

Assessing 7th-Grade Students' Math Problem-Solving Skills Using Polya's Method

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Abstract. The current state of education presents numerous challenges, with students' academic performance showing signs of decline, particularly in core subjects such as mathematics and English. This study aimed to assess the problem-solving ability of 7th-grade students using Polya's Method and examine its relationship to their prior academic performance in Mathematics and English. It also sought to determine differences in students' performance when grouped according to sex. The researcher employed a descriptive-correlational and comparative research design, utilizing a cluster sampling technique to identify 229 respondents. Validated test questions were used to assess students' problem-solving abilities. Data were analyzed using percentages, t-test for independent samples, and Pearson Product-Moment Correlation Coefficient. The findings revealed that students' prior academic performance in both Mathematics and English was generally very satisfactory. However, their problem-solving ability was only satisfactory in understanding the problem, poor in devising a plan, and very poor in executing the plan and reflecting on it. No significant relationship was found between Mathematics performance and any of the problem-solving steps. In contrast, English performance showed a weak but significant correlation with the "Carrying Out a Plan" stage. Additionally, female students outperformed males in academic subjects, though no significant difference was found in problem-solving ability between the sexes. A significant gap was revealed between students' academic success and their actual ability to apply problem-solving strategies effectively, as indicated by the results of this study. It also highlights the need for instructional strategies that go beyond rote memorization and focus on cognitive and metacognitive development. Reinforcing literacy and analytical thinking across disciplines, particularly through explicit teaching of problem-solving strategies, can better prepare students to engage with complex, real-world challenges. The results also support inclusive intervention strategies, as problem-solving difficulties affect both sexes equally, regardless of academic performance.

Keywords: Carrying out the plan; Devising a plan; Looking back; Polya's method; Problem-solving ability; Understanding the problem.

1.0 Introduction

Mathematics is a discipline that equips students with the fundamental knowledge necessary to become critical and analytical thinkers (Judijanto et al., 2024). To achieve these skills, students must acquire strong problem-solving abilities (Yapatang & Polyiem, 2022; Daulay & Ruhaimah, 2019). Rahman (2019) emphasized that problem-solving is indispensable to human life and crucial for survival. It helps increase students' mathematics achievement and equips them with the skills essential for navigating complex real-world challenges. However, global studies indicate that the quality of mathematics education and students'

problem-solving abilities pose a risk to maintaining established standards in mathematics education. For instance, the Programme for International Student Assessment (PISA) results often reveal a significant disparity in problem-solving competencies among students from different countries, highlighting a gap between high-performing and low-performing regions. These discrepancies can be attributed to factors such as socioeconomic status, quality of teaching, and access to educational resources (OECD, 2019), which significantly impact certain developing countries, particularly those in Southeast Asia.

In the context of the Philippines, the National Achievement Test (NAT) results consistently reflect low proficiency levels in mathematics, particularly in problem-solving, with the national average mean percentage score (MPS) of 37.44 for Grade 6 and 29.66 for Grade 10 (Añar et al., 2023). The 2018 PISA results revealed that the Philippines ranked second-to-last in mathematics based on average country scores (Department of Education, 2019). Moreover, the traditional emphasis on rote memorization rather than conceptual understanding further impedes the development of critical problem-solving skills (Nilimaa, 2023). In support of this, Lapuz and Fulgencio (2020) found, in their study on improving students' critical thinking skills, that learners' critical thinking skills are low and still require improvement.

There is a need to investigate the capacity of grade 7 students to apply structured problem-solving methods, specifically Polya's, as this is their foundational year, and the skills they acquire will define their performance in the succeeding levels. With this, Dailo and Dailo (2022) explored the impact of differentiated instruction on Grade 7 critical thinking; however, they did not assess each stage of Polya's method in math problem-solving. Similarly, another study by Siregar and Amir (2024) demonstrated the formulation of problems related to critical thinking, but it lacked a focus on cognitive development specific to 7th graders. Furthermore, Malibiran et al. (2019) examined factors such as gender and academic achievement in problem-solving; however, their study failed to associate prior performance in Math and English at every stage of Polya's method. These studies may be related to problem-solving; however, they did not cover the specific areas that are precisely addressed in this current study. It is in this regard that the heart of this study is centered.

These gaps highlight the importance of assessing how 7th-grade students at Bayawan National High School apply Polya's method, analyzing links between prior academic performance in Mathematics and English, and exploring the impact of gender on problem-solving and academic success. Polya's method, with its focus on systematic thinking and reflection, is valuable for identifying students' strengths and weaknesses in problem-solving. The study's findings could inform educational practices and curriculum design, leading to effective strategies for improving students' problem-solving skills. Furthermore, the study responds to Sustainable Development Goal 4 (Quality Education), which advocates for inclusive and equitable quality education and the promotion of lifelong learning opportunities for all, particularly by enhancing learners' problem-solving competencies essential for navigating 21st-century challenges.

2.0 Methodology

2.1 Research Design

The researcher utilized the descriptive-correlational and comparative methods. It is descriptive because it examined students' prior academic performance in mathematics and English, as well as their problem-solving ability. It is correlational because it identified the relationship between students' prior academic performance and their problem-solving ability. Additionally, it is comparative, as students were grouped by sex, and their academic performance and problem-solving ability were compared across these groups.

2.2 Research Locale

The study was conducted in one of the public and largest schools in Bayawan City, Negros Oriental, located in the southern part of the province, and also known as the "City of Character." This study specifically focused on 7th-grade students from the school. Bayawan National High School caters to a diverse student body from both urban and rural communities. The school is recognized for its dedication to delivering accessible and high-quality education, in line with the Department of Education's mission to foster lifelong learning and academic excellence. This school is located in Barangay Villareal, Bayawan City, Negros Oriental. It has one principal, 105 teachers, and six non-teaching staff, ensuring a supportive and resourceful learning environment.

2.3 Research Participants

This study involved randomly selecting 7th-grade students enrolled in the school year 2024-2025 from Bayawan City National High School. The sample was selected using cluster sampling, where the population was divided into 14 sections of 7th-grade students. From each section, a sample of students was chosen using proportionate sampling, meaning the number of students selected from each section matched its size relative to the total population of 560 students. This ensured fair representation of each section, with a total of 229 students chosen. The sample size was calculated using Raosoft Sample Size Online Calculator, an open-source tool to ensure statistical adequacy. By combining cluster sampling and proportionate sampling, the researcher ensured that the sections were fairly represented, and the sample within each section was in line with the overall population.

2.4 Research Instrument

The researcher used an adapted questionnaire consisting of the following parts: Part I was a disclosure statement, which provided adequate evidence of informed consent from the students. Part II gathered information on the students' profiles in terms of sex and prior academic performance in Mathematics and English. Part III contained word problems adapted from the *MathCounts Textbook* by Jeanette Hilot, explicitly focusing on the topics of "Percentage Increase" and "Percentage Decrease," as these had already been covered in the first quarter of the school year. The reliability and validity of the research instrument were carefully addressed to ensure the accuracy and credibility of the results. A mathematics teacher with a doctoral degree and research background reviewed the questionnaire to validate its content. Content validity was supported by the fact that the word problems were adapted from a textbook already aligned with the curriculum. The expert also ensured that the items were developmentally appropriate for Grade 7 students and aligned with the four stages of Polya's problem-solving method. To further establish reliability, the expert computed the Cronbach's alpha coefficient, which confirmed the instrument's internal consistency. Additionally, a scoring rubric adopted from the work of Roxan Dayao was used to evaluate student responses systematically. Each of Polya's steps was assigned a maximum of five points, with deductions applied for missing or incorrect information. This rubric, combined with structured data analysis using Microsoft Excel, helped ensure consistent scoring and minimized bias, thereby supporting the overall reliability of the instrument.

2.5 Data Gathering Procedure

A formal letter, endorsed by the Dean of the Graduate School at Foundation University, was sent to the Schools Division Superintendent of Bayawan City, Negros Oriental and the principal of Bayawan National High School, requesting permission to conduct the study. The signed letter of endorsement from the office of the Schools Division Superintendent and the School Principal was presented to the 7th-grade Mathematics teacher, and the researcher explained the testing that would be conducted on the 7th-grade students, as well as the purpose and importance of the study. Upon agreement between the researcher and the math teachers, parents' consent was distributed to the students and collected on the day of the testing, with their parents' and/or guardians' signatures, ensuring their awareness of their children's participation in the testing. The researcher conducted the assessment during the mathematics period of every section. Finally, the researcher checked and interpreted the students' responses using the rubrics and MS Excel.

2.6 Data Analysis Procedure

The researcher employed several tools for data analysis, including the use of percentages to present the profile of the students in terms of sex and academic performance in mathematics and English. Additionally, the mean was also used to determine the students' ability in problem-solving using Polya's method. The t-test for independent data was utilized to identify whether there is a difference between the students' (a) academic performance in mathematics and English, and (b) ability in problem-solving using Polya's method when grouped according to sex. Lastly, the Pearson product-moment correlation coefficient was used to determine whether a significant relationship exists between students' academic performance in mathematics and English and their ability in problem-solving using Polya's method. The researcher analyzed the students' computational ability using scales. Each stage was equivalent to five points, and a one-point deduction was made for every missing information.

2.7 Ethical Considerations

The researcher strictly adhered to all ethical standards throughout the study. Before data collection, formal approval was obtained from the relevant authorities, and the study was conducted in full compliance with the ethical guidelines established by the Ethics Committee of Foundation University. All participants were provided with a disclosure statement outlining the study's objectives, the voluntary nature of their participation, and their right to withdraw at any time without consequence. Informed consent was obtained from all respondents before they participated in the survey. To ensure the protection of personal information, confidentiality was consistently maintained, and all collected data were used solely for research purposes. These measures were implemented to uphold the integrity of the study and protect the rights and well-being of the participants.

3.0 Results and Discussion

3.1 Prior Academic Performance of the Students in Mathematics and English

Table 1 presents the students' prior academic performance in mathematics and English. The data show that most students perform at a "Very Satisfactory" level in Mathematics (46.72%) and an "Outstanding" level in English (38.86%). In terms of average scores, the mean for mathematics is 86.26 with a standard deviation of 4.59, while for English, the mean is 87.27 with a standard deviation of 5.47. These results indicate that students generally performed well in both subjects. The lowest category, "Fairly Satisfactory," had the fewest students in both subjects, suggesting that the majority achieved at least a satisfactory level of academic performance.

Table 1. *Prior Academic Performance of the Students in Mathematics and English*

Rating	Verbal Description	Mathematics				English			
		f	%	$\bar{x}$	SD	f	%	$\bar{x}$	SD
90-100	Outstanding	49	21.40	86.26	4.59	89	38.86	87.27	5.47
85-89	Very Satisfactory	107	46.72			70	30.57		
80-84	Satisfactory	60	26.20			49	21.40		
75-79	Fairly Satisfactory	13	5.68			21	9.17		
Total		229	100			229	100		

These findings suggest that students demonstrate an understanding of key concepts in both Mathematics and English, and actively participate in activities that contribute to their academic achievement in these areas. They also suggest a solid foundational competence and active engagement in academic activities, supporting Singh's (2021) assertion that academic achievement reflects not only comprehension but also learners' cognitive involvement. Similarly, Nurudeen et al. (2024) emphasized that strong performance in core subjects is a predictor of readiness for higher-order cognitive tasks. These results support the claim by Roslan and Chen (2023), who found that high levels of prior achievement in language and mathematics predict students' performance in problem-solving assessments, particularly when they are exposed to well-structured instructional environments. Furthermore, Lopez (2023) found that students with higher English proficiency tended to have better mathematics competency, indicating a positive correlation between the two subjects. This suggests that students who perform well in English are also likely to excel in Mathematics, reinforcing the notion of overall satisfactory academic performance in both areas. However, despite the relatively high scores observed in this sample, Ambasa and Tan (2022) noted that Filipino students continue to struggle with problem-solving, especially when tasks deviate from textbook examples. This claim suggests that high academic grades may not always accurately reflect deeper cognitive competencies, such as critical thinking and complex problem-solving.

Regarding the standard deviation, despite the very satisfactory overall performance, the relatively higher standard deviation in English suggests greater variability in how students engage with language skills compared to Mathematics. A study by Pham et al. (2025) suggests that language acquisition and literacy development often require different cognitive processes than those involved in numeracy, which may help explain the broader range of English performance. Since English is more verbally and contextually based, students' proficiency may be influenced by a wider array of factors, including reading habits, family background, and exposure to diverse linguistic environments (Guthrie & Wigfield, 2020). As Shanta and Wells (2022) argue, fostering such skills requires the integration of structured problem-solving strategies and authentic assessment tasks that challenge students to apply knowledge in unfamiliar and complex contexts.

3.2 Extent of Students' Ability in Problem-Solving Using the Steps in Polya's Method

Table 2 presents the students' problem-solving abilities, as assessed by Polya's four-step approach, across three problems. The results show that students scored highest in "Understanding the Problem," with an overall mean of 2.72, rated as "Satisfactory." However, scores declined in the subsequent steps. "Devising the Plan" is rated "Poor" ($\bar{x} = 1.50$), while both "Carrying Out the Plan" and "Looking Back" are rated "Very Poor," with mean scores of 1.26 and 1.24, respectively. These findings suggest that while students are generally able to comprehend what a problem requires, they struggle significantly with planning, implementing strategies, and reflecting—critical components of effective problem-solving.

Table 2. *Extent of Students' Ability in Problem-Solving Using the Steps in Polya's Method*

Polya's 4 Steps	Problem1		Problem 2		Problem 3		Overall	
	$\bar{x}$	VD	$\bar{x}$	VD	$\bar{x}$	VD	$\bar{x}$	VD
Understanding the Problem	3.70	VG	2.56	S	1.89	P	2.72	S
Devising the Plan	2.08	P	1.33	VP	1.10	VP	1.50	P
Carrying Out a Plan	1.59	P	1.15	VP	1.05	VP	1.26	VP
Looking Back	1.49	VP	1.16	VP	1.09	VP	1.24	VP

Note: 5 (Very Good, VG); 4 (Good, G); 3 (Satisfactory, S); 2 (Poor, P); 1 (Very Poor, VP)

These results align with the findings of Arfiana and Wijaya (2018), who observed that students often leave responses blank or provide incorrect answers, particularly in the execution and reflection phases. Similarly, studies by Gulam and Arenas (2024) and Ilonga and Ogbonnaya (2024) support the observation that students face the most significant difficulties during the "Looking Back" stage, which indicates limited metacognitive skills and a lack of self-reflection. Furthermore, Korkmaz et al. (2024) and Shanta and Wells (2022) emphasized that although understanding the problem is essential, many students fail to transition effectively into the planning and execution phases—an issue confirmed by the present study.

Moreover, Vidad and Quimbo (2023) analyzed students' performance across Polya's four stages, and they discovered that learners encountered the most difficulty when devising a plan and executing it systematically. The study emphasized the need for differentiated instruction to guide students in formulating effective solutions and reflecting on their processes. Similarly, Sauro (2024) demonstrated that the absence of strong learning strategies and metacognitive practices impairs students' ability to navigate complex problems, especially in STEM contexts. These studies affirm that students' struggles in problem-solving stem not from a lack of comprehension but from underdeveloped skills in planning, strategic execution, and reflection.

Despite students performing well in math and English, as indicated in Table 1, their problem-solving skills remain low. This contrast may stem from the DepEd grading system, which considers written outputs, performance tasks, and periodic assessments (Selorio, 2024). Pascua and Dulos (2020) suggested that strong academic performance may also result from the combined support of teachers and parents in both classroom and home learning environments. Consolidating the evidence, emphasis on explicit instruction and reinforcement of all stages of Polya's problem-solving method was provided. By adopting this method, educators can better equip students to engage in deeper cognitive processing, ultimately enhancing their ability to apply problem-solving strategies in diverse and complex contexts.

3.3 Relationship between the Students' Prior Academic Performance in Mathematics and English and Their Problem-Solving Ability Using Polya's Method

Table 3 examines the correlation between students' academic performance in Mathematics and English and their problem-solving. The results indicate no significant relationship between Mathematics performance and any of the problem-solving steps, as all p-values exceed the 0.05 significance level. However, a significant correlation was found between English performance and the "Carrying Out a Plan" step ($r = 0.185$, $p = 0.005$). This suggests that students with stronger English skills may be somewhat more capable of executing problem-solving strategies, likely due to better reading comprehension and communication abilities.

Table 3. Relationship between the Students' Prior Academic Performance and Their Problem-Solving Ability Using Polya's Method

Variables	r	p	Decision	Remark
Math and...				
Understanding the Problem	0.060	0.367	Fail to Reject H_{01}	Not significant
Devising the Plan	0.075	0.261	Fail to Reject H_{01}	Not significant
Carrying Out a Plan	0.116	0.081	Fail to Reject H_{01}	Not significant
Looking Back	0.103	0.119	Fail to Reject H_{01}	Not significant
English and...				
Understanding the Problem	0.032	0.627	Fail to Reject H_{01}	Not significant
Devising the Plan	0.075	0.256	Fail to Reject H_{01}	Not significant
Carrying Out a Plan	0.185	0.005	Reject H_{01}	Significant
Looking Back	0.126	0.058	Fail to Reject H_{01}	Not significant

This significant relationship supports the findings of Jala (2020) and Timario (2020), who linked higher English proficiency, particularly in reading comprehension, with improved problem-solving skills. Students with a stronger command of English can better understand and interpret word problems, enabling them to translate textual information into appropriate mathematical operations. Likewise, Cabansag (2024) identified a strong connection between Grade 10 students' reading comprehension and problem-solving skills, highlighting the importance of English language competency in understanding and handling complex problems. Additionally, Umunna (2023) noted that integrating problem-solving strategies into instruction enhances students' reading comprehension, which also leads to improved academic performance, revealing a simultaneous development between linguistic competence and strategic thinking.

Despite the relatively high academic performance reported in Table 1, students continue to face difficulties in applying their knowledge to real-world problem-solving tasks. This observation aligns with the studies of Futral and Santisteban (2024) and Djudin (2023), who argued that academic grades do not always accurately reflect students' actual problem-solving abilities. These findings underscore the importance of instructional strategies that extend beyond content mastery and prioritize the development of students' cognitive and metacognitive skills, including analytical thinking, logical reasoning, and reflective learning.

3.4 Difference in the Students' Academic Performance in Mathematics and English and Problem-Solving Abilities when Grouped According to their Sex

Table 4 explores differences in academic and problem-solving performance between male and female students. The data show that female students perform significantly better than their male counterparts in both mathematics ($\bar{x} = 87.82$ vs. 86.25 , $p = 0.008$) and English ($\bar{x} = 86.85$ vs. 85.17 , $p = 0.037$), as indicated by statistically significant t-test results. However, no significant difference was found in problem-solving abilities between the two groups ($p = 0.408$), with males scoring a mean of 1.73 and females 1.66 . This suggests that although females tend to outperform males academically in these subjects, both sexes demonstrate similarly low levels of problem-solving skills. These findings are consistent with Mullis et al. (2020), who reported that female students generally perform better in academic subjects. In contrast, Capinding and Ducut (2021) found that males tend to achieve higher academic performance, highlighting that gender-related academic differences may vary depending on context.

Table 4. Difference in the Students' Academic Performance and Problem-Solving Abilities when Grouped According to Their Sex

Variables	n	$\bar{x}$	t	p	Decision	Remark
Mathematics						
Male	81	86.25	2.683	0.008	Reject H_{02}	Significant
Female	148	87.82				
English						
Male	81	85.17	2.103	0.037	Reject H_{02}	Significant
Female	148	86.85				
Problem-Solving Abilities						
Male	81	1.73	0.830	0.408	Fail to Reject H_{02}	Not significant
Female	148	1.66				

t-test for independent data at 0.05 Level of Significance

The absence of a significant difference in problem-solving skills supports the conclusions of Ocak, Doğruel, and Tepe (2021) and Futalan and Santisteban (2024), who reported no meaningful relationship between gender and cognitive abilities related to problem-solving. This suggests that while gender may influence academic achievement, it does not necessarily impact students' ability to engage in complex cognitive tasks, such as structured problem-solving.

4.0 Conclusion

The study's findings reveal a notable gap between students' academic achievements and their ability to solve problems effectively. Despite their strong performance in mathematics and English, this proficiency did not consistently translate into successful problem-solving, especially in the advanced stages of Polya's method. This suggests that strong grades alone are not reliable indicators of students' ability to think critically or apply their knowledge in unfamiliar contexts.

The results also point to a potential overemphasis on procedural learning and assessment, which may prioritize correct answers over strategic thinking and reflective reasoning. The lack of a strong correlation between mathematics grades and problem-solving abilities suggests that conventional assessments may be emphasizing rote memorization rather than fostering adaptable problem-solving skills. Conversely, the correlation between English performance and the "carrying out a plan" phase suggests that comprehension and interpretative skills—central to language learning—play a crucial role in implementing problem-solving strategies, highlighting the cross-disciplinary value of literacy. It emphasizes the compelling need for reinforcing students' literacy and numeracy skills, which are critical to closing learning gaps and equipping them with the ability to question, reason, and confidently navigate future complex challenges. Ultimately, these skills are not only confined to mathematics or language subjects but are vital across all content areas.

The absence of significant sex-based differences in problem-solving ability—despite the academic advantage observed among female students—reinforces the notion that challenges in problem-solving are not confined to a specific sex but instead are experienced universally. This reinforces the need for instructional approaches that explicitly develop cognitive strategies rather than relying solely on content mastery.

5.0 Contributions of Authors

The authors confirm their equal contribution to every part of this research. All authors reviewed and approved the final version of this paper.

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7.0 Conflict of Interests

This study has no conflict of interest of any sort.

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