Extent of the Experience in the Use Of Metacognitive Problem- Solving Strategies of the Technical Education and Skills Development (TESDA) Students

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Abstract

Learning requires using processes such as planning, application, regulation, and reflection, which are considered metacognitive. Studies have shown that metacognition is associated with problem-solving skills. Studying metacognition opens the emergence of a possible problem- solving strategy in Mathematics instruction. This descriptive research primarily aims to verify the presence of theory-based metacognitive problem-solving strategies (MPSS) among students when they solve math problems. Specifically, it intends to determine the 1) extent of their experience on the use of MPSS when classified according to their performance in the problem-solving test, and as a whole; 2) the most experienced MPSS when ranked; and 3) the relationship between the MPSS and students' performance in the test. The researcher-made questionnaire and a set of problem-solving items in Mathematics were used to collect data on the MPSS and students' performance in the problem-solving test, respectively. The descriptive statistics using the mean and standard deviation were used to analyze the data. All four MPSS were at a moderate to high experience. The findings show that the Metacognitive Knowledge of the Nature of the Problem was the most experienced metacognitive strategy in problem solving. Students' performance in their problem-solving test is significantly related to the Metacognitive Knowledge of the Nature of the Problem and the Metacognitive Knowledge of the Problem Typology. This finding supports the theory on metacognition used in this study that accurate mathematical knowledge, together with the richness of experiences on various kinds of problem-solving, plays a crucial role in the success of the Mathematical Knowledge and Thinking as the core phenomenon of successful problem-solving solution outcomes.

Hence, the result of this study sees the importance of the integration of these metacognitive problem-solving strategies in designing instructions, and so with mathematics teacher education.

Key Words: Metacognition; Metacognitive Problem-solving Strategies; performance in solving-test; designing instructions; mathematics teacher education

Introduction

Learning is a complex process that involves not only acquiring knowledge but also regulating and monitoring one's cognitive activities. Central to this process is metacognition, which encompasses higher-order thinking skills such as planning, applying strategies, self-monitoring, and reflection (Flavell, 1979). Metacognition enables learners to become aware of their cognitive processes (Loaiza et al., 2023) and adjust learning strategies (Nechyporuck & Romaniuk, 2025), fostering better control over their learning.

In the context of mathematics education, metacognitive strategies have been shown to significantly enhance the problem-solving skills of students. Studies consistently demonstrate that students who actively employ metacognitive processes are more likely to achieve success in solving mathematical problems (Loaiza et al., 2023; Panigrahi et al., 2025). Furthermore, metacognitive skills are closely linked to self-regulated learning, which has been identified as a critical factor in academic achievement across various disciplines (Siregar et al., 2024; Pandey & Mohan, 2024).

Despite extensive studies on metacognition in general educational settings, a notable few studies focus on its application within technicalvocational education, particularly among students enrolled in the Technical Education and Skills Development Authority (TESDA) programs in the Philippines. TESDA students often face unique challenges due to the practical, skills-oriented nature of their training, yet little is known about how they utilize metacognitive strategies during academic tasks such as mathematics problemsolving. Understanding their metacognitive habits is crucial, given that effective problem-solving underpins success in both academic and real-world contexts.

While existing literature has established the importance of metacognitive awareness for improving mathematical performance (Velasquez & Bueno, 2019; Loaiza et al., 2023), most prior studies focus on traditional school populations. The specific behaviors and strategies employed by TESDA students remain underexplored. Moreover, although some frameworks describe various metacognitive processes, such as those proposed by Divinagracia (2019), there is limited empirical evidence examining which strategies TESDA students are most proficient in and how these strategies influence their problemsolving performance.

Thus, there is a need to investigate the nature and extent of metacognitive strategy use among TESDA students, especially in the context of mathematics problem-solving. Subsequently, the results will inform targeted instructional interventions and curriculum designs that foster metacognitive skills aligned with students' unique learning environments.

This study aims to fill the abovementioned gap by determining the extent of TESDA students' experience in using metacognitive problem-solving strategies during mathematics tasks, identifying which metacognitive strategies are most frequently employed by students, and examining the relationship between the use of metacognitive strategies and students' problem-solving performance. Through achieving these objectives, this study intends to contribute to the understanding of metacognitive processes among technicalvocational learners and to provide practical insights for educators in designing instruction that cultivates these essential skills.

Review of Related Literature

Metacognition, often described as "thinking about one's own thinking" (Kumar & Soni, 2025), plays a crucial role in learning and problem-solving. It encompasses higher-order cognitive processes, such as planning, monitoring, evaluation, and reflection, that enable learners to regulate their own learning effectively (Livingston, 2003). Siregar et al. (2024) emphasize that metacognitive strategies are fundamental components of self-regulated learning, fostering awareness of cognitive processes and promoting effective learning behaviors.

Research indicates that metacognitive skills serve as predictors of successful learning outcomes in problem-solving contexts (Bubnic et al., 2024).

Ishak et al. (2025) further confirm that students' ability to implement metacognitive strategies enhances their problem-solving effectiveness. Supporting this, Abu Bakar and Ismail (2019) advocate for integrating metacognitive strategies into instruction, highlighting their positive impact on academic achievement.

Furthermore, Divinagracia (2022) identified four key themes of metacognitive process strategies relevant to mathematics problem solving: (1) metacognitive knowledge of problem typology, (2) knowledge of the nature of mathematical problems, (3) metacognitive awareness of mathematical knowledge and thinking, and (4) metacognitive solution qualities. These themes guide students in understanding and approaching mathematical problems more effectively. The study emphasizes that students with strong metacognitive awareness, such as recognizing familiar problems as easier or identifying errors during solving, are more likely to achieve success (Divinagracia, 2019).

Several researchers have investigated the impact of metacognitive instruction on problem-solving skills. A study shows that students' mathematical problem-solving abilities improve when they are aware of their cognitive processes (Cayetano & Ibarra, 2024), and structured learning interventions can enhance this metacognitive awareness (Anjelina et al., 2021). Studies demonstrated that metacognitive training enhances students' problemsolving, critical thinking performance (Panigrahi et al., 2025), problem recognition, logical sequencing, and solution accuracy (Mamatokhunov & Kholmirzayevam, 2025), contributing to improved learning outcomes. Similarly, Safari and Meskini (2016) found that metacognitive problem-solving instruction positively affects the development of students' problem-solving abilities, encouraging the design of courses and workshops to reinforce these strategies.

Other studies highlight the importance of students' awareness of their metacognitive processes. Guner and Erbay (2021) emphasized that students with high metacognitive skills tend to solve the problem correctly by using appropriate strategies, whereas the study of Azevedo and Dever (2021) shows that ineffective strategy use has negative consequences. Sanjaya et al. (2024) advocate that effective techniques, including guided reflection, self-assessment,

peer cooperation, and scaffolded learning, positively impact metacognitive skill development.

In terms of collaborative learning, Smith and Mancy (2018) identified that collaborative metacognitive talk facilitates group understanding and problem-solving success. Sternberg and Sternberg (2017) point out that encountering obstacles during problem solving necessitates strategic approaches and a broader comprehension—attributes supported by metacognitive thinking. Metacognitive training incorporating monitoring and evaluation stages improves problem recognition, solution accuracy, and overall academic achievement (Mamatokhunov & Kholmirzayevam, 2025).

Finally, Villanueva and Divinagracia (2025) elaborate on the interrelationship among these metacognitive processes, describing how metacognitive knowledge of problem typology and the nature of mathematical problems influences learners' reflective thinking and problem-solving efficacy. It stresses that metacognitive behaviors, such as planning, clarifying task requirements, and error detection, are indicative of successful problem-solving (Divinagracia, 2022). Zulkiply (2016) adds that a positive relationship exists between students' metacognitive awareness and their academic performance, suggesting that fostering metacognitive regulation strategies can significantly enhance learning outcomes.

Methodology

This study was a descriptive correlational research design. The study sample included 33 TESDA students who are taking Mathematics in the Modern World course in the first semester, A.Y. 2020-2021, and were selected through stratified sampling and randomly picked using simple random sampling.

The instruments for data collection were a 10-item problem-solving quiz validated by 5 experts in the mathematics discipline and a researcher-made metacognitive questionnaire validated by 5 experts in Mathematics and Research. It is a 35-item multi-dimensional scale that examines the metacognition used by a student while answering the problem. The dimensions were derived from Divinagracia (2022). These are Metacognitive Knowledge of the Nature of the Problem, Metacognitive Knowledge of the Problem's Typology, Metacognitive Mathematical Knowledge and Thinking, and

Metacognitive Solution Qualities. The first three dimensions consist of 5 statements each. The last dimension consists of 20 statements, two for each Metacognitive Solution Qualities, namely diagnostic, scanning, searching & referencing, direction steering, rectification, restoration, pattern-seeking, predicting, natural flipping of thought, evaluating, and controlling time.

Reliability Analysis was run to determine the Cronbach's Alpha of the scale, which yielded a value of 0.653. No items were significantly needed to be removed from the original questionnaire.

Statistical Package for Social Sciences (SPSS) was used in the investigation of data for reliability of the two (2) self-made questionnaires, mean and standard deviation, and Pearson product-moment correlation.

The results of the study were analyzed using the following statistical tools:

a. Mean and standard deviation were used to determine the extent of their experience on the use of MPSS when classified according to their performance in the problem-solving test, and as a whole by the respondents.

Table 1

Extent of the respondent's experiences with the use of Metacognitive problem-solving strategies

Description	Mean Range
Poor to marginalize (P-M)	1.00-1.75
Marginalize to moderate (M-M)	1.76-2.50
Moderate to high (M-H)	2.51-3.25
High to extensive (H-E)	3.26-4.00

Ranking was used to determine the most experienced MPSS of the respondents.

b. Pearson Product Moment Correlation was used to find out the relationship between the MPSS and students' performance in the test.

Results and Discussion

Table 2

Metacognitive Problem-Solving Strategies of the Respondents

MPSS	Passed	Failed	Weighted Mean	Verbal Interpretation
Metacognitive Knowledge of the Nature of the Problem	3.01	2.77	2.91	Moderate to High
Metacognitive Knowledge of the Problem Typology	2.93	2.76	2.86	Moderate to High
Metacognitive Mathematical Knowledge and Thinking	2.79	2.90	2.84	Moderate to High
Metacognitive Solution Qualities	2.81	2.82	2.81	Moderate to High
Metacognitive Problem-Solving Strategies	2.85	2.81	2.86	Moderate to High

The overall extent of experience on the use of metacognitive problemsolving strategies of the TESDA students in the problem-solving test shows moderate to highly experienced ($\bar{x}$ = 2.86). Based on the results, respondents who passed the mathematics test have a greater mean in the nature of the problem and typology of the problem than respondents who failed the test. This result conforms to the findings of Divinagracia (2022) that the

Metacognitive stages of Successful MPS are influenced by the regulated metacognitive knowledge of the typology and nature of the problem being solved.

Table 3

Most experienced Metacognitive Problem-solving Strategies of the Respondents when ranked

MPSS	Weighted Mean	Verbal Interpretation
Metacognitive Knowledge of the Nature of the Problem	2.91	Moderate to High
Metacognitive Knowledge of the Problem Typology	2.86	Moderate to High
Metacognitive Mathematical Knowledge and Thinking	2.84	Moderate to High
Metacognitive Solution Qualities	2.81	Moderate to High

Table 3 shows the metacognitive problem-solving strategies used by the respondents when ranked. The first problem-solving strategy used by the respondents is the Metacognitive Knowledge of the Nature of the Problem ($\bar{x}$ =2.91). The second problem-solving strategy used by the respondents is the Metacognitive Knowledge of the Problems Typology ($\bar{x}$ ==2.86). The third is Metacognitive Knowledge and Thinking ($\bar{x}$ =2.84). The last problem-solving strategy used by the respondents is Metacognitive Solution Qualities ($\bar{x}$ = 2.81).

Table 4

Relationship between the respondent's Metacognitive Problem-Solving Strategies and their Mathematics performance

MPSS (N=33)	r	p
Metacognitive Knowledge of the Nature of the Problem	0.456	0.008*
Metacognitive Knowledge of the Problem Typology	0.094	0.787
Metacognitive Mathematical Knowledge and Thinking	0.207	0.248
Metacognitive Solution Qualities	0.462	0.007*

**Significant at p<0.05*

The data analysis in Table 4 shows that the metacognitive nature of the problem and Mathematics performance were found to be moderately positively correlated, r(33) = .520, p = .002.

The result of the study of Zulkiply (2016) revealed a significant positive relationship between a student's academic performance and metacognitive awareness. It seems that students who do well in examinations are better on metacognition measures.

The data also reveal a moderate positive correlation between Metacognitive Typology of the problem and Mathematics Achievement, r(33) = .456, p = .008.

This means that the higher the scores in the metacognitive nature and typology of the problem, the higher the scores in the mathematics test. The lower the score in the metacognitive nature and typology of the problem, the lower the score in Mathematics achievement, and moderate metacognition is associated with average scores in Mathematics achievement. The study revealed that the level of metacognition of the respondents is at the initiator level. This means that they might understand the problem, but they have difficulty forming a solution.

Meanwhile, there is no significant correlation between metacognitive Mathematical knowledge and thinking, and Mathematical performance (p = 0.787). The relationship between Metacognitive Solution Qualities and Mathematical Achievement also garnered no significant correlation(p=0.462). This means that scores in Metacognitive Solution Qualities and Metacognitive Mathematical Knowledge and Thinking are not associated with scores in Mathematical achievement. The result of the study might be affected by the type of problems being presented. To support the findings, the study of Sternberg & Sternberg (2017), as cited by Divinagracia (2019) in Metacognitive Processes in Successful Mathematical Problem Solving, emphasized that there is always a sort of "obstacle" that prevents one from successfully solving a problem. Thus, it implies that the need for wider comprehension and strategic techniques is necessary for the MPS to be done correctly. This would help to look for the potential of the metacognitive results that would lead to the accurate solution.

Conclusion

This research aims to determine the extent to which the respondent's experiences of the use of Metacognitive problem-solving strategies influence their performance in the problem-solving test, and as a whole. All four metacognitive problem-strategies are moderate to highly experienced. Respondents who passed the mathematics test have a greater mean for the problem and typology of the problem compared to respondents who failed the mathematics test. It can be concluded that the nature of the problem and typology of the problem are key factors in successful problem-solving. Students need to practice meta-awareness of nature and typology while solving problems.

Another goal of the study is to ascertain the most experienced metacognitive problem-solving strategies when ranked. The typology of the problem is the most experienced metacognitive strategies applied in problem solving. Students' ability to detect the relationship of a particular problem or lesson, comprehend similar difficulties that have been faced, and determine whether a problem is similar to or distinct from instances is common.

Metacognitive Solution Qualities are the least experienced metacognitive strategies. Teachers could come up with more techniques to help pupils develop these Metacognitive Control Qualities as a strategy. It is also

suggested that more research be done into why Metacognitive Control Qualities is the least used problem- solving strategy.

Lastly, this research aims to find out the significant relationship between the Metacognitive Problem-Solving Strategies and the Mathematics performance of the respondents. The two metacognitive problem-solving strategies, namely the nature of the problem and the typology of the problem, are associated with Mathematics achievement. Students who got high scores in the mathematics test have high metacognition in nature and typology of the problem. Students who got low scores have experienced low metacognition, and those who got average scores have experienced moderate metacognition. Recognizing the Nature and Typology of the problem should be a part of teachers' instruction of the lessons for higher Mathematical achievement. Instructions should be grounded in the prior experiences of the learner that lead the learner to construct meanings. The teacher can repeatedly ask if the problem has been encountered and recognized previously. This study sees the importance of the integration of these metacognitive problem-solving strategies in designing instructions, and so with mathematics teacher education.

While Mathematical Knowledge and Thinking, and Metacognitive Solution Qualities have shown no significant relationships to Mathematical achievement, it is objectionable to undervalue the impact they may bring to Mathematical Problem Solving. Despite the lack of statistical evidence, these two themes undeniably have an association with the big Metacognition process. This gives direction to other researchers to further look into these two themes.

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