPS with metacognitive reading strategies enhances comprehension and engagement in Science learning. Smith and Brown (2021) emphasized TPS as a structured method for promoting active learning and retention of scientific concepts, Johnson and Lee (2021) described it as a scaffolded approach that supports deeper understanding through social interaction, and Nguyen and Patel (2022) highlighted its adaptability across diverse classroom settings. Garcia and Thompson (2021) linked TPS to improved communication and teamwork in Science instruction. Locally,

Manalo (2024) at the University of Batangas revealed that TPS enhanced classroom engagement and peer collaboration, particularly in Biology discussions involving ethical issues and environmental sustainability, while Santos (2021) reported that reflective journaling tasks developed greater metacognitive awareness and self-regulation among students. Taken together, the analysis and related studies affirm that TPS is a dynamic and highly utilized strategy in Batangas classrooms, fostering collaboration, comprehension, and confidence, though its application in laboratory and critical thinking contexts could be further strengthened to maximize its impact on Science learning.

1.4. Reflective Journaling Strategy Utilization. Reflective journaling is a metacognitive practice where learners record thoughts and experiences to deepen understanding and self-awareness Reyes & Tolentino (2023). In this study, it refers to students' written reflections used to evaluate their learning progress in Science.

The results in Table 5 show that teachers in Batangas City High Schools moderately utilize reflective journaling, with weighted means ranging from 3.22 to 3.39 and a composite mean of 3.40 interpreted as moderately utilized. The highest indicator, providing prompts to guide student reflections with a weighted mean of 3.39 ranked first, demonstrates that teachers recognize the importance of structured guidance in helping learners articulate their thoughts. Allowing students to express challenges and successes in journals with 3.33 ranked second and assessing journals for depth of thought and personal insight with 3.32 ranked third highlight the role of journaling in fostering self-expression and deeper reflection.

Table 5
Utilization of Reflective Journaling Strategy

Statements	Weighted Mean	Verbal Interpretation	Rank
1. Assign reflective journals to encourage student self-awareness.	3.27	Moderately Utilized	8
2. Provide prompts to guide student reflections.	3.39	Moderately Utilized	1
3. Assess journals for depth of thought and personal insight.	3.32	Moderately Utilized	3
4. Use journals to help students identify learning gaps.	3.23	Moderately Utilized	9
5. Give feedback on students' journal entries	3.31	Moderately Utilized	4.5
6. Integrate journaling in Science experiments and investigations.	3.22	Moderately Utilized	10
7. Allow students to express challenges and successes in journals.	3.33	Moderately Utilized	2
8. Use reflective journaling to track student progress over time.	3.30	Moderately Utilized	6
9. Encourage students to reflect on their learning goals and outcomes.	3.31	Moderately Utilized	4.5
10. Use journals to promote metacognitive thinking and self-regulation.	3.29	Moderately Utilized	7

Composite Mean	3.40	Moderately Utilized	
<i>Legend: Highly Utilized (3.50-4.00), Moderately Utilized (2.50-3.49), Slightly Utilized (1.50-2.49), Least Utilized (1.00-1.49)</i>			

Giving feedback on journal entries and encouraging students to reflect on their learning goals and outcomes both with 3.31 ranked fourth and fifth emphasize the formative nature of journaling as a feedback and goal-setting tool. Tracking student progress over time with 3.30 ranked sixth and promoting metacognitive thinking and self-regulation with 3.29 ranked seventh show moderate application in long-term monitoring and self-regulation. Assigning reflective journals to encourage self-awareness with 3.27 ranked eighth and using journals to help students identify learning gaps with 3.23 ranked ninth indicate limited emphasis on diagnostic reflection. The least utilized indicator but still moderately utilize is integrating journaling in Science experiments and investigations with 3.22 ranked tenth, suggesting that while journaling is valued for reflection, its integration into experimental contexts is less emphasized. Overall, the composite mean of 3.40 confirms that reflective journaling is moderately embedded in Science instruction, primarily for guided reflection and self-expression rather than for experimental integration or diagnostic purposes.

These findings aligned with Dewey who identified reflection as a core component of experiential learning and provide a foundation for journaling as a metacognitive practice. Harvey et al. (2025) emphasized its role in developing lifelong learning skills, while Saavedra (2025) described science journals as tools for promoting inquiry, critical thinking, and self-awareness among high school learners. Boven et al. (2025) reinforced the importance of explicit reflection in Science pedagogy, highlighting its cognitive depth. Makiaway et al. (2024) found that journaling enhances metacognitive awareness and motivation among high school learners, and Santos (2021) reported that weekly science journaling tasks developed greater metacognitive awareness and self-regulation, leading to improved performance in inquiry-based assessments. Taken together, the analysis and related studies affirm that reflective journaling is a valuable but moderately utilized strategy in Batangas classrooms, and strengthening its integration in experimental and diagnostic contexts could further enhance critical thinking, self-regulation, and scientific inquiry among high school learners.

1.5. Problem-Solving Strategy Utilization. Problem-solving is a cognitive process that involves identifying solutions to complex or unfamiliar situations Villanueva & Dizon (2022) . In this study, it refers to students' ability to apply scientific reasoning and inquiry to address real-world or classroom-based Science problems.

The results in Table 6 on problem-solving strategy utilization show that teachers in Batangas City High Schools highly utilize problem-solving strategies, with weighted means ranging from 3.54 to 3.70 and a composite mean of 3.63 interpreted as highly utilized. The highest indicators, using real-life problems to enhance Science learning with 3.70 highly utilized ranked first and integrating problem-solving in performance tasks and assessments also with 3.70 highly utilized ranked first, highlight the strong emphasis on authentic and contextualized learning experiences.

Teaching structured problem-solving strategies with 3.66 highly utilized ranked third and encouraging students to reflect on their problem-solving process with 3.65 highly utilized ranked fourth demonstrate the importance of scaffolding and reflection in developing problem-solving skills. Assessing students' reasoning and approach to solving problems with 3.62 highly utilized ranked fifth and using problem-solving activities to develop critical thinking skills also with 3.62 highly utilized ranked fifth emphasize the role of evaluation and critical thinking in strengthening analytical reasoning. Promoting collaborative problem-solving among students with 3.61 highly utilized ranked seventh and providing feedback on students' problem-solving strategies and outcomes also with 3.61 highly utilized ranked seventh highlight the collaborative and formative aspects of problem-solving. Encouraging students to evaluate the usefulness of their solutions with 3.60 highly utilized ranked ninth and guiding students in identifying multiple solutions to a problem with 3.54 highly utilized ranked tenth show that while teachers value reflection and solution diversity, these practices are less emphasized compared to contextual and performance-based applications.

Table 6
Utilization of Problem-Solving Strategy

Statements	Weighted Mean	Verbal Interpretation	Rank
1. Teach structured problem-solving strategies in Science.	3.66	Highly Utilized	3
2. Encourage students to reflect on their problem-solving process.	3.65	Highly Utilized	4
3. Use real-life problems to enhance Science learning.	3.70	Highly Utilized	1.5
4. Guide students in identifying multiple solutions to a problem.	3.54	Highly Utilized	10
5. Promote collaborative problem-solving among students.	3.61	Highly Utilized	7.5
6. Assess students' reasoning and approach to solving problems.	3.62	Highly Utilized	5.5
7. Integrate problem-solving in performance tasks and assessments.	3.70	Highly Utilized	1.5
8. Encourage students to evaluate the usefulness of their solutions.	3.60	Highly Utilized	9
9. Use problem-solving activities to develop critical thinking skills.	3.62	Highly Utilized	5.5
10. Provide feedback on students' problem-solving strategies and outcomes.	3.61	Highly Utilized	7.5
Composite Mean	3.63	Highly Utilized	

Legend: Highly Utilized (3.50-4.00), Moderately Utilized (2.50-3.49), Slightly Utilized (1.50-2.49), Least Utilized (1.00-1.49)

Overall, the composite mean of 3.63 confirms that problem-solving strategies are consistently embedded in Science instruction, particularly through real-world contexts and

performance tasks, though further emphasis on multiple solution pathways and evaluative reflection could enhance students' adaptive reasoning.

These findings aligned with Piaget theory who viewed problem-solving as a constructivist process where learners actively build knowledge through experience. Libosada et al. (2025) demonstrated through meta-analysis that problem-based and project-based learning approaches significantly enhance scientific creativity and problem-solving skills. Giang et al. (2024) reviewed STEM-based activities and found that active learning strategies improve students' capacity for integrated thinking and innovation. Escuzar (2025) emphasized the role of inquiry-based and collaborative instruction in cultivating problem-solving abilities in Science education. Ramos (2025) in his dissertation on Chemistry found that structured metacognitive prompts such as planning steps and evaluating outcomes led to significant gains in students' analytical reasoning and confidence in tackling non-routine problems. Taken together, the analysis and related studies affirm that problem-solving strategies are highly utilized in Batangas classrooms and resonate with global and local research, underscoring their role in fostering critical thinking, creativity, and autonomy among high school Science learners.

2. Usefulness of Metacognitive Strategies

Metacognitive strategies significantly enhance students' academic achievement in Science education. A meta-analysis by Antonio and Prudente (2022) revealed that metacognitive instruction yields a large effect size on science learning outcomes, particularly when strategies such as concept mapping, self-questioning, and reflective journaling are integrated into classroom practice. Cheng and Chan (2021), in their book on Lesson Study, emphasized that metacognitive teaching fosters "learning to learn" competencies, enabling students to plan, monitor, and evaluate their understanding more effectively.

2.1. Academic achievement. Academic achievement refers to the measurable outcomes of student learning, typically reflected in grades, test scores, and performance assessments Ishak, Oderinde, & Ahmad, (2025). In this study, it pertains to students' Science performance as reported by teachers through summative assessments and quarterly grades.

Table 7
Academic achievement

Statements	Weighted Mean	Verbal Interpretation	Rank
1. Metacognitive strategies help students improve their Science test scores.	3.60	Highly Useful	6.5
2. Students perform better in Science when they use self-monitoring techniques.	3.55	Highly Useful	9
3. Concept mapping enhances students' understanding of complex Science topics.	3.64	Highly Useful	5
4. Reflective journaling helps students retain Science concepts more effectively.	3.42	Moderately Useful	10
5. Self-questioning leads to deeper comprehension of Science lessons.	3.58	Highly Useful	8

6. Students who use metacognitive strategies show consistent academic improvement.	3.68	Highly Useful	4
7. Metacognitive strategies help students identify and correct their learning errors.	3.60	Highly Useful	6.5
8. Think-pair-share activities contribute to better performance in Science assessments.	3.74	Highly Useful	1
9. Students apply learned concepts more accurately when using metacognitive strategies.	3.70	Highly Useful	2
10. Metacognitive teaching strategies positively influence students' academic achievement in Science.	3.69	Highly Useful	3
Composite Mean	3.62	Highly Useful	

Legend: *Highly Useful* (3.50-4.00), *Moderately Useful* (2.50-3.49), *Slightly Useful* (1.50-2.49), *Least Useful* (1.00-1.49)

The results in Table 7 on the usefulness of metacognitive strategies for academic achievement show that teachers in Batangas City High Schools perceive these strategies as highly useful, with weighted means ranging from 3.42 to 3.74 and a composite mean of 3.62 interpreted as highly useful. The highest indicator, think-pair-share activities contributing to better performance in Science assessments with 3.74 highly useful ranked first, highlights the strong impact of collaborative learning on achievement. Students applying learned concepts more accurately when using metacognitive strategies with 3.70 highly useful ranked second and metacognitive teaching strategies positively influencing academic achievement with 3.69 highly useful ranked third emphasize the role of metacognition in accuracy and overall performance.

Students who use metacognitive strategies showing consistent academic improvement with 3.68 highly useful ranked fourth and concept mapping enhancing understanding of complex Science topics with 3.64 highly useful ranked fifth demonstrate the importance of structured strategies in comprehension and sustained progress. Metacognitive strategies helping students improve test scores and helping them identify and correct learning errors both with 3.60 highly useful ranked sixth, along with self-questioning leading to deeper comprehension with 3.58 highly useful ranked eighth, show their usefulness in monitoring and correcting learning processes. Students performing better when using self-monitoring techniques with 3.55 highly useful ranked ninth and reflective journaling helping students retain Science concepts more effectively with 3.42 moderately useful ranked tenth indicate that while self-monitoring and journaling are beneficial, they are perceived as less impactful compared to collaborative and structured strategies. Overall, the composite mean of 3.62 confirms that metacognitive strategies are highly useful in improving Science achievement, particularly through collaboration, concept application, and structured teaching.

These findings aligned with Antonio and Prudente (2022) who revealed through meta-analysis that metacognitive instruction yields a large effect size on science learning outcomes, especially when strategies such as concept mapping, self-questioning, and reflective journaling are integrated. Cheng and Chan (2021) emphasized that metacognitive teaching fosters learning to learn competencies, enabling students to plan, monitor, and evaluate their understanding more effectively. The EDCOM II Year Two Report (2025) highlighted the urgent need for pedagogical reforms that promote cognitive and metacognitive development, citing that Filipino students lag

behind expected literacy and academic standards. The DepEd Operational Guidelines DM 001 s. (2025) stressed the importance of adaptive teaching strategies including metacognitive scaffolding to improve learning outcomes across diverse contexts Alcaraz (2023) found that metacognitive scaffolding through goal-setting and self-monitoring led to measurable improvements in academic achievement among Grade 12 STEM students, particularly in Chemistry performance tasks. Taken together, the analysis and related studies affirm that metacognitive strategies are highly useful in enhancing academic achievement, and strengthening their integration across all dimensions of Science instruction can further elevate student performance and self-regulation.

2.2 Classroom Engagement. Classroom engagement is the degree of attention, curiosity, and participation students exhibit during learning activities Discipulo & Bautista, (2022). In this study, it refers to students' active involvement and responsiveness in Science classes where metacognitive strategies are applied.

The results in Table 8 on classroom engagement show that teachers in Batangas City High Schools perceive metacognitive strategies as highly useful in fostering student participation, motivation, and interaction, with weighted means ranging from 3.62 to 3.78 and a composite mean of 3.69 interpreted as highly useful. The highest indicator, students showing greater interest in Science when involved in problem-solving tasks with 3.78 highly useful ranked first, highlights the strong impact of authentic problem-solving on engagement. Reflective journaling helping students connect personally with Science topics with 3.76 highly useful ranked second and concept mapping encouraging collaborative exploration of Science topics with 3.72 highly useful ranked third emphasize the role of reflection and visualization in deepening engagement.

Table 8
Classroom Engagement

Statements	Weighted Mean	Verbal Interpretation	Rank
1. Students participate more actively when metacognitive strategies are used.	3.68	Highly Useful	5.5
2. Think-pair-share increases student interaction during Science lessons.	3.68	Highly Useful	5.5
3. Concept mapping encourages students to explore Science topics collaboratively.	3.72	Highly Useful	3.5
4. Metacognitive strategies make Science classes more engaging.	3.72	Highly Useful	3.5
5. Students are more motivated to learn when they reflect on their progress.	3.62	Highly Useful	9.5
6. Self-questioning promotes curiosity and active learning.	3.65	Highly Useful	7
7. Students show greater interest in Science when they are involved in problem-solving tasks.	3.78	Highly Useful	1
8. Reflective journaling helps students connect personally with Science topics.	3.76	Highly Useful	2

9. Metacognitive strategies foster a more interactive classroom environment.	3.62	Highly Useful	9.5
10. Students are more engaged when they are aware of their own learning processes.	3.64	Highly Useful	8
Composite Mean	3.69	Highly Useful	

Legend: *Highly Useful* (3.50–4.00), *Moderately Useful* (2.50–3.49), *Slightly Useful* (1.50–2.49), *Least Useful* (1.00–1.49)

Metacognitive strategies making Science classes more engaging also with 3.72 highly useful ranked third further affirms their usefulness in energizing classroom dynamics. Students participating more actively when metacognitive strategies are used with 3.68 highly useful ranked fifth and think-pair-share increasing student interaction also with 3.68 highly useful ranked fifth show the importance of structured collaboration. Self-questioning promoting curiosity and active learning with 3.65 highly useful ranked seventh and students being more engaged when aware of their own learning processes with 3.64 highly useful ranked eighth highlight the reflective dimensions of engagement. The lowest indicators, students being more motivated to learn when reflecting on their progress with 3.62 highly useful ranked ninth and metacognitive strategies fostering a more interactive classroom environment also with 3.62 highly useful ranked ninth, suggest that while reflection and interactivity are valued, they are perceived as less impactful compared to problem-solving and journaling. Overall, the composite mean of 3.69 confirms that metacognitive strategies are highly useful in enhancing classroom engagement, particularly through problem-solving, reflective journaling, and collaborative concept mapping.

These findings align with Capillas and Cancio (2025) who demonstrated that Think-Pair-Share and reflective journaling significantly increased student interaction and motivation in Science classes. Bautista and Mercado (2023) found that metacognitive prompts and collaborative inquiry tasks led to higher engagement levels, especially in large and resource-constrained classrooms. Cheng and Chan (2021) emphasized that metacognitive teaching strategies such as goal setting, peer feedback, and self-monitoring create inclusive environments that encourage students to take ownership of their learning. The EDCOM II Report (2025) highlighted that classroom disruptions and learning loss post-pandemic can be mitigated by strategies that promote engagement and resilience, including metacognitive reflection and adaptive learning routines. Dimaculangan (2022) reported that strategies such as Think-Pair-Share and guided inquiry increased student participation and reduced passive behavior during Biology discussions. Taken together, the analysis and related studies affirm that metacognitive strategies are highly useful in sustaining classroom engagement, energizing participation, and fostering autonomy, though strengthening their application in reflective progress monitoring and interactive routines could further enhance resilience and motivation among high school Science learners.

2.3. Self-Reflection and Feedback. Self-reflection and feedback together refer to the continuous process in which individuals critically examine their own thoughts, actions, and performance while also integrating constructive external input from others, with the goal of fostering self-awareness, learning, and improvement (Wang & Gan, 2025). In this study, it pertains to students'

critically examining one's own thoughts, actions, and performance in Science classes where metacognitive strategies are applied.

The results in Table 9 on self-reflection and feedback show that teachers in Batangas City High Schools perceive these strategies as highly useful overall, with weighted means ranging from 3.43 to 3.66 and a composite mean of 3.55 interpreted as highly useful. The highest indicator, students using feedback to improve their Science performance with 3.66 highly useful ranked first, highlights the strong impact of feedback application on achievement. Students providing more meaningful feedback to peers during think-pair-share activities and metacognitive strategies promoting a culture of reflective learning both with 3.62 highly useful ranked second emphasize the collaborative and cultural dimensions of reflection. Students becoming more aware of their learning habits through reflection with 3.59 highly useful ranked fourth and revising their work based on self-reflection and teacher feedback with 3.56 highly useful ranked fifth show the importance of reflection in habit formation and iterative improvement.

Feedback becoming more constructive when students engage in metacognitive activities with 3.55 highly useful ranked sixth and students reflecting on their learning goals with 3.53 highly useful ranked seventh highlight the formative role of reflection in goal-setting and feedback quality. Moderately useful indicators include reflective journaling helping students evaluate their own progress and self-questioning encouraging students to think about their learning choices both with 3.49 ranked eighth, and metacognitive strategies helping students identify strengths and weaknesses in their learning with 3.43 ranked tenth, suggesting that while journaling and self-questioning are valuable, they are perceived as less impactful compared to feedback-driven practices. Overall, the composite mean of 3.55 confirms that self-reflection and feedback are highly useful in Science instruction, particularly in fostering feedback application, peer interaction, and reflective learning culture.

Table 9
Self-Reflection and Feedback

Statements	Weighted Mean	Verbal Interpretation	Rank
1. Students reflect on their learning goals when metacognitive strategies are used.	3.53	Highly Useful	7
2. Reflective journaling helps students evaluate their own progress.	3.49	Moderately Useful	8.5
3. Self-questioning encourages students to think about their learning choices.	3.49	Moderately Useful	8.5
4. Students provide more meaningful feedback to peers during think-pair-share activities.	3.62	Highly Useful	2.5
5. Metacognitive strategies help students identify strengths and weaknesses in their learning.	3.43	Moderately Useful	10
6. Students become more aware of their learning habits through reflection.	3.59	Highly Useful	4
7. Feedback becomes more constructive when students engage in metacognitive activities.	3.55	Highly Useful	6
8. Students revise their work based on self-reflection and	3.56	Highly Useful	5

teacher feedback.			
9. Metacognitive strategies promote a culture of reflective learning.	3.62	Highly Useful	2.5
10. Students use feedback to improve their Science performance.	3.66	Highly Useful	1
Composite Mean	3.55	Highly Useful	

Legend: *Highly Useful* (3.50–4.00), *Moderately Useful* (2.50–3.49), *Slightly Useful* (1.50–2.49), *Least Useful* (1.00–1.49)

These findings aligned with Harvey et al. (2025) who emphasized that structured reflection practices such as journaling and self-assessments develop metacognitive awareness and lifelong learning skills. Saavedra (2025) argued that journaling fosters inquiry and self-awareness among high school learners, while Daradkeh et al. (2021) introduced digital scaffolds for reflection and feedback that improved self-regulated learning. The DepEd Order No. 21 s. (2019) encouraged formative assessments tools that promote learner reflection and feedback loops, aligning with the goals of the K to 12 curriculum. Mendoza (2024) documented that reflective journaling and peer-assessments activities enhanced students' ability to evaluate their own learning, resulting in more accurate self-appraisals and improved formative assessments scores. Taken together, the analysis and related studies affirm that self-reflection and feedback are highly useful strategies in Batangas classrooms, strengthening metacognitive awareness, collaborative learning, and performance, though greater emphasis on identifying strengths and weaknesses could further enhance diagnostic reflection and self-regulation among high school Science learners.

2.3 Development of Critical Thinking Skills. Critical thinking involves the ability to analyze, evaluate, and synthesize information to make reasoned decisions Ishak et al., (2025). In this study, it pertains to students' ability to apply logical reasoning and evidence-based thinking in Science tasks and problem-solving.

The highest indicator, students identifying cause-and-effect relationships in Science more accurately with 3.74 highly useful ranked first, highlights the strong role of metacognitive strategies in fostering analytical reasoning. Think-pair-share promoting logical reasoning and argumentation with 3.71 highly useful ranked second and concept mapping helping students organize and evaluate scientific ideas with 3.68 highly useful ranked third emphasize the collaborative and organizational aspects of critical thinking. Students demonstrating improved critical thinking through reflective and analytical tasks with 3.66 highly useful ranked fourth and reflective journaling encouraging students to think critically about their learning experiences with 3.64 highly useful ranked fifth show the importance of reflection and analysis in strengthening higher-order thinking.

Metacognitive strategies enhancing students' ability to evaluate evidence and draw conclusions also with 3.64 highly useful ranked fifth and students justifying their answers more clearly with 3.63 highly useful ranked seventh highlight the evaluative and explanatory dimensions of critical thinking. Self-questioning promoting deeper thinking in Science tasks with 3.59 highly useful ranked eighth and metacognitive strategies helping students analyze Science

problems more effectively with 3.57 highly useful ranked ninth demonstrate the reflective and analytical contributions of metacognition. The lowest indicator, students evaluating multiple solutions during problem-solving activities with 3.54 highly useful ranked tenth, suggests that while solution diversity is valued, it is less emphasized compared to cause-and-effect reasoning and collaborative approaches. Overall, the composite mean of 3.64 confirms that metacognitive strategies are highly useful in developing critical thinking skills, particularly through cause-and-effect analysis, logical reasoning, and reflective practices.

These findings aligned with Ankita and Khagendra (2024) who emphasized that strategies such as self-questioning and problem-solving enhance students' ability to analyze, evaluate, and synthesize scientific information. Jegstad (2023) and Strat et al. (2024) found that inquiry-based learning paired with metacognitive scaffolding significantly improves critical thinking dispositions among secondary students. Larkin (2023) highlighted that metacognitive learners are strategic thinkers who can transfer knowledge across contexts and adapt to complex tasks. The EDCOM II Report (2025) called for instructional reforms that prioritize higher-order thinking and problem-solving to prepare Filipino learners for global competitiveness. Ocampo (2025) revealed that problem-solving tasks embedded with metacognitive prompts such as planning, evaluating, and revising significantly developed students' critical thinking skills in Physics, particularly in interpreting data and constructing scientific explanations. Taken together, the analysis and related studies affirm that metacognitive strategies are highly useful in cultivating critical thinking among Batangas high school learners, fostering deeper learning.

Table 10
Development of Critical Thinking Skills

Statements	Weighted Mean	Verbal Interpretation	Rank
1. Metacognitive strategies help students analyze Science problems more effectively.	3.57	Highly Useful	9
2. Students evaluate multiple solutions during problem-solving activities.	3.54	Highly Useful	10
3. Self-questioning promotes deeper thinking in Science tasks.	3.59	Highly Useful	8
4. Concept mapping helps students organize and evaluate scientific ideas.	3.68	Highly Useful	3
5. Reflective journaling encourages students to think critically about their learning experiences.	3.64	Highly Useful	5.5
6. Students justify their answers more clearly when using metacognitive strategies.	3.63	Highly Useful	7
7. Think-pair-share promotes logical reasoning and argumentation.	3.71	Highly Useful	2
8. Students identify cause-and-effect relationships in Science more accurately.	3.74	Highly Useful	1
9. Metacognitive strategies enhance students' ability to evaluate evidence and draw conclusions.	3.64	Highly Useful	5.5
10. Students demonstrate improved critical thinking	3.66	Highly Useful	4

through reflective and analytical tasks.			
Composite Mean	3.64	Highly Useful	

Legend: Highly Useful (3.50–4.00), Moderately Useful (2.50–3.49), Slightly Useful (1.50–2.49), Least Useful (1.00–1.49)

3. Relationship between the Assessment on the Utilization of Metacognitive Teaching Strategies and on their Usefulness in Science Instruction

Table 11

Utilization of Metacognitive Teaching Strategies and their Usefulness in Science instruction (Academic Achievement)

Variables	Computed r-Value	p-Value	Decision	Remarks
Self-Questioning	0.24	0.02	Reject Ho	Significant
Concept Mapping	0.20	0.05	Failed to Reject Ho	Not Significant
Think-Pair-Share	0.73	<0.001	Reject Ho	Significant
Reflective Journaling	0.65	<0.001	Reject Ho	Significant
Problem-Solving	0.67	<0.001	Reject Ho	Significant

Table 11 presents the relationship between the utilization of metacognitive teaching strategies and their usefulness in science instruction in terms of academic achievement. The data show the computed r-values and corresponding p-values for each strategy.

The results indicate that self-questioning ($r = .24$, $p = .02$) has a weak but statistically significant relationship with academic achievement. Concept mapping ($r = .20$, $p = .05$), on the other hand, shows a weak relationship that is not statistically significant. Meanwhile, think-pair-share ($r = .73$, $p = .001$), reflective journaling ($r = .65$, $p = .001$), and problem-solving ($r = .67$, $p = .001$) all exhibit strong positive relationships and are statistically significant.

These findings imply that most metacognitive teaching strategies, particularly think-pair-share, reflective journaling, and problem-solving, are significantly associated with improved academic achievement in science. However, concept mapping does not show sufficient evidence of a significant relationship, suggesting limited influence on students' performance in this context.

This interpretation is supported by Kumar (2024) who highlighted those metacognitive strategies such as planning, monitoring, and evaluating enable students to become active participants in Science classrooms, resulting in higher achievement scores and deeper conceptual understanding. Famarin (2024) further found that students exposed to metacognitive-based teaching strategies like self-questioning, reflection, and regulation of learning achieved significantly higher post-test scores compared to those taught with traditional methods.

Table 12 presents the relationship between the utilization of metacognitive teaching strategies and their usefulness in science instruction in terms of class management. The table shows the computed r-values and corresponding p-values for each strategy.

The results reveal that self-questioning ($r = .10$, $p = .31$) has a very weak and non-significant relationship with class management. In contrast, concept mapping ($r = .21$, $p = .04$) shows a weak but statistically significant relationship. Moreover, think-pair-share ($r = .70$, $p = .001$) demonstrates a strong and significant relationship. Reflective journaling ($r = .39$, $p = .001$) indicates a moderate and significant relationship, while problem-solving ($r = .54$, $p = .001$) shows a moderate to strong significant relationship.

Table 12
Utilization of Metacognitive Teaching Strategies and their Usefulness in Science instruction
(Class Management)

Variables	Computed r-Value	p-Value	Decision	Remarks
Self-Questioning	0.10	0.31	Failed to Reject H_0	Not Significant
Concept Mapping	0.21	0.04	Reject H_0	Significant
Think-Pair-Share	0.70	<0.001	Reject H_0	Significant
Reflective Journaling	0.39	<0.001	Reject H_0	Significant
Problem-Solving	0.54	<0.001	Reject H_0	Significant

These findings suggest that most metacognitive teaching strategies are significantly associated with effective class management, particularly think-pair-share and problem-solving. However, self-questioning does not show a significant relationship, indicating that it may have limited influence on managing classroom dynamics in this context.

Table 13
Utilization of Metacognitive Teaching Strategies and their Usefulness in Science instruction
(Self Reflection and Feedback)

Variables	Computed r-Value	p-Value	Decision	Remarks
Self-Questioning	0.14	0.16	Failed to Reject H_0	Not Significant
Concept Mapping	0.08	0.42	Failed to Reject H_0	Not Significant
Think-Pair-Share	0.60	<0.001	Reject H_0	Significant
Reflective Journaling	0.69	<0.001	Reject H_0	Significant
Problem-Solving	0.55	<0.001	Reject H_0	Significant

Table 13 presents the relationship between the utilization of metacognitive teaching strategies and their usefulness in science instruction in terms of self-reflection and feedback. The computed r-values and p-values are shown for each variable.

The results indicate that self-questioning ($r = .14$, $p = .16$) and concept mapping ($r = .08$, $p = .42$) both have weak and non-significant relationships with self-reflection and feedback. In contrast, think-pair-share ($r = .60$, $p = .001$) shows a strong and statistically significant relationship. Reflective journaling ($r = .69$, $p = .001$) also demonstrates a strong and significant

relationship, while problem-solving ($r = .55$, $p = .001$) indicates a moderate to strong significant relationship.

These findings imply that think-pair-share, reflective journaling, and problem-solving are significantly associated with improved self-reflection and feedback among students. However, self-questioning and concept mapping do not exhibit significant relationships, suggesting limited contribution to this aspect of science instruction. Harvey et al. 2025 highlighted that structured reflection practices contribute to lifelong learning skills while simultaneously reducing classroom disruptions by encouraging students to self-assess and adjust their actions. Saavedra 2025 described reflective practice in Science education as a tool for promoting inquiry and self-awareness, which translates into more engaged and responsible learners.

Table 14 presents the relationship between the utilization of metacognitive teaching strategies and their usefulness in science instruction in terms of the development of critical thinking skills. The table displays the corresponding r-values and p-values for each variable.

The findings show that self-questioning ($r = .16$, $p = .11$) and concept mapping ($r = .15$, $p = .14$) both have weak and non-significant relationships with critical thinking skills. On the other hand, think-pair-share ($r = .67$, $p = .001$) demonstrates a strong and statistically significant relationship. Reflective journaling ($r = .41$, $p = .001$) shows a moderate and significant relationship, while problem-solving ($r = .53$, $p = .001$) indicates a moderate to strong significant relationship.

Table 14
Utilization of Metacognitive Teaching Strategies and their Usefulness in Science instruction
(Development of Critical Thinking Skills)

Variables	Computed r-Value	p-Value	Decision	Remarks
Self-Questioning	0.16	0.11	Failed to Reject Ho	Not Significant
Concept Mapping	0.15	0.14	Failed to Reject Ho	Not Significant
Think-Pair-Share	0.67	<0.001	Reject Ho	Significant
Reflective Journaling	0.41	<0.001	Reject Ho	Significant
Problem-Solving	0.53	<0.001	Reject Ho	Significant

These results suggest that think-pair-share, reflective journaling, and problem-solving significantly contribute to the development of students' critical thinking skills. However, self-questioning and concept mapping do not show significant relationships, indicating limited impact on enhancing critical thinking in this context.

These results are consistent with Ankita and Khagendra (2024) who emphasized that strategies such as self-questioning and problem-solving enhance students' ability to analyze, evaluate, and synthesize scientific information, and with Jegstad (2023) and Strat et al. (2024) who found that inquiry-based learning paired with metacognitive scaffolding significantly improves critical thinking dispositions among secondary students.

4. Challenges Met by Teachers

Science teachers encounter multiple challenges when integrating metacognitive strategies into classroom instruction, particularly in public high schools. Cheng and Chan (2021) emphasized that while Lesson Study can support metacognitive teaching, many educators lack structured time for collaborative planning and reflection, which are essential for strategy implementation. In their book, Hornby and Greaves (2022) noted that teachers often struggle with balancing curriculum coverage and the depth required for metacognitive activities such as self-questioning and reflective journaling.

Alam and Antipolo (2021) found that Filipino science teachers face difficulty in simplifying complex concepts while simultaneously fostering metacognitive awareness, especially in classrooms with diverse learner profiles. Meanwhile, Boateng and Tatira (2023) reported that pre-service teachers often feel underprepared to model metacognitive thinking due to limited exposure during their training, highlighting a gap in professional development.

The results in Table 15 on the challenges faced by Science teachers in implementing metacognitive teaching strategies reveal that the most pressing issue is large class sizes and diverse student backgrounds with a weighted mean of 2.81 interpreted as agree and ranked first, followed by students showing resistance or lack of interest in reflective or self-directed learning tasks with 2.67 agree ranked second.

Table 15
Challenges Faced

Statements	Weighted Mean	Verbal Interpretation	Rank
1. I am not very familiar with metacognitive teaching strategies such as self-questioning, concept mapping, think-pair-share, reflective journaling, and problem-solving.	2.27	Disagree	10
2. I find it difficult to implement metacognitive strategies in my Science classes.	2.35	Disagree	8
3. Time, resources, and curriculum constraints limit my ability to use metacognitive strategies.	2.68	Disagree	2
4. Students often show low engagement or difficulty in responding to metacognitive activities.	2.49	Disagree	6
5. I feel insufficiently trained or unsupported in using metacognitive strategies.	2.36	Disagree	7
6. Large class sizes and diverse student backgrounds make it harder to implement metacognitive strategies effectively.	2.81	Agree	1
7. It is challenging to assess student learning when using metacognitive strategies.	2.59	Agree	4
8. Lack of school leadership or administrative support hinders my ability to apply metacognitive strategies.	2.31	Disagree	9

9. Students sometimes show resistance or lack of interest in reflective or self-directed learning tasks.	2.67	Agree	3
10. Integration of metacognitive strategies in Science instruction across high schools is not well supported or encouraged.	2.51	Agree	5
Composite Mean	2.50	Agree	

Legend: *Strongly Agree* (3.50–4.00), *Agree* (2.50–3.49), *Disagree* (1.50–2.49), *Strongly Disagree* (1.00–1.49)

Time, resources, and curriculum constraints with 2.68 disagree ranked third and challenges in assessing student learning when using metacognitive strategies with 2.59 agree ranked fourth also emerged as significant barriers. Integration of metacognitive strategies across high schools with 2.51 agree ranked fifth and low student engagement in metacognitive activities with 2.49 disagree ranked sixth highlight systemic and learner-related difficulties. Insufficient training or support with 2.36 disagree ranked seventh, lack of familiarity with strategies with 2.27 disagree ranked tenth, and lack of administrative support with 2.31 disagree ranked ninth suggest that while teachers acknowledge some gaps in preparation and support, these are not perceived as the most critical challenges. Overall, the composite mean of 2.50 interpreted as agree indicates that teachers generally face moderate challenges, with class size, student resistance, and systemic constraints being the most significant.

These findings resonate with Cheng and Chan (2021) who emphasized that teachers often lack structured time for collaborative planning and reflection needed for metacognitive teaching. Hornby and Greaves (2022) noted the difficulty of balancing curriculum coverage with the depth required for strategies such as self-questioning and journaling. Alam and Antipolo (2021) found that Filipino teachers struggle to simplify complex concepts while fostering metacognitive awareness in diverse classrooms, while Boateng and Tatira (2023) reported that pre-service teachers feel underprepared to model metacognitive thinking due to limited training. Policy reports such as DepEd Order No. 002 s. 2024 and DepEd Order No. 005 s. (2024) attempted to reduce workload, yet the EDCOM II Year Two Report (2025) revealed that teachers still spend excessive time on non-teaching tasks, limiting their capacity to implement reflective strategies. Antipolo and Rogayan (2021) documented that prospective teachers feel overwhelmed by the demands of the K to 12 curriculum, Canuto (2024) highlighted barriers in rural schools such as limited access to technology, and Awal and Asaduzzaman (2024) emphasized the need for institutional support and coaching. Lapada et al. (2020) as cited by Barron et al. 2021 revealed that the pandemic further complicated metacognitive instruction, reducing engagement and reflection in online settings. Locally, Llamas (2023) found that overloaded curricula hinder reflective activities, Rivera (2022) revealed that lack of professional development leads to inconsistent application of strategies, Torres (2024) emphasized student resistance to metacognitive routines, and Enriquez (2025) identified resource constraints as a major barrier. Taken together, the analysis and related studies affirm that challenges in implementing metacognitive strategies stem from systemic workload issues, large class sizes, limited training, and resource constraints, underscoring the need for targeted support, contextualized training, and institutional alignment to strengthen Science instruction.

5. Proposed Enhancement Activities

This table integrates the findings with practical activities, ensuring that teacher preparation, systemic constraints, resource gaps, and learner engagement are addressed holistically to promote effective and sustainable metacognitive instruction in Science education.

Based on the findings regarding the challenges faced by Science teachers in implementing metacognitive teaching strategies, several proposed enhancement activities may be given to strengthen classroom practice and overcome barriers. First, capacity-building programs such as sustained professional development, coaching, and mentoring should be prioritized to equip teachers with practical skills in strategies like self-questioning, reflective journaling, and concept mapping.

Table 16
Enhancement Activities

Enhancement Activities	Description	Objectives	Activities	Persons Involved	Expected Outputs
Capacity-Building Programs	Provide sustained professional development, coaching, and mentoring on metacognitive strategies	1. Strengthen teachers' knowledge and skills in metacognitive pedagogy 2. Build confidence in applying strategies consistently	Conduct training workshops, peer coaching sessions, and professional learning communities	DepEd, school administrators, master teachers, Science teachers	Teachers equipped with practical skills in self-questioning, reflective journaling, concept mapping, and problem-solving
Curriculum and Workload Adjustments	Reduce non-teaching tasks and provide adequate instructional time	1. Ensure teachers have sufficient time to integrate metacognitive activities 2. Balance curriculum coverage with depth of learning	Review and streamline teacher workload, adjust schedules, integrate metacognitive strategies into lesson plans	DepEd policymakers, school heads, curriculum planners	More time for reflective and inquiry-based activities, improved instructional focus
Resource Provision and Digital Support	Supply instructional materials and technology tools to facilitate metacognitive practices	1. Provide access to digital platforms and tools for concept mapping and feedback	Distribute digital devices, software, and instructional materials; establish resource centers	DepEd, LGUs, ICT coordinators, school administrators	Enhanced access to tools supporting metacognitive strategies, improved classroom implementation

		2. Ensure availability of printed and online resources			
Classroom Management Activities	Apply differentiated instruction and peer-assisted learning to address diverse learners	1. Manage large class sizes effectively 2. Promote inclusivity and collaboration	Implement peer tutoring, group work, differentiated tasks, and scaffolding techniques	Science teachers, students, class advisers	Improved classroom participation, reduced disengagement, stronger collaborative learning culture
Student Engagement Initiatives	Use motivational prompts and contextualized problem-solving tasks	1. Increase student interest and reduce resistance to metacognitive routines 2. Foster active participation and autonomy	Design real-world Science problems, reflective prompts, and interactive activities	Science teachers, students	Higher student motivation, deeper engagement in metacognitive activities
Institutional Alignment and Leadership Support	Strengthen school leadership and policy support for metacognitive instruction	1. Ensure consistent application of strategies across classrooms 2. Align institutional policies with instructional goals	Conduct leadership orientations, monitoring, and evaluation of metacognitive practices	School heads, administrators, DepEd supervisors	Stronger institutional support, consistent implementation of metacognitive strategies

Second, curriculum and workload adjustments are necessary to provide teachers with adequate instructional time and reduce non-teaching tasks, ensuring they can integrate reflective and inquiry-based activities without sacrificing coverage. Third, resource provision and digital support should be enhanced by supplying schools with instructional materials, technology tools, and platforms that facilitate metacognitive practices such as feedback loops and collaborative mapping. Fourth, classroom management activities like differentiated instruction and peer-assisted learning can help address challenges posed by large class sizes and diverse learner backgrounds. Fifth, student engagement initiatives such as structured scaffolds, motivational prompts, and contextualized problem-solving tasks should be implemented to reduce resistance and foster active participation. Finally, institutional alignment and leadership support must be strengthened through clear policies, monitoring, and encouragement from school heads and administrators to ensure consistent application of metacognitive strategies across classrooms. Collectively, these activities address teacher preparation, systemic constraints, resource gaps, and learner engagement, thereby promoting effective and sustainable metacognitive instruction in Science education.

Conclusion

The study concluded that Science teachers in Batangas City High Schools highly utilized concept mapping, think-pair-share, and problem-solving strategies, while self-questioning and reflective journaling were only moderately utilized. Teachers also assessed metacognitive strategies as highly useful in improving students' academic achievement, classroom engagement, self-reflection and feedback, and critical thinking skills. Furthermore, collaborative and reflective strategies such as think-pair-share, reflective journaling, and problem-solving showed significant positive relationships with academic achievement, classroom management, self-reflection and feedback, and critical thinking skills. The findings also revealed that teachers generally experienced moderate challenges in implementing metacognitive teaching strategies, particularly in terms of class size, student resistance, and systemic constraints. Lastly, the proposed enhancement activities emphasized continuous teacher development, curriculum and workload adjustments, resource and digital support, improved classroom management, stronger student engagement initiatives, and institutional leadership alignment to ensure the effective and sustainable implementation of metacognitive strategies in Science instruction.

Recommendation

The study recommends that the proposed enhancement activities be reviewed by the appropriate authorities prior to their implementation in the Division of Batangas City. It is also recommended to strengthen Science instruction by sustaining the high utilization of concept mapping, think-pair-share, and problem-solving strategies while giving greater emphasis to improving the moderate use of self-questioning and reflective journaling to better support reflective, independent, and adaptive learning among students. Furthermore, the high usefulness of metacognitive strategies in Science instruction should be sustained by enhancing collaborative approaches such as think-pair-share and problem-solving, as well as reflective practices like journaling and feedback, to maximize their positive effects on academic achievement, classroom engagement, self-reflection, and critical thinking skills. To address the moderate challenges encountered by Science teachers, stronger classroom management support for large class sizes, increased student engagement initiatives to lessen resistance, and systemic adjustments should be provided, alongside continuous training and administrative support to ensure the effective implementation of metacognitive teaching strategies. Lastly, similar or parallel studies in Science education are encouraged to further validate the findings of the present study and to examine the usefulness of metacognitive teaching strategies across different contexts, grade levels, and subject areas.

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