Metacognitive Strategies as a Tool for Building Students' Confidence in Science

Ginalyn R. Rabino[1], Dr. Jesus Paguigan[2], Jensen Kay B. Norte[3], Elizabeth L. Tragura[4]

[1,3]Teacher 1, Eulogio Amang Rodriguez Institute of Science & Technology (EARIST) Graduate School, Manila, Philippines
[2]Dean of Computer Studies, Eulogio Amang Rodriguez Institute of Science & Technology (EARIST) Graduate School, Manila, Philippines
[4]Instructor, line 3: Eulogio Amang Rodriguez Institute of Science & Technology (EARIST) Graduate school, Manila , Philippines

Abstract:
This study investigates the impact of an instructional intervention designed to enhance students' metacognitive skills in science education. Although science is widely valued by learners. The low prevalence of poor self-confidence among students is a serious problem in the field of science education, many students exhibit low confidence and self-efficacy, often due to limited strategic tools for managing academic challenges. The intervention focuses on equipping students with cognitive and metacognitive capabilities such as plan, monitor, and evaluate their own work. The questionnaire was administered to both the experimental and control groups. A mixed method design with pretest–posttest measures was employed to compare students who received metacognitive instruction with those in traditional classrooms. The results indicated that students in the experimental group showed a notable increase in scores on the pre-test and post-test from the start to the end of the study. Students demonstrated progress in key areas of metacognition. By the end of the intervention, students in the experimental group excel compared to those on standardized Science assessments, particularly in tasks requiring higher-order thinking and open-ended problem-solving.

Keywords: Self-Confidence, Metacognition, Science

I. Introduction (*Background of the Study*)

Science teaching is very important for students, helping them to think, solve problems and think critically. Many students are afraid to study science because they think it can be too much for average students to handle. One of the biggest problems teachers have is not only teaching students but also helping them develop a positive attitude toward school. Many students are afraid of science and don't believe they can do it because they think it's only for "naturally gifted" people. This lack of confidence makes it hard to get involved and do well, and it often leads to a cycle of avoidance and low performance (Usher & Pajares, 2008).

This lack of confidence often manifests in classroom behaviors such as reluctance to participate in discussions, avoidance of challenging tasks, and adherence to a fixed mindset that views ability as innate rather than improvable. At the heart of this issue lies a deeper challenge: students frequently lack the strategic tools required to independently manage academic difficulties. When confronted with complex problems, they are unable to deconstruct tasks, evaluate their own understanding, or apply effective learning strategies. This inability not only hinders their performance but also erodes their belief in their capacity to succeed. Addressing this confidence gap requires more than content delivery; it calls for instructional interventions that explicitly cultivate cognitive and metacognitive skills essential for self-regulated learning. By empowering students with strategies for planning, monitoring, and reflecting on their learning, educators can directly target the root causes of low confidence and foster resilience in scientific problem-solving.

Historically, several attempts to enhance scientific outcomes focusing on curricular content of pedagogical methodologies designed for knowledge transfer. These approaches, though significant, frequently overlook the psychological aspects of learning. In recent years, educational research has increasingly focused on the significance of metacognition—the awareness and regulation of one's cognitive processes—as a vital element of academic achievement (Flavell, 1979). Planning how to do a task.

A. *Statement of the Problem*

Even though many students believe that science education is important, it is concerning that many pupils lack confidence and self-efficacy in their scientific talents. This manifests in classroom actions including a fixed perspective that leads to a lack of inherent ability, hesitancy to participate in discussions, and hesitancy to take on challenging tasks. The primary issue is that many students lack the strategic tools necessary to independently handle academic challenges. When faced with difficulties, individuals are unable to deconstruct the issue, assess their level of understanding, or employ effective learning techniques. Their confidence is immediately damaged by this impotence. Therefore, the goal of this research is to determine whether an instructional intervention that gives students the cognitive capabilities necessary for self-regulated learning is necessary in order to directly address the root cause of this confidence gap..

B. *Research Objectives*

This study aims at the effects of integrating digital technologies on students' metacognitive processes and academic performance in Science at FFHNAS Mag-asawang Sapa High School.

The specific objectives are:

1. To assess changes in students' abilities to plan, monitor, and evaluate their own learning in Science through the use of digital tools.
2. To explore students' engagement, problem-solving strategies, and application of reflective thinking during Science lessons.
3. To examine the relationship between students' development of metacognitive skills and their Science learning outcomes using both quantitative and qualitative data.
4. To determine metacognition strategies that science teachers use in science lessons and activities they can perform within the scope of these strategies.

II. SIGNIFICANCE OF THE STUDY

Many stakeholders will find the result of this study useful. To help students feel better about themselves and get better grades in science, this study teaches them how to learn on their own and in different ways. To make the classroom a better and more upbeat place for everyone, teachers can use this tool. By clearly showing the link between teaching metacognitive skills and building students' confidence, this study gives teachers evidence-based ways to deal with the emotional parts of learning. Science standards should include goals for social and emotional learning as well as metacognitive skills, according to this study. As a result, science education is made more complete.

III. Methods

This study employed a mixed-methods research design, integrating both quantitative and qualitative data to obtain a comprehensive understanding of how digital technologies support and enhance the metacognitive processes of students at FFHNAS Mag-asawang Sapa High School. The approach was intended not only to explore students' metacognitive development but also to determine how the use of digital interventions can contribute to improving their academic performance, particularly their grades for the second quarter.

A. *Participants and Settings*

The participants of the study were 40 students from FFHNAS Mag-Asawang Sapa High School. They were randomly assigned to either the experimental group (n = 20) or the control group (n = 20). All participants shared comparable socio-economic backgrounds, and their prior academic performance showed no significant differences. The key distinction between the two groups was that the experimental group received instruction supplemented with integrated digital interventions across selected learning activities.

B. *Pedagogical Intervention*

The intervention was implemented across three structured phases. During the first phase, students were introduced to key metacognitive concepts, including planning learning tasks, selecting appropriate study strategies, and monitoring their comprehension. The second phase entailed the gradual integration of digital tools—such as educational applications and interactive online platforms into classroom activities to foster self-monitoring and reflective learning. In the final phase, regular feedback sessions were conducted to guide students in optimizing their use of these digital tools, thereby strengthening their ability to regulate, assess, and evaluate their cognitive processes.

C. *Data Collection*

A simplified version of the Metacognitive Awareness Inventory, adapted for younger learners and the learners needs, was employed to quantitatively assess changes in students' perceived abilities to plan, monitor, and evaluate their own work. The questionnaire was administered to both the experimental and control groups at the beginning and end of the study.

On the qualitative side, structured observations were conducted to capture students' engagement, behaviors, and challenges in using digital tools and applying reflective strategies. Furthermore, semi-structured interviews with both students and teachers provided insights into how effectively students were able to monitor their progress and implement the newly introduced metacognitive strategies.

D. *Data Analysis*

To analyze the inventory data, averages for each group were first calculated using simple descriptive statistics. Changes within each group from pre-test to post-test in science were examined using paired t-tests, while differences between the experimental and control groups were assessed with independent t-tests. Academic performance, based on standardized test scores, was analyzed in the same way. For the qualitative data, classroom observations and interview transcripts were carefully reviewed to identify recurring themes, such as levels of engagement, problem-solving behaviors, and how students approached metacognitive tasks. These qualitative insights were then compared with the quantitative findings to form a well-rounded picture of the students' learning progress and development of cognitive skills.

IV. RESULTS

The quantitative results indicated that students in the experimental group showed a notable increase in scores on the pre-test and post-test from the start to the end of the study. They demonstrated significant improvement in key areas of metacognition, including planning (e.g., setting learning goals), monitoring (e.g., recognizing difficulties during tasks), and evaluation (e.g., assessing the quality of their work). Although the control group also showed some improvement. A similar pattern was observed in Science academic performance. By the end of the intervention, students in the experimental group outperformed their peers on standardized Science assessments, particularly in tasks requiring higher-order thinking and open-ended problem-solving. These results suggest that enhanced metacognitive skills may play a key role in improving both students' grades and their confidence in Science. Findings from classroom observations and interviews supported these quantitative trends, providing additional insight into students' engagement and application of metacognitive strategies.

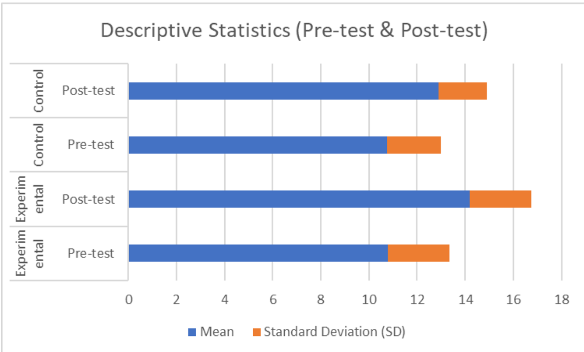

Fig 1. Bar Graph showing the pre-test and post test scores of the learners in science

Group	Variable	t-value	p-value	Interpretation
Experimental	Scores in Science	7.84	0	Significant improvement
Control	Scores in Science	1.22	0.23	Not significant

Figure 2. Table showing the results of a paired t-test comparing the pre–post science scores of students.

Figure 2 shows that the experimental group demonstrated a statistically significant improvement in their science assessment scores, as indicated by a t-value of 7.84 and a p-value of 0.00. This suggests that the intervention had a meaningful impact on their performance. In contrast, the control group showed no significant change, with a t-value of 1.22 and a p-value of 0.23, indicating that their scores remained relatively stable without the intervention.

Analysis of classroom observations and interview data revealed patterns that aligned closely with the quantitative results. During lessons, students in the experimental group were more actively engaged, frequently reflecting on their understanding and adjusting their strategies when encountering difficulties. They demonstrated greater initiative in planning and organizing tasks, sought help when necessary, and applied problem-solving approaches more consistently. Interviews with students indicated that the digital tools helped them monitor their progress and gain confidence in tackling challenging Science tasks.

Teachers also noted that these students showed increased independence and a deeper understanding of concepts compared with the control group. Together, these qualitative insights reinforced the conclusion that integrating digital technologies can enhance metacognitive skills and, in turn, positively influence learning outcomes in Science.

V.CONCLUSION

The findings of this study demonstrate that implementing metacognitive strategies alongside digital learning tools can significantly enhance students' confidence and ability to manage their own learning in Science. Students who participated in the intervention not only developed stronger metacognitive awareness but also showed improved performance in Science, particularly on tasks that required higher-order thinking and problem-solving. These results suggest that digital tools, when integrated thoughtfully with metacognitive instruction, can promote self-reflection, self-regulation, and greater assurance in tackling scientific concepts[1]. To replicate these outcomes in other classrooms, it is essential to provide teachers with professional development and adequate technological resources. Furthermore, metacognitive skills should be reinforced consistently through lesson planning and curriculum design, ensuring that students internalize these strategies and apply them effectively. By fostering these skills early, schools can empower learners to approach Science confidently and adaptively in a rapidly evolving, technology-rich environment.

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