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The Influence of Problem-Solving Skills and Prior Achievement on Student Performance in a Literacy and Numeracy Program

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Abstract. Following the 2022 EGMA results showing weak problem-solving skills among early learners in Negros Oriental, this study examined Grade 12 students' perceived proficiency in problem-solving, prior academic performance, and actual results using the PS-ELANS tool. A descriptive-correlational design was used with 250 systematically selected students. Data were collected using a validated questionnaire and analyzed through appropriate statistical tests. Findings revealed that students rated themselves as moderately proficient in strategies like trial-and-error, guess-and-check, collaboration, and metacognition. However, they felt less skilled in using mathematical models, heuristics, working backward, and pattern recognition. Their PS-ELANS performance was moderate, while prior achievement was very satisfactory. A significant positive relationship was found between perceived proficiency and actual performance. Socioeconomic factors such as income level and parental education also had a significant effect on performance. The study recommends using PS-ELANS data to develop targeted interventions like peer mentoring and strategy-based workshops. Schools should train teachers in advanced problem-solving instruction and provide remedial support. Parents are encouraged to promote persistence and resilience in learning, while students should actively engage in lessons and seek extra challenges. Community support through scholarships and educational aid is also vital. This study highlights the importance of collaborative efforts among educators, families, and communities in strengthening students' problem-solving abilities and addressing learning gaps.

Keywords: Problem-solving; PS-ELANS; Student performance; Academic support; Mathematics strategies.

1.0 Introduction

Developing strong problem-solving skills is recognized as a global priority in education, essential for preparing young people to address the complex challenges of modern society (Care et al., 2024). According to Irshad (2024) and the World Economic Forum (2020), a solid foundation in mathematics and the ability to solve critical problems are crucial for success across various areas of life. The World Economic Forum stressed the increasing importance of critical thinking, analytical skills, and problem-solving abilities in future employment. Almulla and Al-Rahmi (2023) further emphasized that in Saudi Arabia's higher education system, students' learning capacity is significantly influenced by their problem-solving and critical thinking proficiency. However, despite ongoing efforts to improve mathematics instruction, research reveals persistent challenges in fostering students' analytical reasoning and critical thinking skills. Lestari et al. (2020) observed that many students struggle to apply problem-solving strategies effectively in academic and professional contexts.

This issue is particularly evident in the Philippines. Gonzales (2023) reported that Filipino students rank among the lowest in reading, mathematics, and science performance. Alarmingly, only 19% of students demonstrate basic proficiency in mathematics, while 81% fall below this level. According to Santisteban and Futalan (2024), many students struggle to understand complex mathematical and scientific concepts, often resorting to rushed problem-solving attempts without fully grasping fundamental principles. This lack of foundational understanding hinders the development of critical thinking and systematic problem-solving skills. Moreover, the Organization for Economic Cooperation and Development (OECD, 2020) emphasized the vital role of problem-solving skills in future success, echoing Rahman's (2019) assertion that acquiring broad knowledge across disciplines is essential for developing life-ready skills.

In response to these challenges, the Negros Oriental Division Mathematics Core Team, led by the Education Program Supervisor in Mathematics, has implemented the PS-ELANS (Problem Solving–Enriching Literacy and Numeracy Skills) program across Grades 1 to 12. This initiative supports Sustainable Development Goal (SDG) 4: Quality Education, specifically Target 4.6, which aims to ensure that all youth and a significant proportion of adults, both men and women, achieve literacy and numeracy. The PS-ELANS program directly addresses learning deficiencies identified in the 2022 Early Grade Mathematics Assessment (EGMA), which revealed high failure rates in problem-solving among Grades 1 to 3 students, particularly in areas such as word problems, subtraction, addition, and missing numbers (EOSY-NLRP, 2022). By systematically targeting these gaps, the program aims to enhance mathematical proficiency and critical thinking, fostering lifelong learning and future employability (SDG Target 4.4).

Therefore, this research explored the impact of students' engagement with the PS-ELANS program on their literacy and numeracy skills, prior mathematical achievements, and problem-solving performance. By examining the relationship between students' problem-solving competency and academic achievement, the study aims to contribute to evidence-based educational strategies that support inclusive and equitable quality education (SDG Target 4.5). As mathematics educators, the researchers believe in equipping students with theoretical knowledge and practical problem-solving abilities—skills essential for academic success, career readiness, and lifelong learning, which are key pillars of Sustainable Development Goal 4.

2.0 Methodology

2.1 Research Design

The study employed a quantitative research approach using descriptive-correlational and comparative designs. It is descriptive because the researchers identified (a) the perceived proficiency of students in their problem-solving strategies, (b) the students' performance in problem-solving based on PS-ELANS, and (c) their prior achievement in the Math subjects. It is correlational since the following were determined: (a) the relationship between the extent of students' proficiency in the enumerated problem-solving strategies and their performance in problem-solving based on PS-ELANS; and (b) the relationship between the students' prior achievement and their performance in problem-solving based on PS-ELANS. Moreover, the study is comparative, as it aimed to identify differences in students' performance in problem-solving based on PS-ELANS when grouped according to their profiles.

2.2 Research Locale

The study was conducted in Manjuyod Districts 1 and 2, specifically in the Senior High School Departments of Manjuyod National Senior High School, Manjuyod Science High School, Kauswagan High School, Sampiniton Provincial Community High School-DOADM, and Panciao High School. These schools are located within the municipality of Manjuyod, Negros Oriental, a second-class municipality with a population of 44,799 based on the 2020 census. These schools have a stable electricity and water supply, ensuring a conducive learning environment that supports effective teaching and learning processes. Additionally, internet connectivity in all schools facilitates research-based learning, allowing teachers and students to access online educational resources, implement digital interventions, and engage in real-time data reporting. This accessibility strengthens the study's relevance, as technological tools enable the exploration and implementation of innovative numeracy interventions to address learning deficiencies.

2.3 Research Participants
The study respondents were randomly selected Grade 11 students of Manjuyod Districts 1 and 2 during the school year 2023-2024. Out of a total population of 554 students, only 250 were selected as representatives using the systematic sampling technique, wherein every second student on the list was chosen as a respondent. Yamane's formula was used to determine the sample size of 250 representatives.

2.4 Research Instrument
The questionnaire used in this study was self-developed; however, the researchers consulted various resources, including similar studies and existing questionnaires, to shape its structure and content. Part I of the questionnaire included a disclosure statement, which acted as the respondents' informed consent. Part II gathered demographic information from students, such as sex, family monthly income, and parents' educational attainment. Part III evaluated students' perceived proficiency in problem-solving strategies.

The researchers reviewed various articles to develop ten problem-solving strategies and their indicators. Meanwhile, students' prior achievements were determined based on their Math grades from Grade 7 to Grade 11. These grades were obtained from Form 10 or the students' permanent records. The researchers secured parental consent and sought guidance from the school registrar for data retrieval. The entire questionnaire was presented to three experts in the field of mathematics to verify content validity and whether the items aligned with the study's specific problems. The researchers considered the experts' corrections and suggestions for improving the questionnaire's items. Furthermore, the researchers conducted a dry run with 30 selected students who were not part of the study's respondents. Cronbach's Alpha Coefficient test was used to determine the reliability of each item. This test was regarded as the most suitable for survey research, where items were not scored as right or wrong, and each item could have different answers.

2.5 Data Gathering Procedure
Following the design hearing, the researchers integrated all revisions and recommendations from the panel members. A formal request letter to conduct the study was forwarded to the Public Schools District Supervisors of Manjuyod Districts 1 and 2, endorsed by the Dean of the Graduate School at Foundation University. Indorsement letters were then forwarded to the office of the Schools Division Superintendent of Negros Oriental for approval. Once the letter was signed and approved, it was sent to the principals of each participating school. Subsequently, the researchers presented the approved request to the teachers. During the distribution, the researchers explained the purpose and significance of the research to the students. Questionnaires were collected immediately after completion. Upon retrieval, the data were compiled, analyzed using Jamovi software, and interpreted accordingly.

2.6 Ethical Considerations
Several ethical considerations guided the study. First, informed consent was essential from the parents of students (if they were minors) and from school authorities. This ensured that the participants understood the purpose, procedures, and potential risks associated with the research. Confidentiality measures, such as using codes or pseudonyms and securely storing data to protect the identities and sensitive information of the participants, were strictly observed. Participants were assured of voluntary participation and the right to withdraw at any time without consequences. The researchers secured parents' consent letters to use students' permanent records. The researchers minimized potential harm by conducting non-invasive procedures and ensuring participants' emotional and psychological well-being throughout the study. Fairness and equity were maintained, and any form of discrimination was avoided. Participants were given access to the study's findings to promote transparency and accountability.

3.0 Results and Discussion
3.1 Students' Perceived Proficiency in Problem-Solving
In terms of Trial and Error
The data in Table 1 indicates that students generally rate their problem-solving proficiency through trial and error as average, with a composite mean of 2.76. This suggests that while students recognize trial and error as a viable strategy, they may not demonstrate high confidence or mastery in applying it effectively.

Table 1. *Students' Perceived Proficiency in Problem-Solving in terms of Trial and Error (n=250)*

	I am proficient in…	$\bar{x}$	VD	SD
1.	identifying the problem.			
	(I can clearly identify what the problem is.)	2.71	Average	0.77
2.	generating possible solutions.			
	(I come up with multiple potential solutions to the problem.)	2.70	Average	0.88
3.	implementing a solution.			
	(I choose one of the possible solutions and implement it.)	2.75	Average	0.92
4.	observing and evaluating.			
	(I check whether the problem is resolved or if there are many improvements.)	2.84	Average	1.03
5.	analyzing the outcome			
	(I determine whether the solution was successful.)	2.92	Average	1.01
6.	iterating			
	(I discard the unsuccessful solution.)	2.73	Average	1.03
	(I modify the solution based on the insights gained.)	2.84	Average	0.91
	(I try a different solution from the list or create a new one.)	2.91	Average	0.97
7.	refining the approach.			
	(I refine my approaches and make more informed choices in subsequent attempts.)	2.59	Less Proficient	0.87
	Composite	**2.76**	**Average**	**0.92**

Note: 4.21–5.00, Very Proficient (VP); 3.41–4.20, Proficient (P); 2.61–3.40, Average (A); 1.81–2.60, Less Proficient (LP); 1.00–1.80, Not Proficient (NP)

This finding aligns with those of Setiawan (2020) and Pascual and San Pedro (2018), who identified that students generally perceive themselves as having average proficiency in problem-solving when utilizing trial-and-error strategies. The data indicate that students exhibit average proficiency in analyzing the outcome ($\bar{x}$ = 2.92) and trying a different solution or creating a new one ($\bar{x}$ = 2.91). This signifies that while they can assess their problem-solving strategies and make adjustments, their ability to do so is not highly developed. Their moderate proficiency in these areas implies that they recognize the importance of reflection and adaptability in problem-solving but may still struggle with fully optimizing their approaches. These findings correspond with the statements of Setiawan (2020), Pascual and San Pedro (2018), and Chen et al. (2024) that students demonstrate an average ability to analyze the results of their attempted solutions and are willing to modify or create new approaches when initial attempts fail.

Analyzing outcomes is a crucial aspect of effective problem-solving, as it enables individuals to evaluate the effectiveness of their strategies and make necessary adjustments. Chiu et al. (2022) maintained that students often face difficulties in this area, resulting in repeated mistakes and inefficient strategies. On the other hand, the results also revealed the lowest mean score, which is observed in "refining the approach" ($\bar{x}$ = 2.59), indicating that students are less proficient in this area. This could mean students face challenges in making more informed decisions during subsequent attempts. This result supports Reinhard et al. (2022), who found that students often struggle with refining their approaches in subsequent problem-solving attempts. The table indicates that standard deviations range from 0.77 to 1.03, suggesting that students' responses are relatively consistent. However, this observation contrasts with the findings of Amalina and Vidákovich (2023), who emphasized the variability in students' problem-solving skills. Their study revealed that while some students exhibited confidence and proficiency, others encountered significant challenges.

In terms of Mathematical Models

Table 2 presents students' perceived proficiency in problem-solving using mathematical models across various components. The findings indicate that students are generally less proficient in applying mathematical models, as reflected in the composite mean 2.51. This implies they may struggle with formulating, solving, interpreting, validating, and communicating mathematical models to solve problems effectively. Their lower proficiency in this area could indicate difficulties translating real-world situations into mathematical representations or utilizing mathematical structures to analyze and solve problems systematically.

This trend is consistent with Corrêa's (2021) finding that students often manage the early stages of mathematical modeling, such as identifying measurable components, but struggle with later phases, including validating models and communicating results. Similarly, Anhalt et al. (2018) noted that difficulties in interpreting problems, performing arithmetic operations, and effectively communicating solutions can hinder students' ability to validate models and convey results accurately.

Table 2. *Students' Perceived Proficiency in Problem-Solving in terms of Mathematical Models (n=250)*

	I am proficient in…	$\bar{x}$	VD	SD
1.	Formulating the model.			
	(I can determine what needs to be measured or calculated.)	2.66	Average	0.83
	(I can simplify the problem by making reasonable assumptions.)	2.49	Less Proficient	0.79
	(I can determine the mathematical relationships between variables.)	2.43	Less Proficient	0.80
2.	Solving the models.			
	(I can decide on the techniques required to solve the model.)	2.50	Less Proficient	0.77
	(I can execute the chosen methods to find solutions.)	2.55	Less Proficient	0.83
3.	Interpreting the results			
	(I can evaluate the solutions obtained from the mathematical models.)	2.52	Less Proficient	0.83
4.	Validating the model.			
	(I can assess the accuracy and reliability of the model.)	2.44	Less Proficient	0.85
	(I can modify the model to better align with observed data.)	2.48	Less Proficient	0.75
5.	Communicating the result.			
	(I can clearly communicate the results and insights gained from the model.)	2.58	Less Proficient	0.78
	(I can provide recommendations or solutions based on the model.)	2.47	Less Proficient	0.82
	Composite	**2.51**	**Less Proficient**	**0.81**

Note: 4.21–5.00, Very Proficient (VP); 3.41–4.20, Proficient (P); 2.61–3.40, Average (A); 1.81–2.60, Less Proficient (LP); 1.00–1.80, Not Proficient (NP)

The standard deviations across individual items range from 0.75 to 0.85, indicating that students' proficiency perceptions are relatively consistent. This proposes that most students share similar self-assessments regarding their problem-solving abilities, with minimal variation in responses. The low dispersion further reinforces the reliability of the findings, as it reflects a general agreement among students about their perceived proficiency levels.

In terms of Algorithmic Thinking

Table 3 presents the results on students' perceived proficiency in problem-solving using algorithmic thinking. Proficiency is measured across two main components: clarifying the problem and planning the solution. The composite mean of 2.54 shows that students generally lack proficiency in applying algorithmic thinking to problem-solving.

Table 3. *Students' Perceived Proficiency in Problem-Solving in terms of Algorithmic Thinking (n=250)*

	I am proficient in…	$\bar{x}$	VD	SD
1.	clarifying the problem.			
	(I can identify the inputs, and the desired outputs.)	2.60	Less Proficient	0.81
	(I can divide the problem into smaller, more manageable sub-problems.)	2.45	Less Proficient	0.82
2.	planning the solutions.			
	(I can select the most appropriate method and outline the steps.)	2.55	Less Proficient	0.81
	Composite	**2.54**	**Less Proficient**	**0.81**

Note: 4.21–5.00, Very Proficient (VP); 3.41–4.20, Proficient (P); 2.61–3.40, Average (A); 1.81–2.60, Less Proficient (LP); 1.00–1.80, Not Proficient (NP)

Stephens and Kadijevich (2020) emphasized that algorithmic thinking involves a deeper cognitive process, highlighting students' challenges in developing critical thinking skills. Santisteban and Futalan's (2024) findings further support these difficulties. This finding also coincides with Ibrahim (2024), who reported that students perceive themselves as having lower proficiency in algorithmic thinking than in other computational thinking dimensions. The data also emphasize the need for further intervention to improve students' proficiency in algorithmic thinking. In support of this, Chen et al. (2020) found that students who received training in algorithmic thinking demonstrated enhanced performance in solving word problems. A composite standard deviation of 0.81 signifies that while most students share a similar perception of their problem-solving proficiency, there is still some variation in their proficiency levels. This could imply differences in students' exposure to algorithmic problem-solving strategies, varying levels of mathematical background, or differing experiences in applying these skills.

In terms of Guess and Check

The data in Table 4 indicate that students perceive themselves as having an average proficiency in problem-solving using the "Guess and Check" strategy, as evidenced by the composite mean of 2.79. A closer look at the findings reveals that students demonstrate an average competence in three key aspects of the strategy: making an initial guess, checking the accuracy of the guess, and identifying and correcting errors.

Table 4. *Students' Perceived Proficiency in Problem-Solving in terms of Guess and Check (n=250)*

	I am proficient in…	$\bar{x}$	VD	SD
1.	making initial guess.			
	(I can make an initial guess based on intuition, prior knowledge, or any patterns observed.)	2.66	Average	0.94
	(I write down the guess for reference to avoid repeating the same guess.)	2.70	Average	0.96
2.	checking the guess.			
	(I check if the guess satisfies all conditions and constraints of the problem.)	2.75	Average	0.95
3.	identifying errors.			
	(If the guess is incorrect, I analyze why it failed.)	2.94	Average	0.93
	Composite	**2.79**	**Average**	**0.94**

Note: 4.21–5.00, Very Proficient (VP); 3.41–4.20, Proficient (P); 2.61–3.40, Average (A); 1.81–2.60, Less Proficient (LP); 1.00–1.80, Not Proficient (NP)

These components all fall within the mean range of 2.61 to 3.40, reinforcing that students engage in guess-and-check approaches but may not fully optimize their guessing strategies to reach efficient solutions. Similar to the trial-and-error problem-solving strategy, research by Chen et al. (2024) suggests that there is another efficient strategy for solving complex problems aside from guess and check. These findings support Capraro et al. (2012), who found that students often make systematic mistakes when applying the guess-and-check method. Similarly, Johanning (2010) noted that while students use this strategy frequently, they often do so without a clear structure, making it less effective. Barham (2020) also pointed out that guessing and checking help students understand problems, but they should lead to more structured strategies. In addition, the standard deviations range from 0.93 to 0.96, suggesting that students' self-assessed proficiency levels show high consistency.

In terms of Working Backwards

The results in Table 5 indicate that students perceive themselves as less proficient in using the working backwards strategy, with a composite mean of 2.53. Among the indicators, students demonstrated average proficiency in documenting each step ($\bar{x}$ = 2.65), suggesting that they can somewhat record the steps they take when working backward to solve a problem. However, they rated themselves less proficient in identifying key steps backward ($\bar{x}$ = 2.45) and explaining their solutions ($\bar{x}$ = 2.47), signifying that they struggle with breaking down complex problems into structured, logical steps when solving them in reverse. This suggests that while students may attempt to use this strategy, they may not fully understand how to apply it effectively in problem-solving situations.

Table 5. *Students' Perceived Proficiency in Problem-Solving in terms of Working Backwards (n=250)*

	I am proficient in…	$\bar{x}$	VD	SD
1.	identifying key steps backward.			
	(I can identify the immediate step that would lead directly to the end state.)	2.45	Less Proficient	0.77
	(I can determine the prerequisites needed for the step.)	2.50	Less Proficient	0.79
2.	documenting each step.			
	(I write down each step as I trace it backward to ensure clarity and accuracy.)	2.65	Average	0.98
3.	explaining the solution.			
	(I can write a clear explanation of how the solution was derived using the working backward strategy.)	2.47	Less Proficient	0.87
	Composite	**2.53**	**Less Proficient**	**0.88**

Note: 4.21–5.00, Very Proficient (VP); 3.41–4.20, Proficient (P); 2.61–3.40, Average (A); 1.81–2.60, Less Proficient (LP); 1.00–1.80, Not Proficient (NP)

Correspondingly, Chen et al. (2024) claimed that students often fail to establish clear connections between the steps involved in backward reasoning. Teachers could provide more guided exercises focusing on logical sequencing and structured explanations to enhance proficiency in this area. Gurat (2018) further affirmed that students often struggle with identifying key steps in problem-solving processes, particularly in breaking down problems into manageable parts and determining the sequence of steps needed to reach a solution. Meanwhile, the variation in standard deviations, spanning from 0.77 to 0.98, reflects minimal dispersion in students' perceived proficiency.

In terms of Pattern Recognition

The findings in Table 6 on the next page suggest that students perceive themselves as less proficient in pattern recognition, with a composite mean of 2.52. This indicates that they struggle to identify and apply patterns effectively in problem-solving situations. They have low proficiency levels across all indicators, such as recording observations, analyzing data, applying hypotheses, and generalizing patterns.

Table 6. *Students' Perceived Proficiency in Problem-Solving in terms of Pattern Recognition (n=250)*

	I am proficient in…	$\bar{x}$	VD	SD
1.	recording observations. *(I document any noticeable patterns, regularities, or anomalies in the examples.)*	2.52	Less Proficient	0.85
2.	analyzing the data. *(I can examine the collected data to identify commonalities, trends, or repeated elements.)*	2.48	Less Proficient	0.84
3.	applying hypotheses. *(I can test the identified patterns or rules on new examples to see if they hold true.)*	2.53	Less Proficient	0.84
4.	generalizing the pattern. *(I can develop a general based on the identified patterns.)*	2.54	Less Proficient	0.85
	Composite	**2.52**	**Less Proficient**	**0.85**

Note: 4.21–5.00, Very Proficient (VP); 3.41–4.20, Proficient (P); 2.61–3.40, Average (A); 1.81–2.60, Less Proficient (LP); 1.00–1.80, Not Proficient (NP)

One possible explanation for these findings is that students may lack sufficient practice in pattern recognition techniques, which are crucial for developing problem-solving skills in mathematics. Additionally, weak analytical skills may hinder their ability to identify recurring structures or relationships, making applying learned patterns to new problems challenging. The above findings align with Alharbi et al. (2023), who found that students often fail to extract relevant information from datasets, leading to ineffective pattern recognition and incorrect problem-solving approaches. Susanti et al. (2024) backed this up. They found that their respondents faced challenges in identifying and generalizing patterns during problem-solving tasks, indicating a lower perceived proficiency in pattern recognition. The data further reflect a standard deviation range of 0.84 to 0.85, indicating that students generally share similar perceptions of problem-solving proficiency.

In terms of Collaborative Problem-Solving

Table 7 shows that students perceive themselves as having an average proficiency in collaborative problem-solving. Explicitly, they display an average proficiency in facilitating a structured discussion, monitoring progress, gathering feedback, and identifying the lessons learned, as evident in the mean values ranging from 2.61 to 3.40.

Table 7. *Students' Perceived Proficiency in Problem-Solving in terms of Collaborative Problem Solving (n = 250)*

	I am proficient in…	$\bar{x}$	VD	SD
1.	facilitating a structured discussion. *(I can encourage active listening and respectful dialogue.)*	2.82	Average	0.88
2.	selecting the best solution. *(I can work on my own, collaborate effectively, and choose the most promising solution.)*	2.55	Less Proficient	0.89
3.	monitoring progress. *(I can regularly monitor progress and make adjustments as needed to stay on track.)*	2.62	Average	0.88
4.	gathering feedback. *(I can collect feedback to understand the effectiveness of the solution.)*	2.85	Average	0.88
5.	identifying lessons learned. *(I can identify what worked well and what could be improved for future collaborative efforts.)*	2.82	Average	0.91
	Composite	**2.73**	**Average**	**0.89**

Note: 4.21–5.00, Very Proficient (VP); 3.41–4.20, Proficient (P); 2.61–3.40, Average (A); 1.81–2.60, Less Proficient (LP); 1.00–1.80, Not Proficient (NP)

This suggests they are fairly comfortable reflecting on group work and integrating feedback, as Acquandoh et al. (2022) and Klang et al. (2021) emphasized in their studies, a positive impact on collaborative learning on students' problem-solving performance. However, the lowest-rated indicator was selecting the best solution ($\bar{x}$ = 2.55), implying that students struggle with independently choosing the most effective method in solving mathematical problems. This concern might be due to students' inability to connect prior knowledge to the situation. This finding aligns with Yurtseven et al. (2021), who found that students frequently struggle with decision-making processes and problem-solving strategies, reinforcing that they may need further support in evaluating and selecting solutions. Additionally, Nuñez (2021) found that students in the Philippines often feel less confident in making decisions, particularly when faced with complex or multi-step problems.The data also indicate that the standard deviations fall between 0.88 and 091. This means the students' self-evaluations on proficiency levels are relatively stable and uniform.

In Terms of Use of Heuristics

Table 8 shows that students are less proficient in problem-solving using heuristics in general, as reflected in the mean score of 2.45. The results indicate students' challenges in selecting appropriate heuristics, applying them effectively, and evaluating generated solutions, as shown by the mean values ranging from 2.29 to 2.50.

Table 8. *Students' Perceived Proficiency in Problem-Solving in terms of Use of Heuristics (n = 250)*

	I am proficient in…	$\bar{x}$	VD	SD
1.	selecting appropriate heuristics. *(I can assess whether the chosen heuristics are suitable given the problem's context and constraints.)*	2.45	Less Proficient	0.91
2.	applying heuristics. *(I can break down the problem into smaller, more manageable parts using the chosen heuristics.)*	2.29	Less Proficient	0.94
3.	evaluating and testing solutions. *(I can evaluate the feasibility of each proposed solution generated by applying heuristics.)*	2.50	Less Proficient	0.73
	Composite	**2.45**	**Less Proficient**	**0.86**

Note: 4.21–5.00, Very Proficient (VP); 3.41–4.20, Proficient (P); 2.61–3.40, Average (A); 1.81–2.60, Less Proficient (LP); 1.00–1.80, Not Proficient (NP)

These findings imply that students may not have received sufficient guidance in recognizing, selecting, and applying heuristic strategies. The low proficiency in heuristic application suggests that students rely heavily on rote memorization rather than strategic thinking. These findings align with De Leon (2021) and Zimmerman and Schunk (2001), who reported that many students often fail to apply heuristics systematically, leading to inefficient problem-solving. Similarly, Apostol (2017) found that students struggle with the systematic application of heuristics, reinforcing De Leon's (2021) findings that students perceive themselves as less proficient in selecting and implementing heuristic approaches. Moreover, this finding supports Hashemi et al. (2019), who observed that students faced difficulties applying problem-solving steps as an initial entry point for deriving a solution, highlighting their challenges in using heuristics effectively. Additionally, a standard deviation range of 0.73 to 0.91 indicates that students generally share similar perceptions of their problem-solving proficiency.

In terms of Visualization

The results in Table 9 reveal that students are less proficient in using visualization as a problem-solving strategy, with a composite mean of 2.52. They are particularly less proficient in sketching initial visuals, developing detailed visuals, identifying and explaining insights, and brainstorming and executing solutions, as evident in the mean values ranging from 2.47 to 2.60.

Table 9. *Students' Perceived Proficiency in Problem-Solving in terms of Visualization (n = 250)*

	I am proficient in…	$\bar{x}$	VD	SD
1.	sketching initial visuals. *(I can start with rough sketches to lay out the basic structure of the visualization.)*	2.48	Less Proficient	0.91
2.	developing detailed visuals. *(I can create detailed and accurate visual representations of the problem and its components.)*	2.48	Less Proficient	0.84
3.	identifying insights. *(I can identify key insights and areas that require further investigation or action.)*	2.50	Less Proficient	0.80
4.	brainstorming solutions. *(I can use the visualization to brainstorm potential solutions and strategies.)*	2.60	Less Proficient	0.94
5.	executing the solution. *(I can implement the chosen solution, using the visualization as a guide.)*	2.57	Less Proficient	0.89
6.	explaining insights. *(I can provide a clear explanation of the insights gained from the visualizations.)*	2.47	Less Proficient	0.77
	Composite	2.52	Less Proficient	0.86

Note: 4.21–5.00, Very Proficient (VP); 3.41–4.20, Proficient (P); 2.61–3.40, Average (A); 1.81–2.60, Less Proficient (LP); 1.00–1.80, Not Proficient (NP)

The composite mean of 2.52 implies that students generally consider themselves less proficient in using visualization as a problem-solving tool. The result implies that students may not have received sufficient training or practice in using visual tools like diagrams, mind maps, or flowcharts in solving problems, which resulted in challenges in the visualization problem-solving strategy. These findings align with Mudaly and Narriadoo (2023), who found that weak visualization skills contribute to misinterpreting word problems and difficulties structuring solutions. Similarly, a study by Moeller et al. (2013) revealed that while students are generally comfortable with visual strategies, they often require guidance and practice to maximize their potential in idea generation. Likewise, Francisco (2021) found that Filipino students have moderate confidence in visualization strategies and recommended teacher-led interventions to enhance their visual brainstorming skills further. A similar finding is evident in the study of Asamoah (2022), which affirmed that students often struggle to explain the insights they derive from visual data representations, underscoring the need for explicit instruction and structured practice to improve idea generation. Meanwhile, the observed standard deviations, which range from 0.77 to 0.94, imply that students' perceptions of their proficiency remain relatively consistent across different items.

In terms of Metacognitive Strategies

Table 10 shows students' perceived proficiency in problem-solving using metacognitive strategies. With a composite mean of 2.71, students perceive themselves as having an average proficiency in metacognitive strategies. Their highest-rated skill is staying motivated ($\bar{x}$ = 2.99), indicating they can maintain focus and perseverance when solving problems. They also demonstrate an average proficiency in tracking progress ($\bar{x}$ = 2.63) and assessing outcomes ($\bar{x}$ = 2.63), suggesting they can monitor their performance and evaluate their problem-solving effectiveness. However, they are less proficient in choosing strategies ($\bar{x}$ = 2.60), implying that they struggle with selecting the most appropriate approach to problem-solving.

Table 10. *Students' Perceived Proficiency in Problem-Solving in terms of Metacognitive Strategies (n = 250)*

	I am proficient in…	$\bar{x}$	**VD**	**SD**
1.	choosing strategies. *(I can decide on the strategies and resources I will use to tackle the problem.)*	2.60	Less Proficient	0.85
2.	tracking progress. *(I can keep track of my progress and make notes of what is working and what is not.)*	2.63	Average	0.90
3.	assessing outcomes. *(I can evaluate the results of my problem-solving efforts and determine if the goals are met.)*	2.63	Average	0.90
4.	staying motivated. *(I can keep myself motivated and reminding myself of the importance of solving the problem.)*	2.99	Average	1.17
	Composite	**2.71**	**Average**	**0.95**

Note: 4.21–5.00, Very Proficient (VP); 3.41–4.20, Proficient (P); 2.61–3.40, Average (A); 1.81–2.60, Less Proficient (LP); 1.00–1.80, Not Proficient (NP)

This finding aligns with Gasayme (2024), who highlighted students' difficulty determining which strategies are most effective for different problems. Similarly, Torres and Peralta (2020) found that while students excel in self-monitoring and self-evaluation, they struggle to select appropriate problem-solving approaches. Moreover, the composite standard deviation value of 0.95 indicates that students' self-assessed proficiency levels are relatively stable across various items.

Summary Table of the Students' Perceived Proficiency in Problem-Solving

The overall findings in Table 11 indicate that students perceive themselves as having average proficiency, with a composite mean of 2.61 across all problem-solving strategies. The highest-rated strategies were guess and check ($\bar{x}$=2.79); trial and error ($\bar{x}$=2.76), and collaborative problem-solving ($\bar{x}$=2.73), suggesting that students are more comfortable with approaches that allow for experimentation, teamwork, and iterative problem-solving. In contrast, the lowest-rated strategies were the use of heuristics ($\bar{x}$=2.45), the use of mathematical models ($\bar{x}$=2.51), and pattern recognition and visualization ($\bar{x}$=2.52), indicating difficulties in applying structured mathematical reasoning and visual problem-solving techniques.

Table 11. *Summary Table of the Students' Perceived Proficiency in Problem-Solving (n = 250)*

	Variables	$\bar{x}$	**VD**	**SD**
1.	Trial and Error	2.76	Average	0.92
2.	Use of Mathematical Models	2.51	Less Proficient	0.81
3.	Algorithmic Thinking	2.54	Less Proficient	0.81
4.	Guess and Check	2.79	Average	0.94
5.	Working Backwards	2.53	Less Proficient	0.88
6.	Pattern Recognition	2.52	Lee Proficient	0.85
7.	Collaborative Problem Solving	2.73	Average	0.89
8.	Use of Heuristics	2.45	Less Proficient	0.86
9.	Visualization	2.52	Less Proficient	0.86
10.	Metacognitive Strategies	2.71	Average	0.95
	Overall	**2.61**	**Average**	**0.88**

Note: 4.21–5.00, Very Proficient (VP); 3.41–4.20, Proficient (P); 2.61–3.40, Average (A); 1.81–2.60, Less Proficient (LP); 1.00–1.80, Not Proficient (NP)

These results suggest that students have some confidence in exploratory problem-solving methods but may need additional support in structured and systematic strategies. Strengthening their ability to use heuristics, mathematical models, and visualization techniques could improve their problem-solving proficiency. Furthermore, the consistency in standard deviation values (0.81 to 0.95) reflects minimal variation in students' perceived proficiency across different problem-solving aspects.

3.2 Summary Table of the Students' Performance in Problem-Solving

Table 12 presents the distribution of students' performance in problem-solving, as assessed by the PS-ELANS with a total sample size of 250 students. It shows that 20 students (8%) are in the outstanding level, achieving ratings between 90% and 100%. This represents a small portion of the total student population but highlights a group that excels in problem-solving. Very satisfactory performances are evident in 102 students (40.80%) with ratings ranging from 80% to 89%. Moreover, 69 students (27.60%) obtained a failing rating of 74% or below. These students did not meet the minimum problem-solving standards.

Table 12. *Performance of the Students in Problem Solving Based on PS-ELANS*

Rating	Verbal Description	Frequency	Percent	$\bar{x}$	Standart Deviation
90% - 100%	Outstanding	20	8.00		
85% - 89%	Very Satisfactory	36	14.40		
80% - 84%	Satisfactory	66	26.40	78.80	7.93
75% - 79%	Fairly Satisfactory	59	23.60		
74% and Below	Did Not Meet Exp.	69	27.60		
Total		**250**	**100**		

This result is congruent with Santisteban and Futalan's (2024) findings, which indicate that a significant number of students face challenges in effectively applying problem-solving skills in real-world scenarios. The overall problem-solving performance of students, with a rating of 78.80%, falls within the satisfactory category, indicating that students possess the minimum knowledge and skills in problem-solving and require support throughout the process (DepEd Order No. 73, s. 2012). The standard deviation of 7.93 suggests a high variation in students' performance, meaning that while most students scored around the average, some performed significantly higher or lower. This variability highlights differences in students' problem-solving skills.

3.3 Relationship between the Students' Perceived Proficiency in Problem-Solving Strategies and Performance in Problem-Solving

Table 13 highlights the significant correlation (all p-values < α = 0.05) between students' perceived proficiency in problem-solving strategies and their problem-solving performance based on PS-ELANS. All strategies show positive relationships, indicating that students who effectively utilize these strategies perform better in problem-solving.

Table 13. *Correlation between the Students' Perceived Proficiency in Problem-Solving Strategies and Performance in Problem Solving based on PS-ELANS (n = 250)*

Problem Solving based on PS-ELANS and…	r_s	p	Decision	Remark
Trial and Error	0.324	<.001	Reject H_{o1}	Significant
Use of Mathematical Models	0.354	<.001	Reject H_{o1}	Significant
Algorithmic Thinking	0.300	<.001	Reject H_{o1}	Significant
Guess and Check	0.319	<.001	Reject H_{o1}	Significant
Working Backwards	0.410	<.001	Reject H_{o1}	Significant
Pattern Recognition	0.348	<.001	Reject H_{o1}	Significant
Collaborative Problem Solving	0.357	<.001	Reject H_{o1}	Significant
Use of Heuristics	0.288	<.001	Reject H_{o1}	Significant
Visualization	0.411	<.001	Reject H_{o1}	Significant
Metacognitive Strategies	0.332	<.001	Reject H_{o1}	Significant
Overall	**0.393**	**<.001**	**Reject H_{o1}**	**Significant**

Spearman's Rank Order Correlation at 0.05 Level of Significance

The relationship between problem-solving strategies and performance has been widely studied. He et al. (2019) emphasized that students' problem-solving proficiency is closely linked to their ability to effectively apply strategic approaches, reinforcing the significant correlations in this study. Similarly, Wismath et al. (2015) found that self-assessed proficiency in problem-solving strategies, including trial and error, was associated with actual problem-solving performance, supporting the observed correlation (rs=0.324) between trial and error proficiency and performance.

In terms of mathematical models, Santos et al. (2015) demonstrated that incorporating mathematical modeling into instruction significantly improved students' problem-solving abilities. This aligns with the finding that students' perceived proficiency in using mathematical models (rs=0.354) is positively correlated with their actual performance. Likewise, Veerasamy et al. (2018) found that algorithmic thinking contributes to higher academic performance, supporting the significant relationship (rs = 0.300) observed in this study.

The effectiveness of the guess-and-check strategy is highlighted by Hohensee and Lobato (2022), who found that students' success with this approach depends on their reasoning skills and problem context. This aligns with the present study’s findings (rs=0.319), emphasizing the importance of refining students' strategic reasoning. Additionally, Shabrina et al. (2022) demonstrated that explicit instruction in working backwards improves problem-solving outcomes, supporting the strong correlation (rs=0.410) between perceived proficiency in this strategy and actual performance.

Pattern recognition is another crucial component of problem-solving. Braun et al. (2024) and Rizos and Gkrekas (2024) found that students with strong pattern recognition skills tend to perform better in problem-solving tasks, reinforcing the observed correlation (rs=0.348) in this study. Similarly, collaborative problem-solving (rs=0.357) was shown by Wismath et al. (2015) to enhance students' confidence in their problem-solving abilities, while Saadati and Reyes (2019) found that students who engaged in collaborative problem-solving activities demonstrated improved performance and more positive attitudes toward mathematics.

Wakhata et al. (2024) explored the impact of students' perceptions toward problem-solving, finding that positive perceptions of problem-solving strategies enhanced actual performance. However, Kaitera and Harmoinen (2022) noted that a gap often exists between students’ self-perceived proficiency and actual abilities, emphasizing better alignment between perception and skill application. Visualization (rs = 0.411) also plays a vital role in problem-solving. Şahinkaya et al. (2023) found that students who utilized visual aids in problem-solving demonstrated improved performance, reinforcing the present study’s findings. Lastly, Reinhard et al. (2021) and Abdelshiheed et al. (2023) highlighted that fostering metacognitive awareness enhances problem-solving proficiency, supporting the significant correlation (rs = 0.332) between perceived proficiency in metacognitive strategies and performance in this study.

3.4 Prior Achievement of the Students in Mathematics

Table 14 provides an overview of students’ prior achievements in Mathematics across Grades 7 to 11, showing a consistent improvement as students advance in the higher year levels.

Table 14. *Prior Achievement of the Students in Mathematics (n = 250)*

Grade Level	Content Areas	$\bar{x}$	VD	SD
Grade 7	Number and Number Sense, Algebra, Geometry, Statistics and Probability	82.79	S	5.25
Grade 8	Number and Number Sense, Algebra, Geometry, Statistics and Probability	84.30	S	4.87
Grade 9	Adv. Algebra, Geometry and Trigonometry	85.57	VS	4.23
Grade 10	Advanced Topics in Algebra and Statistics	86.14	VS	4.43
Grade 11	General Mathematics and Statistics	85.57	VS	5.18
Overall		**84.87**	**VS**	**4.79**

Note: 90%-100%, Outstanding (O); 85%-89%, Very Satisfactory (VS); 80%-84%, Satisfactory (S); 75%-79%, Fairly Satisfactory (FS)

In Grade 7, students achieved a mean score of 82.79, with a verbal description of "Satisfactory" and a standard deviation (SD) of 5.25. This indicates an adequate level of proficiency in Mathematics but reflects varying performance levels within the cohort, as seen in the relatively high SD. By Grade 8, students slightly improved, achieving a mean score of 84.30, still within the "Satisfactory" range, but with a narrower SD of 4.87, suggesting more consistent performance in Mathematics. The transition to Grade 9 marked a significant improvement, with students attaining a mean score of 85.57 and moving into the "Very Satisfactory" (VS) category. This improvement reflects a growing mastery in Mathematics, with less variation in performance as evidenced by an SD of 4.23. This positive trajectory continues into Grade 10, where students achieved the highest mean score of 86.14, maintaining the "Very Satisfactory" rating. The SD of 4.43 indicates a sustained level of consistent performance in Mathematics. In Grade 11, students maintained their "Very Satisfactory" performance with a mean score of 85.57, similar to their Grade 9 performance. However, the slightly higher SD of 5.18 points indicates some variability in their grasp of Mathematics, specifically in General Mathematics and Statistics.

Overall, the mean score across all grade levels is 84.87, classified as "Very Satisfactory," with an SD of 4.79. This overall performance highlights a steady improvement from Grade 7 to Grade 11, reflecting enhanced proficiency and understanding as students progress through more advanced mathematical content.

Recent studies and literature provide valuable insights into students' prior achievement in mathematics, supporting the observed trends in the presented data in Table 4. A local study by Cardino and Ortega-Dela Cruz (2020) revealed that consistent mastery of basic mathematical skills in earlier years, such as General Mathematics, leads to better proficiency in advanced topics like Algebra, Geometry, and Trigonometry. This aligns with the observed improvement from a "Satisfactory" rating in Grade 7 to "Very Satisfactory" ratings in higher grades. The study supports the upward trend in the data, indicating that students' ability to handle complex mathematical topics strengthens as they progress through higher grades.

On a broader scale, the PISA 2018 Results (OECD, 2020) found that students who excel in foundational mathematics tend to perform better in advanced topics because of their ability to connect earlier concepts to more complex ones. This mirrors the gradual improvement in the presented data, showing students progressing from a "Satisfactory" performance in Grade 7 to a "Very Satisfactory" level by Grade 10. Similarly, the National Council of Teachers of Mathematics (NCTM) (2021) reported that consistent progress in foundational topics in earlier grades leads to enhanced performance in advanced mathematics. This aligns with the upward trend in the data, where improved performance in Algebra and Geometry in Grade 8 prepares students for Trigonometry and Statistics in Grades 9, 10, and 11. Furthermore, Zhang et al. (2022) studied mathematics achievement in East Asia and concluded that students' performance significantly improves when foundational concepts are well-taught and mastered. Their findings reflect the progression from "Satisfactory" to "Very Satisfactory" performance levels in the presented data, highlighting the cumulative nature of mathematical learning. These studies highlight the importance of foundational knowledge and effective instructional strategies in enhancing students' mathematical achievement. The increasing trends in the data align with these findings, demonstrating that prior achievement and consistent learning significantly contribute to success in advanced mathematical topics.

3.5 Relationship between the Prior Achievement of the Students and Performance in Problem Solving

The results in Table 15 unveil the relationship between students' prior achievement and their performance in problem-solving based on PS-ELANS. The r-coefficients (>0.5) and p-values (<.001) indicate a strong and positive relationship between the prior achievements of the students from Grade 7 to Grade 11 and their performance in problem solving based on PS-ELANS results. This connotes that prior mathematical knowledge is a crucial predictor of success in problem-solving tasks. Students who performed well in mathematics in previous grades tend to have better problem-solving skills as assessed by PS-ELANS. This further signifies that sustained focus on mathematical proficiency in earlier grades is pivotal to enhancing problem-solving skills.

Table 15. *Correlation between the Prior Achievement of the Students and Performance in Problem Solving based on PS-ELANS (n=250)*

Problem Solving based on PS-ELANS and Math in…		**r**	**p**	**Decision**	**Remark**
Grade 7	Number and Number Sense, Algebra, Geometry, Statistics and Probability	.61	<.001	Reject H_{o2}	Significant
Grade 8	Number and Number Sense, Algebra, Geometry, Statistics and Probability	.58	<.001	Reject H_{o2}	Significant
Grade 9	Advanced Algebra, Geometry and Trigonometry	.64	<.001	Reject H_{o2}	Significant
Grade 10	Advanced Topics in Algebra and Statistics	.65	<.001	Reject H_{o2}	Significant
Grade 11	General Mathematics and Statistics	.68	<.001	Reject H_{o2}	Significant
Overall		**.70**	**<.001**	**Reject H_{o2}**	**Significant**

Pearson Product-Moment Correlation at 0.05 Level of Significance

This trend is reinforced by local and international studies, highlighting the cumulative impact of early mathematics proficiency on later academic success. A local study by Amador et al. (2020) on Filipino junior high school students confirms that mastery of foundational skills in algebra and geometry strongly predicts performance in advanced topics such as trigonometry and statistics. Similarly, Birgin and Peker (2024) indicate that many students struggle with basic algebraic concepts, including number sense, which negatively impacts their ability to solve polynomials, linear equations, and systems of equations (Yap, 2019; Gari & Malonisio, 2023; Tadios, 2023; Salde, 2013). These studies collectively emphasize that consistent mastery of basic mathematical skills in earlier years helps students build confidence, leading to improved performance in more complex mathematical concepts (Tadios, 2023; Garcia & Cruz, 2020; Fennema & Sherman, 2019).

International research further supports this correlation between foundational mathematics skills and later success. Fennema and Sherman (2019) highlight the importance of early mathematical proficiency, aligning with the increasing correlation values observed from Grade 7 to Grade 11 in Table 15. Additionally, a study by Nguyen et al. (2022) in Vietnam revealed a clear link between substantial prior achievements in algebra and geometry and superior performance in advanced mathematics. This regional perspective underscores the universal importance of a solid mathematical foundation as a critical building block for solving more advanced problems. These findings align with Vygotsky's Zone of Proximal Development (ZPD), which suggests that students build upon their earlier mathematical understanding to tackle increasingly challenging problem-solving scenarios. This is evident in the progressively stronger correlations across grade levels, emphasizing the importance of structured, scaffolded learning in mathematics education.

3.6 Difference in the Performance of the Students in Problem-Solving when Grouped according to Profile

Table 6 examines the influence of profile variables such as sex, income, and parents' educational attainment on students' problem-solving performance. The results reveal no significant difference between male and female students ($p = 0.686$), indicating that sex is not a determinant of problem-solving ability.

Table 6. *Difference in the Performance of the Students in Problem-Solving based on PS-ELANS when Grouped according to Their Profile (n = 250)*

Variables	$\bar{x}$	n	Comp.	p	Decision	Remark
Sex			**t-value**			
Male	77.80	142	0.404	0.686	Fail to reject H_{o4}	Not significant
Female	80.00	108				
Income			**F-value**			
(1) <12,030 (Poor)	76.80	144	23.60	<.001	Reject H_{o4}	Significant
(2) 12,030 – 24,060 (Low Income)	80.00	76				
(3) 24,061 – 48,120 (Lower Mid. Income)	85.40	30				
	Post Hoc Analysis (Games-Howell)					
	(1) vs. (2); p = 0.009 (significant)					
	(1) vs. (3); p <.001 (significant)					
	(2) vs. (3); p <.001 (significant)					
Educational Attainment of the Mothers						
(1) Elem Level/Grad	77.20	101	4.96	0.008	Reject H_{o4}	Significant
(2) HS Level/Grad	79.00	102				
(3) College Level/Grad.	81.70	47				
	Post Hoc Analysis (Games-Howell)					
	(1) vs. (2); p = 0.221					
	(1) vs. (3); p = 0.007 (significant)					
	(2) vs. (3); p = 0.155					
Educational Attainment of the Fathers						
(1) Elem Level/Grad	77.20	116	7.03	0.001	Reject H_{o4}	Significant
(2) HS Level/Grad	79.20	99				
(3) College Level/Grad.	83.00	35				
	Post Hoc Analysis (Games-Howell)					
	(1) vs. (2); p = 0.153					
	(1) vs. (3); p = 0.002 (significant)					
	(2) vs. (3); p = 0.054					

t-test for independent Data and ANOVA at 0.05 Level of Significance

This finding aligns with Santisteban and Futalan (2023), who found no significant association between students' sex and thinking skills in real-life problem-solving. However, existing literature presents mixed results regarding gender differences in problem-solving abilities (Acquandoh et al., 2022; Berrington & Roberts, 2019). Moreover, income level emerged as a significant factor ($p < .001$) in students' problem-solving ability. Post-hoc analysis reveals that poor-income students ($\bar{x} = 76.80$) perform lower than low-income and lower middle-income students ($\bar{x} = 80.00$ and 85.40, respectively). This finding aligns with previous research highlighting the impact of socioeconomic status on mathematical problem-solving skills (Sagario et al., 2023; Amalina & Vidákovich, 2023; Osadebe & Oghomena, 2018). Students from higher-income families often have greater access to quality educational resources, such as private tutoring, advanced learning materials, and technology, which enhance their problem-solving abilities. They also attend schools with better infrastructure, experienced teachers, and lower student-to-teacher ratios, all contributing to improved academic performance.

Similarly, Fryer and Levitt (2020) found that socioeconomic factors significantly influence cognitive development and academic achievement. Children from wealthier backgrounds are more likely to receive early exposure to numeracy skills, parental guidance, and structured learning environments, giving them an advantage in mathematical reasoning. In contrast, students from lower-income families may face challenges such as limited access to supplementary learning materials, financial stress, and reduced parental involvement due to work obligations, which can hinder their mathematical proficiency. However, McFarland et al. (2018) observed that high- and low-income students exhibited similar proficiency levels in most mathematical functions, suggesting that other factors, such as school quality and available learning resources, also play a role. This indicates that while income level is important, it is not the sole determinant of mathematical achievement.

The table also shows that students whose parents had higher educational attainment performed significantly better than those whose parents had only completed elementary education. This finding supports Shaheen and Awan (2020), who reported that students with highly educated mothers performed better in problem-solving tasks. As emphasized by Spruijt et al. (2020), mothers with higher education tend to create a stimulating home learning environment, fostering their children's educational engagement and study habits. A similar trend is observed for fathers, where students whose fathers had higher educational attainment also performed better. According to Rumberger and Lim (2020), parental education is a strong predictor of academic success, as it often correlates with greater access to resources, parental encouragement, and a conducive home learning environment. Spruijt et al. (2020) also highlighted that parents who ask thought-provoking questions and encourage critical thinking can help their children develop strong problem-solving skills.

4.0 Conclusion

The results of this study unveil the significance of foundational mathematical skills and the continuous enhancement of these skills to prepare students for higher mathematical courses and real-world problem-solving. Strong primary mathematical skills—such as number sense, arithmetic fluency, pattern recognition, and logical reasoning—are the bedrock for more advanced problem-solving strategies. Strengthening these fundamental skills early ensures students build confidence and competence in tackling complex mathematical challenges.

While students demonstrate competence in intuitive and collaborative approaches, their struggles with structured problem-solving strategies reveal mathematical reasoning and analytical thinking, necessitating early intervention and ongoing skill reinforcement. A solid grasp of basic mathematical principles enables students to develop structured approaches to problem-solving, fostering a deeper understanding of mathematical concepts rather than relying on rote memorization or intuition alone.

Moreover, the study highlights the influence of income and parental educational attainment on students' problem-solving performance. Educators must bridge learning gaps and provide all students with resources and opportunities to develop strong problem-solving abilities, starting with a firm foundation in essential mathematical skills. Addressing these differences contributes to more effective learning outcomes and greater academic success for students across different backgrounds. As John Dewey emphasized, "Give the pupils something to do, not something to learn; and the doing is of such a nature as to demand thinking." Thus, to improve students' problem-solving skills, educators must first ensure the mastery of primary mathematical skills and engage students in hands-on tasks that require active thinking rather than passive learning.

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The authors confirm the equal contribution in each part of this work. All authors reviewed and approved the final version of this work.

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All authors declare that they have no conflicts of interest.

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