

ASSESSING THE EFFECT OF POLYA'S THEORY IN IMPROVING PROBLEM-SOLVING ABILITY OF GRADE 11 STUDENTS IN SAN MARCELINO DISTRICT

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ABSTRACT : The study focused on the assessment on effect of Polya's theory in improving problem-solving ability among senior high school students in San Marcelino District. The respondents of this study were the Grade 11 Senior High School students a total of one hundred twenty from San Marcelino District. This research study employed descriptive and quasi- experimental research design. Both designs used a quantitative approach. Based on the summary of the investigations conducted, the intervention plan was developed to improve the delivery system and enhance the problem-solving ability of the students. The respondents are on their young adolescence and female. The respondents obtained a did not meet expectation descriptive rating during pre – test and fairly satisfactory after using Polya's theory. The respondents Agreed that Polya's Theory is effective improving problem solving ability in terms of understanding, planning, implanting and look back. There is a significant difference on the perception of the students on the effectiveness of Polya's theory in improving problem solving when grouped according to age and sex profile in terms of understanding; and according to age profile in terms of planning; implementing and look back. On the other hand, there is no significant difference in terms of planning when grouped according to sex. The respondents Agreed that Polya's Theory is effective improving problem solving ability in terms of understanding, planning, implanting and look back. There is a significant difference on the performance of the students before and after using Polya's solving analysis. The intervention plan was developed to improve the delivery system and enhance the problem-solving ability of the students. Based on the summary of findings and conclusions, the researcher recommended Intervention plan can be implemented to improve the delivery system and enhance the problem-solving ability of the students. Further research study may be conducted in other districts or locale for verification of results. The use of Polya theory may be encouraged during teaching and learning of mathematics in senior high school since result shows that the students' performance has improved. Mathematics teachers may be trained through intensive workshop, seminars, and in-service training on the use of Polya Problem solving model. The proposed intervention may be used in remedial classes to help the students familiarize with the theory. Intervention plan can be implemented to improve the delivery system and enhance the problem-solving ability of the students. Future researchers may use the current study as references.

KEYWORDS: *Assessing, Effect, Polya's Theory, Problem Solving Ability*

I. INTRODUCTION

Every human being will always be faced with a problem. Therefore, one of the most important skills in which knowledge and mathematical skills are applied at the highest level is problem-solving. Every student has distinct intellectual ability in this scenario. Problem solving skill might enable them to deal with various emerging challenges effectively. The development of students' problem-solving skill is one of the needs of the hour. In 2018, Filipino students ranked second lowest among 79 countries in both mathematical and scientific literacy in the Programme for International Student Assessment (PISA). Moreover, Filipinos fared worst among 58 countries in an assessment for mathematics and science for Grade 4 students, according to a study by a Netherlands-based research institution (Bernardo, 2020). The Philippines scored 297 in math and 249 in science, according to the Trends in International Mathematics and Science Study (TIMSS) 2019 by the International Association for the Evaluation of Educational Achievement (IEA). Both TIMMS and PISA measures a variety of problem-solving scenarios in mathematics, with around two-thirds of the tasks requiring students to apply and reason. Results showed low scores that denotes low problem-solving ability among Filipino students.

The Department of Education (DEPED) was alarmed by these results and convene to take necessary actions. One of the actions they conducted was to train teachers in improving problem solving ability of every student. To provide mere routine and ordinary solutions of problems emerging in the contemporary society are inadequate to accelerate rate of progress of the nation. Rather consideration of various different aspects of these multidimensional problems with creative vision leading to wide variety of solutions having novelty and high social relevance are more effective. This is possible only when learners' ability of problem solving and creativity are encouraged simultaneously (Dr. Rajib Mukhopadhyay, 2013).

One of the elements that weakens students' problem-solving ability is the practice of pupils listening to and seeing teachers solve issues without doing so themselves (Daulay & I Ruhaimah, 2019). The fact of the non-existence of face-to-face classes because of the COVID-19 pandemic worsens the situation for students, since they can only learn remotely from their own homes.

Students' dissatisfaction and competitive drive to find a precise answer hampered their capacity to fully investigate the topic at hand, causing them to overlook critical factors required to address the problem. Because of its independence and unstructured character, problem solving has sparked a passion in many pupils, which teachers should encourage (Bradshaw and Hazel, 2016).

The capacity to solve problems is a critical skill in this discipline. Students must be able to comprehend challenges that they may encounter in the actual world. Understanding the issue scenario and the methods required to make judgments, which direct individual understanding, is required for problem-solving. The majority of students read the problem incorrectly. The primary goal of mathematics education is to help pupils understand how to solve problems. Students must comprehend and understand the cognitive process or procedures to achieve the outcomes and become accustomed to solving progressively difficult difficulties while solving mathematical problems.

One of the strategies that is being adapted by the DEPED is through the integration of Polya's four-step problem-solving method. To handle every problem, a guy named George Polya devised a four-step method: understand the situation, establish a plan, carry out the plan, and look back and reflect. The approach has become a traditional way for addressing issues since it is straightforward and generalizes effectively. In reality, the strategy may be used to solve difficulties in every area of our life, not just arithmetic (Tool for the Field: Polya's Problem-Solving Method - OPEPP, 2018).

The primary purpose of this study is to determine the effects of problem-solving ability through Polya's Theory in an advanced high school mathematics class. The teacher's responsibility in this study is to provide appropriate problem-solving exercises and use appropriate questioning to guide the students in working collaboratively and individually to set up the problem so they may persevere in completing the problem.

This study intends to be published in any journal publication because it may aid in the current scenario that may be undertaken in mitigating crisis in problem solving ability among students.

II. STATEMENT OF THE PROBLEM

This study aimed to assess the effect of Polya's theory in improving problem-solving ability among senior high school students in San Marcelino District.

Specifically, this study sought to answer the following questions:

1. What is the profile of the respondents in terms of:age; sex?
2. What is the performance of the students using Polya's problem solving analysis during pre-test and post-test?
3. What is the perception of students on the effectiveness of Polya's theory in improving problem solving ability in terms understanding; planning; implementing; and look back?
4. Is there a significant difference between the perception of students on the effectiveness of Polya's theory in improving problem solving ability when grouped according to profile variables?
5. Is there a significant difference between the performance of the students using Polya's problem solving analysis?
6. What intervention plan could be implemented to improve the delivery system to enhance the problem-solving ability of the students?

III. METHODOLOGY

This research study was employed descriptive and quasi- experimental research design. Both designs will use a quantitative approach.

The researcher constructed a hypothesis after gathering data, rather than starting with one. The hypothesis is tested by analyzing and synthesizing the data. Systematic data collection necessitates the thorough selection of the units to be investigated as well as the precise measurement of each variable (RUTGERS University, 2021). The study aims to describe the perception of students about Polya's Theory. Using a Likert scale, the respondents will rate their performance using Polya's Theory.

It also aims to describe the student's problem-solving analysis. Using a rating scale, the researcher will rate the student's problem-solving analysis. It will come in four parts that corresponds to the four steps of Polya's theory. The first part is understanding the problem. The researcher will assess the respondents on how well did they understand the problem. The second part is Devising a Plan. The researcher assessed how students devise their own plan that leads to the answer of the problem. The third part is Carrying the Plan. The researcher assessed how students utilized all his/ her information to come up with a particular solution. The fourth and the last step is Looking Back. The researcher assessed the student's reflection on the last part of the process. Also, it will assess the correctness of the answer.

A quasi-experimental design, like a true experiment, tries to prove a cause-and-effect link between an independent and dependent variable. A quasi-experiment, unlike a true experiment, does not rely on random assignment. Subjects are instead divided into groups depending on non-random factors. In circumstances where true experiments are not possible due to ethical or practical considerations, quasi-experimental design is a helpful technique (Thomas, 2020). This study will employ a pre-test and posttest to reveal the effect of Polya's problem solving analysis among students.

The researcher employed purposive sampling techniques. Purposive sampling is defined as the purposeful selection of a participant based on their characteristics. Simply said, the researcher determines what information is required and sets out to discover people who can and will supply it based on their expertise or experience (Boudy et al., 2020).

The researcher used a questionnaire and a pre – test and posttest as an instrument. The questionnaire will be adopted from In'am (2014). This will help the researcher to gather information about the effects of Polya's Theory on the analysis and problem-solving skills among students. The pre-test and posttest will be instructed to measure the problem-solving ability of every respondent before and after the intervention.

IV. RESULTS AND DISCUSSION

1. Profile of the Respondents

Age. Out of one hundred twenty (120) respondents, majority or 98 or 81.67% belong to 16-18 years old group age; 20 or 16.67% belong to 22 – 24 years old group age and 1 or 0.83% belong to 19-21 years old and 25 and above years old group age. The mean age of the respondents is 17.77 years old. This means that the respondents are on their young adulthood.

Sex. Out of one hundred twenty (120) respondents, majority were females with 70 or equivalent of 58.33% while 50 or equivalent of 41.67% male respondents. The data demonstrate on the dominance of the female respondents.

Table 2 : Frequency and Percentage Distribution of the Respondents

Profile		Frequency	Percent
Age Mean = 17.77	16-18	98	81.67
	19-21	1	0.83
	22-24	20	16.67
	25 and above	1	0.83
	Total	120	100.00
Sex	Female	70	58.33
	Male	50	41.67
	Total	120	100.00

2. Performance of the Students Using Polya's Problem Solving Analysis

2.1. Pre – Test

Out of one hundred twenty (120) respondents, there were 20 or 16.67% whose performance are from 60- 74; 0 or 0.00% with a performance of 90-100; 85-89; 80-84; and 75-79 respectively. The mean of the pre test performance was 68.67 and interpreted as did not meet expectation. This result means that the pre-test performance of the Senior High School students in Mathematics students signifies that the students' performance was very poor in problem solving. Simamora et al. (2017) reported that the results of interviews with teachers at the school stated that mathematics was a subject that was not in demand by most students.

Table 3 : Performance of the Students Before Using Polya's Problem Solving Analysis

Descriptive Rating	Numerical Rating	Frequency	Percent
Outstanding	90 – 100	0	0.00
Very Satisfactory	85 – 89	0	0.00
Satisfactory	80 – 84	0	0.00
Fairly Satisfactory	75 – 79	20	16.67
Did not meet expectation	60 – 74	100	83.33
	Total	120	100.00
	Mean	68.67	
		Did not meet expectation	

2.2. Post – Test

Out of one hundred twenty (120) respondents, there were 39 or 32.50% whose rating were from 60-74; 23 or 19.17% obtained a rating from 75-78; 36 or 30.00% obtained a rating from 80-84; and 22 or 18.33% of the students has a rating from 85-89. While none of the respondents obtained a rating from 90 – 100. The mean of the post-test performance was 75.58 and interpreted as Fairly Satisfactory. This result means that the post-test performance of the Senior High School students indicates that the students' performance in improved compared to pre-test result. Using Polya's theory problem solving analysis, the performance of the Senior High School students improved in Mathematics.

Table 4 : Performance of the Students Using Polya's Problem Solving Analysis

Descriptive Rating	Numerical Rating	Frequency	Percent
Outstanding	90 - 100	0	0.00
Very Satisfactory	85 - 89	22	18.33
Satisfactory	80 - 84	36	30.00
Fairly Satisfactory	75 - 79	23	19.17
Did not meet expectation	60 - 74	39	32.50
	Total	120	100.00
	Mean	75.58	
		Fairly Satisfactory	

3. Perception of Students on the Effectiveness of Polya's Theory in Improving Problem Solving Ability

3.1. Understanding

Table 5 : Perception of Students on the Effectiveness of Polya's Theory in Improving Problem Solving Ability in terms of Understanding

Understanding	AWM	Descriptive Rating	Rank
1. I try to understand the goal of a problem before answering the problem	3.19	Agree	3

2. I think of the meaning of a problem before I start to answer the problem	3.25	Strongly Agree	2
3. I know how many problems that I can accomplish.	2.96	Agree	4
4. I try to understand a problem before I try to solve them.	3.27	Strongly Agree	1
Overall Weighted Mean	3.17	Agree	

The students Strongly Agree in “I try to understand a problem before I try to solve them (3.17, ranked 1). While, “I know how many problems that I can accomplish” has a descriptive rating of Agree (2.96, ranked 4). The overall weighted mean on perception of the students on the effectiveness of Polya’s theory in improving problem solving ability in terms of understanding was 3.17 interpreted as Agree. According to (Mamona-Downs & Downs, 2005); definitions of solutions to mathematic problems are difficult to understand.

3.2. Planning

The students Strongly Agree in “I try to determine what to be required in solving problem” (3.27, ranked 1). However, students perceived Agree on “I always make plan before solving problems” (3.09, ranked 4). The overall weighted mean on perception of the students on the effectiveness of Polya’s theory in improving problem solving ability in terms of planning was 3.21 interpreted as Agree.

Table 6 : Perception of Students on the Effectiveness of Polya’s Theory in Improving Problem Solving Ability in terms of Planning

Planning	AWM	Descriptive Rating	Rank
1. I always make plan before solving problems	3.09	Agree	4
2. I try to determine what to be required in solving problems.	3.27	Strongly Agree	1
3. I realize about the importance of planning my action	3.26	Strongly Agree	2
4. I choose and organize proper information to solve the problem	3.23	Agree	3
Overall Weighted Mean	3.21	Agree	

3.3. Implementing

Table 7 : Perception of Students on the Effectiveness of Polya’s Theory in Improving Problem Solving Ability in terms of Implementing

Implementing	AWM	Descriptive Rating	Rank
1. I try to solve a problem based on the plan I have made	3.26	Strongly Agree	1
2. I try to find the main idea before solving the problem	3.15	Agree	2
3. I make certain to understand what to do and how to implement it	3.13	Agree	3
4. I determine the ways to solve the problem	3.06	Agree	4
Overall Weighted Mean	3.15	Agree	

The students Strongly Agree in “I try to solve a problem based on the plan I have made” (3.26, ranked 1). However, students perceived Agree on “I determine the ways to solve the problem” (3.06, ranked 4). The overall weighted mean on perception of the students on the effectiveness of Polya’s theory in improving problem solving ability in terms of implementing was 3.15 interpreted as Agree.

3.4. Look Back

Table 8 : Perception of Students on the Effectiveness of Polya’s Theory in Improving Problem Solving Ability in terms of Look Back

Look Back	AWM	Descriptive Rating	Rank
1. I realize that each solution should be reviewed	3.28	Strongly Agree	1
2. I examine the solution I have made	3.12	Agree	4
3. I almost always know how many problems I can solve	3.27	Strongly Agree	2
4. I examine the accuracy of the results after solving problems.	3.13	Agree	3
Overall Weighted Mean	3.20	Agree	

The students Strongly Agree in “I realize that each solution should be reviewed” (3.28, ranked 1). However, students perceived Agree on “I examine the solution I have made” (3.12, ranked 4). The overall weighted mean on perception of the students on the effectiveness of Polya’s theory in improving problem solving ability in terms of look back was 3.20 interpreted as Agree.

4. Significant Difference between Perception of Students on the Effectives of Polya’s Theory in Improving Problem Solving Ability When Grouped According to Profile Variables

Table 12 : Test of Significant Difference between Perception of Students on the Effectiveness of Polya’s Theory in Improving Problem Solving Ability in terms of Understanding When Grouped According to Profile Variables

Source of Variations		Df	F	Sig.	Decision/ Interpretation
Age	Between Groups	3	3.66	0.01	Reject Ho Significant
	Within Groups	116			
	Total	119			
Sex	Between Groups	1	4.81	0.03	Reject Ho Significant
	Within Groups	118			
	Total	119			

The computed significant value for age (0.01) and sex (0.03) is lower than the alpha level of significance values of 0.05, therefore the null hypothesis is rejected, hence there is a significant difference between perception of students on the effectiveness of Polya’s theory in improving problem solving ability in terms of understanding when grouped according to age and sex profile variables. Gallagher et al. (2000) suggested that males tended to be more flexible than females in applying solution strategies.

1. Significant Difference on Performance of the Students Before and After Using Polya’s Problem Solving Analysis

Table 16 : Test of Significant Difference Before and After Using Polya’s Theory Problem Solving Analysis

	t	df	Sig. (2-tailed)	Decision/ Interpretation
Pre and Post Test	-13.55	119	0.00	Reject Ho Significant

The computed significant value of 0.00 is less than 0.05 alpha level of significance, the result indicates that there is a significant difference before and after using Polya’s theory solving analysis. Therefore, hypothesis was rejected and significant. The performances in the pre-test of the students differ from the performances in their post-test which was given after the usage of the Polya’s theory problem solving analysis. The data implied that the interventions used are effective in understanding of the students in problem solving.

The result implies that Polya Problem Solving Model was found to improve the performance of students in word problem compared to traditional method. The students had a higher mean rating after using Polya’s Theory problem solving analysis. The results is similar to the study of Yusha’u, Muhammad , & Usman (2020); in their study It was observed that, Polya Problem Solving Model improve students’ performance in mathematics word problem than the traditional method.

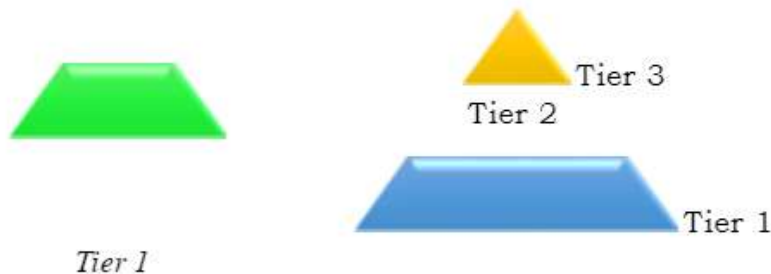
2. Intervention Plan to Improve the Delivery System to Enhance the Problem Solving Ability of the Students.

Proposed Intervention Plan to Improve the Delivery System and Enhance the Problem Solving Ability of the Students Intervention Plan in Enhancing Problem Solving Skills Among Students

Participants: Students

Intervention Type: Mathematics Problem Solving Skills

Objective: To build a student's self-efficacy in mathematics problem solving skills. Tier:



Tier 1 pupils get high-quality, scientifically based training from experienced experts, ensuring that their challenges are not the result of insufficient instruction. All children are assessed on a regular basis to create a baseline in terms of academics and conduct, as well as to identify struggling pupils who require more assistance.

Tier 2

Tier 1 students who are not making acceptable progress in the normal classroom receive progressively rigorous education tailored to their requirements based on their performance and development rates. The intensity of teaching or intervention varies depending on the size of the group, the frequency and duration of the intervention, and the level of training of the professionals giving the instruction or intervention. In addition to general curriculum education, these services and interventions are delivered in small-group settings.

Tier 3

Students get customized, intensive interventions at this level, which focus on the students' skill weaknesses.

Detailed Implementation Plan

Activities	Objectives	Strategies	Timeline
Assessment of students who are lacking in problem solving skills	To identify struggling learners who need additional support.	Assessment on a regular basis	2 months

Intensive instruction matched to student needs on the basis of levels of performance and rates of progress.	To provide intensive care to the students who lack problem solving skills.	Work on enhancing problem solving skills. Lecture method Group work Differentiated Instruction Use research-based learning programs. Full utilization of Polya's Theory	Year Round
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Key Player: Teacher/ Facilitator

Monitoring Method: The teacher will assess the students in a regular basis. Compare and contrast the test results of students. If necessary, find significant differences on the test scores of the students using statistical tools.

Writing the Results: After gathering data, the teacher/ facilitator will create a report and must share to everyone the success of the intervention.

Conclusions

Based on the summary of the investigations conducted, the researchers have arrived to conclude that: The respondents are on their young adolescence and female.

The respondents obtained a did not meet expectation descriptive rating during pre – test and fairly satisfactory after using Polya's theory.

The respondents Agreed that Polya's Theory is effective improving problem solving ability in terms of understanding, planning, implanting and look back.

There is a significant difference on the perception of the students on the effectiveness of Polya's theory in improving problem solving when grouped according to age and sex profile in terms of understanding; and according to age profile in terms of planning; implementing and look back. On the other hand, there is no significant difference in terms of planning when grouped according to sex.

RECOMMENDATIONS

Based on the summary of the investigations conducted and the conclusions arrived at, the researchers have offered the following recommendations.

1. The use of Polya theory may be encouraged during teaching and learning of mathematics in senior high school since result shows that the students' performance has improved.
2. Mathematics teachers may be trained through intensive workshop, seminars, and in-service training on the use of Polya Problem solving model.
3. The proposed intervention may be used in remedial classes to help the students familiarize with the theory.
4. Future researchers may use the current study as references.

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