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Enhancing The Problem-Solving Skills Of Grade 11 Students In Mathematical Word Problems Using Polya's Four-Step Method

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Abstract

This study focused on enhancing the problem-solving skills of grade 11 students in mathematical word problems using Polya's four-step method with the aim of developing the problem-solving skills of students in order to improve their performance. It also looked into the challenges met by the students in problem-solving using Polya's four-step method. Fifty grade 11 students of Buan Technical Integrated High School were the participants of the study. The mixed methods type of research was used in the study where a researcher made questionnaire was used to determine the effectiveness of Polya's four-step method in problem solving. Moreover, a pre-test and post-test assessment was given to determine the performance of the students. The researcher also conducted interviews to identify the difficulties encountered by the students in solving word problem using Polya's four-step method.

Based on the findings of the study, it was found out that the Polya's four-step method is effective in enhancing problem solving skills of grade 11 students in mathematical word problems. The students showed improvement in the result of post assessment after the utilization of intervention. However, students encountered difficulties in solving word-problems in terms of little knowledge on the use of mathematical terms, time limits and absence of confidence.

Based on the findings, it has been recommended that the mathematics teachers convene and come up with particular learning strategies that will be used among the learners to boost their skills in learning problem-solving. Teachers may also be encouraged to develop learning materials in Mathematics particularly on area where most learners encounter difficulty.

Keywords: *Problem-solving skills, Grade 11 students, Mathematical Word Problems, Polya's Four-Step Method.*

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Introduction

Mathematics plays a vital role in developing learners' critical thinking, logical reasoning, and real-life problem-solving skills. However, many students struggle with mathematical word problems due to difficulties in comprehension, analysis, and application of appropriate strategies. In the Philippine context, low performance in national and international assessments highlights the need for effective instructional interventions.

Polya's Four-Step Method—understanding the problem, devising a plan, carrying out the plan, and looking back—provides a structured approach that can improve learners' problem-solving abilities. This method encourages systematic thinking and reflective learning, which are essential in Mathematics education.

Studies have shown that structured problem-solving approaches significantly improve students' mathematical performance. Research indicates that Polya's method enhances learners' ability to analyze problems, apply strategies, and evaluate solutions effectively. Additionally, problem-solving skills are essential for developing higher-order thinking and real-world application of mathematical concepts

This study aimed to assess the problem-solving skills of Grade 11 students in solving mathematical word problems through the use of Polya's Four-Step Method during the first semester of School Year 2025-2026, with the ultimate goal of enhancing their problem-solving abilities. Specifically, this study sought to answer the following questions:

1. What is the performance of the grade 11 students in the teacher-made test?
2. How may the learning of the students in problem-solving through Polya's Four Step method be described in terms of:
   2.1. understanding the problem;
   2.2. devising a plan;
   2.3. carrying out the Plan; and
   2.4. looking back to the
3. How effective is Polya's Four-Step method in enhancing the problem-solving skills of Grade 11students relative to:
   3.1. post assessment; and
   3.2. student feedback?
4. What are the difficulties encountered by the students in solving word problems using Polya's four-step method?
5. Based on the results of the study, how may the prepared learning activities be enhanced?

Methodology

Research Design

This study utilized a **mixed-method research design**, combining quantitative and qualitative approaches to provide a comprehensive analysis of students' problem-solving skills.

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Participants

The participants of the study were Grade 11 students of Bauan Technical Integrated High School (BTIHS) during the School Year 2025–2026, consists of 27 males and 23 female students. They are mostly within the 16–17-year-old age bracket. They were selected using purposive sampling.

Research Instrument

The instruments used in this study included a 30-item teacher-made test administered as both pre-test and post-test, a validated questionnaire using a four-point Likert scale, and an interview guide to gather qualitative data.

Data Collection Procedure

The data collection procedure began with securing formal permission from the school principal to conduct the study. Upon approval, informed consent was obtained from both the students and their parents to ensure voluntary participation. The researcher first administered the pre-test to determine the baseline level of students' problem-solving skills. This was followed by the implementation of the intervention, wherein Polya's Four-Step Method was integrated into classroom instruction over a specified period. After the intervention, the post-test was administered to measure the improvement in students' performance. Subsequently, a structured questionnaire was distributed to assess the learners' problem-solving skills and perceptions of the method. To further validate the findings, selected students participated in face-to-face interviews to provide deeper insights into their experiences and difficulties encountered during the problem-solving process. All collected data were carefully checked, recorded, and organized for analysis.

Data Analysis

The following statistical tools were employed in analyzing the data gathered from the respondents:

Frequency distribution. This was used to identify how often specific responses occurred.

Percentage. This was used to provide a clearer picture of the proportion of learners' responses to each item.

Ranking method. This was used to determine the order of importance or dominance among the identified variables.

Collectively, these tools quantified the learners' level of performance in General Mathematics and provided insights into how frequently certain problem-solving behaviors or skills were demonstrated by the participants.

Weighted Mean. This was used to compute the average response of the participants for each item in the researcher-made questionnaire. It also helped in identifying the general level of learners' problem-solving skills as they applied Polya's Four-Step Method.

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Results

Section 1: Performance of Grade 11 Students in the Teacher-made Test.

Table 1
Performance of Grade 11 Students in the Pre-Test

Score range	Level	Frequency	Percentage	Rank
28 – 30	Advanced	0	0	5
23 - 27	Proficient	5	10.00	4
16 - 22	Approaching Proficiency	6	12.00	3
9 - 15	Developing	15	30.00	2
0 - 8	Beginning	24	48.00	1
Total		**50**	**100**	

The findings indicate that the majority of the Grade 11 students scored lower than the anticipated level of numeracy in the pre-test. Almost half (48.00) became non numerate with 30.00% being developing, which implies that they had limited foundational skills. In the case of approaching proficiency (12.00) and proficient (10.00), only a limited number of them were up to average and above average. These results indicate that there are serious numeracy lapses, which indicate that a specific intervention is required to enhance the initial mathematical abilities of students.

Section 2: Description of how students solve problems using Polya's four-step method.

a. Understanding the Problem:

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Table 2
Learning Capabilities of Grade 11 Students in Problem Solving terms of Understanding the Problem

Indicators	Weighted Mean	Verbal Interpretation	Rank
1. I am able to see what is being requested well before I set out to resolve the issue.	3.26	Often	4
2. I then paraphrase the issue to make sure that the issue is understood	3.48	Often	2
3. I decide the information necessary in the problem and the information that is unnecessary.	3.36	Often	3
4. In some instances, I visualize the problem with the help of diagrams, graphs, or tables.	3.25	Often	5
5. I make sure that I have a complete grasp of all terms and symbols in the problem.	3.52	Always	1
Composite Mean	**3.38**	**Often**	

The composite mean of 3.38 and verbal interpretation of often was an indicator that the respondents' learning capability in problem solving was observable, especially during class discussions and interactions. Moreover, among the items cited, making sure that the students have a complete grasp of all terms and symbols in the problem got the highest weighted mean of 3.52. This is proof that the students have view clear understanding of mathematical terms and symbols as a key foundation for solving word problems effectively. It was followed by paraphrasing the issue to make sure that the issue is understood. with a weighted mean of 3.48. With the learning capabilities of the students, they can think of other ways to solve problems. However, visualizing the problem with the help of diagrams, graphs, or tables. ranked as the lowest and got a weighted mean of 2.53, interpreted as often. This is due to the fact that students tend to rely on numerical procedures rather than visual representations.

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b. Devising a Plan:

Table 3
Learning Capabilities of Grade 11 Students in Problem Solving terms of Devising a Plan

Indicators	Weighted Mean	Verbal Interpretation	Rank
1. I think about ways to deal with the problem before selecting a particular strategy.	3.60	Always	1
2. I attempt to create pictures, diagrams, or models to visualize my plan.	2.92	Often	5
3. I seek patterns or relationships that could bring a solution.	3.34	Often	3
4. I break down the complicated problems by first solving a simpler problem.	3.42	Often	2
5. I develop a list of potential approaches before choosing the approach to use.	3.28	Often	4
Composite Mean	**3.31**	**Often**	

It can be gleaned from the table that devising a plan is also assessed by the Grade 11 students. This is shown by a composite mean of 3.31 interpreted as Often. Among the cited items, the statement I think on ways to deal with the problem before selecting a particular strategy, got the highest weighted mean of 3.60, interpreted as Always. This is due to the fact that learners are always curious about finding other ways to solve problems. They do not stop unless they find something new and different because this excites them most of the time. It was followed by breaking down the complicated problems by first solving a simpler problem with a weighted mean of 3.42, interpreted as Often. However, the lowest mean of 2.92 and interpreted as Often was that learners attempted to create pictures, diagrams, or models to visualize my plan.

c. Carrying out the plan:

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Table 4
Learning Capabilities of Grade 11 Students in Problem-Solving in terms of Carrying out the Plan

Indicators	Weighted Mean	Verbal Interpretation	Rank
1. I observe the plan I have made systematically.	3.40	Often	4
2. My solution is broken down into steps, and I go through them to prevent mistakes.	3.46	Often	2
3. I remain concentrated and do not give up once the plan goes wrong.	3.34	Often	3
4. I make changes in my plan when I realize that the strategy I have selected is not working.	3.48	Often	1
5. My process of finding solutions is well documented.	3.06	Often	5
Composite Mean	**3.35**	**Often**	

This refers to how the Grade 11 students assessed their learning capabilities in problem-solving. Table 4 reveals the learning capabilities of the Grade 11 students in terms of carrying out a plan. It can be gleaned from the table that carrying out the plan is interpreted as Often with the composite mean of 3.35. The highest mean obtained of 3.48 is garnered by the indicator about making changes in their plan when they realize that the strategy they have selected is not working. The second on the rank got a weighted mean of 3.46, indicating that the solution is to break down into steps, and they go through them to prevent mistakes. However, the item process of finding solutions is well documented, got a weighted mean of 3.06. This was rated the lowest maybe because the learners really need to know more about how to conduct research.

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d. Looking back to the problem:

Table 5
Learning Capabilities of Grade 11 Students in Problem- Solving in terms of Looking back to the problem

Indicators	Weighted Mean	Verbal Interpretation	Rank
1. I will verify whether the solution that I have arrived at will resolve the problem presented.	3.50	Always	2
2. I check whether my performance is reasonable or practical.	3.56	Always	1
3. My solution process is reviewed to spot any potential mistakes.	3.34	Often	4
4. I ask myself whether there is a less difficult or more effective method of solving the problem.	3.44	Often	3
5. I consider the possibility of shifting some conditions of the problem.	3.32	Often	5
Composite Mean	**3.43**	**Often**	

The composite mean of 3.43 indicates that respondents' learning capability in looking back to the problem was often observed. The table reveals that the highest mean of 3.56 is garnered by the indicator that the students check whether their performance is reasonable or practical. It is important for learners to understand that reasoning is a skill that they also must possess. This helps them to become better learners. However, the least mean is computed at 3.32 by creating their own frame, like changing unfamiliar words using their own words to solve problems, interpreted as often. This is maybe because learners are still afraid to try new things. They are hesitant to experiment with something new and possible. Rank second, with a mean of 3.50, was dealing more with verifying whether the solution that they have arrived at will resolve the problem presented. It is important that when learners solve problems, they do not just focus on one solution. They have to think of other ways to solve problems.

Section 3: Effectiveness of Polya's four-step method in enhancing the problem-solving skills.
Post assessment:

Table 6
Performance of Grade 11 Students in the Post assessment

Score range	Level	Frequency	Percentage	Rank
28 – 30	Advanced	5	10.00	3
23 - 27	Proficient	25	50.00	1
16 - 22	Approaching Proficiency	16	32.00	2
9 - 15	Developing	4	8.00	4

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0 - 8	Beginning	0	0	5
Total		**50**	**100**	

According to the post-test results, the numeracy performance of the learners has significantly improved. The majority of the students (50.00) achieved the Proficient level, and (10.00) attained the advanced level. The number who were in the approaching proficient was (32.00) and only a very small number (8.00) were in developing, and none in the beginning category. These findings mean that the intervention was successful in improving the numeracy of the students.

Students' Feedback:

Table 7

Effectiveness of the Polya's Four Step method in the problem-solving skills

Indicators	Weighted Mean	Verbal Interpretation	Rank
1. It makes my interpretation of mathematical problems clear.	3.64	Very Effective	3
2. It enables me to plan my thoughts at the beginning of solving a problem.	3.60	Very Effective	5
3. It helps me to select the most appropriate approach to solving a problem.	3.68	Very Effective	1
4. I learned to be more systematic in problem-solving after following the four steps proposed by Polya.	3.62	Very Effective	4
5. I was able to verify and assess the accuracy of my responses through this technique.	3.56	Very Effective	6.5
6. I became more confident with respect to solving word problems through this technique.	3.46	Effective	8
7. I became a critical and logical thinker through this method.	3.56	Very Effective	6.5
8. I became more effective in problem-solving with the help of Polya's method.	3.66	Very Effective	2
Composite Mean	**3.60**	**Very Effective**	

The table shows that the respondents generally find the utilization of Polya's method as very effective, with a composite mean of 3.60. The third rank, with a mean of 3.64, is garnered by the indicator, wherein approach by Polya makes my interpretation of mathematical problems clear. However, the item, the method by Poyla, makes me more confident with respect to word problems got the lowest weighted mean of 3.46, interpreted as effective.

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Section 4: Difficulties encountered in solving word problems using Polya's four-step method.

Table 8
Problems Encountered in Solving Word Problems Through Polya's Four-Step Method

Indicators	Weighted Mean	Verbal Interpretation	Rank
1. I struggle with determining the problem.	2.74	Agree	4
2. I am not able to choose the right strategy or plan to solve the problem.	2.40	Disagree	6
3. I tend to miss or ignore steps in executing the plan of choice.	2.34	Disagree	7
4. I find it difficult to examine or revise their answers while solving the problem.	2.68	Agree	5
5. I have a little knowledge of the use of mathematical terms, which influences my understanding.	2.82	Agree	3
6. I feel that the time limits pose difficulties in taking all four steps in solving problems.	2.86	Agree	2
7. I am aware that the absence of confidence will result in hesitancy to use the method alone.	2.92	Agree	1
8. I do not follow the systematic approach of the Polya method.	1.84	Disagree	8
Composite Mean	**2.58**	**Agree**	

Table 8 presents the problems encountered in solving word problems through Polya's four-step method. The composite mean of 2.58 interpreted as agree indicates that the respondents encountered problems in learning Mathematics. Among the items cited, absence of confidence will result in the hesitancy to use the method alone got the highest weighted mean of 2.92. This implies that that the low confidence of students is a significant factor that influences their capacity to implement the method of Polya on their own allow them to resolve them independently. Hence, it is important to develop learners' self-confidence by directing the practiced tasks with the help of encouragement and positive feedback, so that they become more autonomous and effective in applying Polya method. The next item, which is the fact that time limits pose difficulties in taking all four steps in solving problems, got a weighted mean of 2.86. In this context, students are exposed to difficulties in fully implementing the Polya approach when they are under pressure on time. The scarcity of time does not always allow them to carefully analyze the problem, plan properly, and see their solutions. It is an indication that teachers should give learners sufficient time for problem-solving or introduce timed practice to make learners faster and more accurate in their problem-solving, without affecting understanding. Ranked third was the fact that the learners have little knowledge of the use of Mathematics, which influences their understanding. This indicates that in case of lack of knowledge on important terms, confusion and inability to implement proper procedures are likely to occur. Therefore, mathematical vocabulary should be strengthened by teachers to enhance the understanding and performance of the learners in terms of solving problems. However, the

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indicator that learners do not follow the systematic approach of the Polya method got the lowest mean of 1.84, interpreted as disagree. This means that the majority of learners always take the right procedures of the Polya method of solving problems. It implies that they have made the realization of the value of using a systematic procedure in coming up with the right solutions. It also implies that the introduction of the Polya method has been successful in initiating a systematic and rational approach to solving problems.

Section 4: Proposed Learning Activities to Enhance the Problem-Solving Skills of Grade 11 Students in Mathematics

The following learning activities are proposed based on the findings of the study, particularly the identified difficulties of the learners in understanding word problems, applying mathematical concepts, managing time, and developing confidence in using Polya's Four-Step Method. These activities aim to strengthen learners' problem-solving skills through structured, contextualized, and guided mathematical experiences. These proposed learning activities are aligned with the competencies in General Mathematics and are designed to directly address the gaps identified in the study. Through consistent implementation, these interventions are expected to further enhance the problem-solving skills of Grade 11 students and promote a deeper understanding of mathematical concepts.

Discussion

The findings indicate that Polya's Four-Step Method significantly improved students' problem-solving skills. The increase in post-test performance demonstrates the effectiveness of a structured approach in Mathematics instruction.

These results are consistent with previous studies, which emphasize that systematic problem-solving strategies enhance learners' understanding and performance. The study also highlights that while cognitive skills improved, affective factors such as confidence and motivation remain challenges.

The implications of this study suggest that teachers should integrate structured problem-solving strategies and provide sufficient practice opportunities. Additionally, addressing students' confidence and comprehension skills is essential for maximizing learning outcomes.

However, the study is limited by its small sample size and reliance on researcher-made instruments. Future studies may explore larger samples and experimental designs.

Conclusion

Based on the findings of the study, it can be concluded that Grade 11 students initially demonstrated low performance in problem-solving due to insufficient prior knowledge. While their use of Polya's Four-Step Method was generally observed, it was not consistently applied at a high level. The implementation of Polya's method significantly improved students' performance, indicating its effectiveness in enhancing problem-solving skills. However, learners still experienced difficulties related to limited understanding of mathematical terms, time

constraints, and lack of confidence. Hence, the development of enhanced learning activities grounded on these findings is essential to further strengthen students' problem-solving abilities in Mathematics.

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