Improving Students' Competence in Solving Mathematics Worded Problem Using Polya's Problem Solving Strategy

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Abstract: This study was concerned in the utilization of Polya's Problem Solving Strategy (PPSS) to improve the worded problem-solving skills in Mathematics of Grade 10 students at Basilan National High School. Specifically, to assessed the level of competence of Grade 10 students in solving worded problems in mathematics anchored on the topic in the third quarter of the Most Essential Learning Competencies (MELC) in Mathematics 10. A multi-layered sampling procedure were used particularly, purposive sampling was adopted and a quota sampling were further used in selecting the respondents. The respondents were the Twenty-nine (29) males and Thirty-one (31) females with a total of Sixty (60) students, and a quasi-experiment research method was employed. The findings show that the overall level of competence of Grade 10 students in solving mathematical worded problem for both the control and experimental groups before utilizing the Polya's Problem Solving Strategy (PPSS) revealed as "Beginning Competence". After utilizing the PPSS, the students' level of competence went up to a "Developing competence." Moreover, there is a significant difference between the traditional strategy (Controlled Group) and the treatment group with PPSS (Experimental Group) which means that the performance of students in solving worded problems for Experimental group with PPSS treatment is better than the traditional strategy or the typical way on dealing with worded problems in mathematics. Significant difference was also found in terms of gender and monthly family income.

Keywords: mathematics, problem-solving competence, worded problem, Polya's problem solving strategy

INTRODUCTION

Beginning in the elementary grades, problem solving is one aspect of mathematical competence that is expected to be gained in mathematics learning. The main target of the school's mathematics curriculum is for the students to gain the experience to transfer and apply learned knowledge and skills to solve problems (Permata, 2018). In an article, it had been mentioned that a mathematically competent student does not only understand how to compute and perform algorithms but is also capable to pose and solve mathematical problems [13].

Reading comprehension and math literacy are indispensable as far as student's performance in solving word problems in Mathematics is concerned [6]. Since the adoption of the Philippines Standards of Professional Teacher (PPST) in 2018, integrating literacy skills in all content areas has been required, including math. Implementing literacy strategies into all content areas provide students with the flexibility to critically read, write, and communicate effectively. Accordingly, current educators are now required to integrate writing, vocabulary, and comprehension strategies into everyday instruction to support bridging the gap between literacy and mathematics.

Polya Problem Solving Strategy (PPSS) can help students target a process to decide what problem is being asked, what information is required, and what approach to use in solving the problem in computation. Further, it asks students to reflect on what they are going to solve the problem on their understanding. Hence, this practice explains how (PPSS) works in mathematical reading texts.

According to Benito as cited in [7] and Aguila [2], the aims of learning Mathematics are: (1) mastery of basic mathematical skills is needed in order to cope with the demand of life; (2) Mathematics is the language of sciences,

and many disciplines depend on this subject as a symbolic means of communication; and (3) Mathematics education plays a big role in evolving students' problem solving and decision-making skills. Hence, Permata [10] asserted that Mathematics can be used as a tool to make job easier, more effective, and efficient.

Unfortunately, Patena [9] stated that the low understanding level accompanied by disheartening national test results of the students [11] raised several issues concerning the quality of education particularly in Mathematics. Besides, Mathematics is often perceived as difficult because of its abstract nature [8] resulting to a significantly low achievement in Mathematics as well as relatively low self-efficacy among students who are impatient in solving word problems posed great challenges to current Mathematics educators to change the attitude of the students towards this subject [1].

Relative to this, the Department of Education through DepEd Order No. 42 s. 2017, implemented the PPST aimed to engage teachers to actively embrace a continuing effort in attaining proficiency. It is because quality learning is contingent upon quality teaching. Primarily, the goals of the government at enhancing the quality of education in our country depend on the ability of the teachers for they are the ones who portray the major role of imparting the all the knowledge, skills, and values to the students [2].

As stated in Republic Act 9155, Rule 1, Section 1, "The Department of Education shall protect and promote the right of all citizens to quality basic education and shall take proper steps to make such education accessible to all." Actually, it is specified that the goal of basic education is providing the students with the knowledge, basic skills, and values they need to become self-reliant, caring, productive, and patriotic citizens. Knowing that the progress and development of a strong nation depends primarily on the education that people acquired, excellence and quality in education has been the mission of all leaders [2].

According to NCTM [3] that problem solving is an integral part and not separate from mathematical learning. The statement shows that in every mathematical learning involves solving the problem. Polya [4] mentions that problem solving is an important aspect of intelligence, where problem solving can be understood as an important character for humans and can be learned by imitation or experimentation. Imitation and experiment activities can be facilitated by routine and nonroutine problems. So, it can be said that, mathematical problem's ability is the ability of a person in solving mathematical problems both routine and nonroutine problems. Accordingly, problem solving ability is the ability to solve routine and non-routine problems both applied and non-applied in the field of mathematics [1]. The type of mathematical problem given will lead the student to perform the problem-solving procedure. The routine and non-routine procedure of solving the problem is certainly different in its calculation practice. The non-routine problem requires planning problems that are not merely applications of formulas, theorems, propositions, as well as routine problems that require more algorithmic calculation.

Malibiran et al. [5] stated that problem-solving is an important skill needed not only in mathematics class but in everyday living as well. In some instances, students may have mastery of the mathematical concepts but still find it difficult to apply the skills in real life situations and in solving worded problems. In their study conducted, it was revealed that numerous factors such as prior grade in Mathematics and English, reading comprehension skills and attitude towards Mathematics affect the performance of the students in problem-solving.

Likewise, the average quarterly Mean Percentage Score of students in Mathematics on the first quarter School Year 2022-2023 showed poor results of Thirty-four percent (34.44%). They performed below the target of 75% MPS which indicates that the students' performance in this subject is not quite good. Test results revealed the least mastered competencies wherein one vital contributory factor to the current poor performance is the difficulties in word problem solving. Similarly, Phonapichat et al., (2013) found in their study that students have difficulties in understanding the keywords appearing in problems; thus, they cannot interpret them in mathematical sentences. Students are unable to figure out what to assume and what information from the problem is necessary to solving it. Students are also impatient and do not like to read mathematical problems.

In the same way, Rose [12] imparted in her study that Math text is more complexed to grasp than most written communication student's encounter. Due to this, mathematical word problem solving can become a significant challenge because both the reading comprehension and the technical math knowledge are involved.

STATEMENT OF THE PROBLEM

This study aims to determine and improve the worded problem-solving skills of Grade 10-Thomson Students of Basilan National High School during the school year 2022-2023 in mathematics by utilizing Polya's Problem Solving Strategy (PPSS) in classroom instruction. Specifically, it seeks to answer the following questions:

Research Problem

1. What is the demographic profile of respondents in terms of:

    a. Gender;
    b. Ethnicity; and
    c. Monthly Family Income?

2. What are the level of competence of respondents in solving mathematical worded problem for both the control and experimental groups before utilizing the Polya's Problem Solving Strategy (PPSS)?

3. What are the level of competence of respondents in solving mathematical worded problem for both the control and experimental groups after utilizing the Polya's Problem Solving Strategy (PPSS)?

4. Is there a significant difference on the competence of students in experimental group in solving mathematical worded problems before utilizing the PPSS when they are classified according to the following profile:

    a. Gender;
    b. Ethnicity; and
    c. Monthly Family Income?

5. Is there a significant difference on the competence of students in experimental group in solving mathematical worded problems after utilizing the PPSS when they are classified according to the following profile:

    a. Gender;
    b. Ethnicity; and
    c. Monthly Family Income?

6. Is there a significant difference between the traditional strategy and Polya's Problem Solving Strategy (PPSS) in solving mathematical worded problem?

RESEARCH METHODOLOGY

The research utilized a quasi-experimental research design which intends to distinguished significant difference before and after utilizing Polya's Problem solving Strategy. The study determines the significant difference on the independent variable before and after undergoing intervention and or treatment of Polya's Problem Solving Strategy (PPSS). Twenty (20) item Multiple Choice question adopted from the Self Learning Modules with identified competencies with problem solving in the third quarter of the school year was used. Thenceforward, one-group pretest-posttest design was employed. It is a research design that measured the same dependent variable in one group of participants before and after a treatment is administered (SAGE Publications, 2019) as shown in the pretest and posttest. A multi-layered sampling procedure were used particularly, the first sampling was purposive on which the study intended for grade ten (10) students. Moreover, it was suggested by Lunenberg and Irby (2008) that at least 30 per group must be selected. Thus, in this study, the quotas of 30 students per group were selected.

The group selection for controlled and experimental was employed with a criterion of their academic standing in the previous academic quarter and distributed equally in the basis of range of highest grade minus the lowest grade and the mean percentage grades of the two different groups must be closely similar and/or equal.

The respondents were group in two with controlled and experimental group the first group was identified as controlled group who were taught worded problem solving in the typical classroom setting, meanwhile second group was identified as the experimental group who were received the research intervention or treatment for four(4) weeks according to topic in the Most Essential Learning Competencies (MELC) with worded problem solving employing the Polya's Problem Solving Strategy in teaching worded problem. Both groups were given similar pre-test prior to the beginning of the intervention to determine their level of competence in solving worded problems in mathematics.

A two-part survey questionnaire was used. One part gathered information on the profile of the Secondary Grade 10-Thomson students of Basilan National High School. Part two of the questionnaire determined the Pre-test and Post-test in solving worded problem. The part II of the Instrument tested the Students' Mathematic Worded Problem-Solving Competence which was adopted from Dep.Ed Mathematics Quarter 3 – Module 2,4 and 8 (CO_Q3_Mathematics 10_ Module 2,4 and 8) intended for Grade 10 and made basis also the Three Most Essential Learning Competency (MELC's) of Department of Education Quarter 3 (1) solves problems involving permutations. M10SP-IIIb-1 (2) solves problems involving permutations and combinations. M10SP-IIId-e-1 (3) solves problems involving probability. M10SP-IIIi-j-1 in coming-up with the Problem-solving instrument. Hence, the mathematical worded problems were anchored on Permutations, Combinations and Probability. The data collected was analyzed and compared using the Statistical Package for the Social Sciences (SPSS).

FINDINGS

The pre-test level of competence of respondents in solving mathematical worded problem for both the control and experimental groups before utilizing the Polya's Problem Solving Strategy (PPSS). With the mean percent score of twenty-six-point fifteen percent (26.15%) for controlled group and twenty-seven-point eighty-five percent (27.85%) for experimental group and an overall mean percent score of Twenty-seven percent (27.00%) as per the DepEd Order No. 31, s. 2012 the level of the student respondents in solving mathematical worded problem can be categorized as "Beginning Competence".

The post-test level of competence of respondents in solving mathematical worded problem for both the control and experimental groups after utilizing the Polya's Problem Solving Strategy (PPSS) for experimental group, and traditional classroom teaching and learning for controlled groups. It shows that experimental group with a mean percent score of eighty-one-point fifteen percent (81.15%) which signifies as "Approaching Proficiency" as per the DepEd Order No. 31, s. 2012, whereas for controlled group with mean percent score of sixty-nine-point thirty-five percent (69.35%) it means the level of the competence of the learners are categories as "Beginning Competence". Cumulatively, with an overall mean percent score for both controlled and experimental group it shows that the students respondent categorized with "developing competence" with total mean percent score of Seventy-five-point twenty-five percent (75.25%).

The Paired t-test of the significant difference between the traditional strategy and Polya's Problem Solving Strategy (PPSS) in solving mathematical worded problem. With computed P value of 0.000 less than 0.05 level of significant thus, we conclude that there is a significant difference between the traditional strategy (Controlled Group) and the treatment group with PPSS (Experimental Group). Hence, we say also that the performance of students in solving worded problems for Experimental group with PPSS treatment is better than the traditional strategy or the typical way on dealing with worded problems in mathematics.

The Paired t-test of the significant difference between the traditional strategy and Polya's Problem Solving Strategy (PPSS) in solving mathematical worded problem grouped according to gender. Shows with a mean score of five-point zero seven (5.07) to fourteen-point forty-five (14.45), we say that male respondents in experimental group performed better than controlled group. Similarly, Female in Experimental group significantly performed better than controlled group from mean score five-point seventy-one (5.71) to Fifteen-point sixty-one (15.62).

The Paired t-test of the significant difference between the traditional strategy and Polya's Problem Solving Strategy (PPSS) in solving mathematical worded problem grouped according to individual ethnicity. Shows a mean percent score for controlled and experimental group, to which controlled group take a typical traditional classroom instruction, whereas the experimental group exposed in Teaching worded problem solving in Mathematics 10, with a mean score of Sixteen-point fifty(16.50) for the experimental group, it means "Sinama"

Ethnic group performed better from than the rest of the group, it was followed by "Chavacano" group with fifteen-point sixty-seven(15.67) and followed by "Yakan" group with Fifteen-point zero(15.0) and then the Tausug group with fourteen-point seventy-seven (14. 77) respectively, additionally, when classified individually by ethnic classifications, Yakan, Tausug and Chavacano shows a significant difference between the controlled and experimental group, on the other hand Sinama with least number of respondents revealed a no significant difference. Cumulatively, with a P-Value of 0.066 higher than 0.05 level of significant, it revealed that ethnicity is not a significant factor for the tested strategy.

The Paired t-test of the significant difference between the traditional strategy and Polya's Problem Solving Strategy (PPSS) in solving mathematical worded problem grouped according to monthly family income. For a monthly family income of "₱3,000 to ₱5,000" with a descriptor of "Lower Class Income Earner" with a mean score of five-point thirty-two(5.32) for controlled group and mean score of fourteen-point seventy-one (14.71) for experimental group with a P-value of 0.000, it revealed that there is significant difference between the two group for the first monthly family income interval, this is also similar with family monthly income between ₱6,000 - ₱8,000 with a descriptor of Lower Middle-Class Income Earner with mean score of four-point seventy-seven(4.77) for controlled group and fifteen-point zero-eight (15.08) for experimental group and P-value of 0.000, more so, Monthly Family Income between ₱9,000-₱11,000 with descriptor of Middle Class Income Earner was the only interval that shows a no significant difference between the controlled group and experimental group with P- value of Zero-point zero-five-three(0.053) which is higher than the set level of significance 0.05. Additionally, Monthly Family Income between ₱12,000-₱14,000 and ₱15,000 and above, both shows a significant difference between the two groups. Moreover, with an overall P-value of Zero-point zero-eleven (0.011) less than the 0.05 set level of significance, hence we conclude that there is a significant difference between the traditional strategy and Polya's Problem Solving Strategy (PPSS) in solving mathematical worded problem when respondents are group in terms of Monthly Family Income.

CONCLUSION

Based on the analysis and interpretation of the gathered data, the following were the significant findings:

1. On the Demographic Profile, most of the student-respondents of the Grade 10-Thomson are female which comprises of Fifty-one-point sixty-seven percent (51.67%). Most of whom also are Tausug which comprises Fifty-eight-point thirty-three percent (58.33%). In terms of Monthly Family Income, most of the respondents for about Fifty-one-point sixty-seven percent (51.67%) are belongs to Lower Class Income Earner.
2. The Overall level of competence of Grade 10-Thomson students in solving mathematical worded problem for both the control and experimental groups before utilizing the Polya's Problem Solving Strategy (PPSS) revealed as "Beginning Competence".
3. The Overall level of competence of Grade 10-Thomson students in solving mathematical worded problem for both the control and experimental groups After utilizing the Polya's Problem Solving Strategy (PPSS) revealed as "Developing competence"
4. There was no significant difference found on the competence of students in experimental group in solving mathematical worded problems before utilizing the PPSS when they are classified according to Gender, Ethnicity, and Monthly Family Income
5. There was no significant difference found on the competence of students in experimental group in solving mathematical worded problems after utilizing the PPSS when they are classified according to Gender, Ethnicity, and Monthly Family Income
6. There was a significant difference found on the competence between the traditional strategy and Polya's Problem Solving Strategy (PPSS) in solving mathematical worded problem
7. It was found that the performance of students in solving worded problems for Experimental group with PPSS treatment according gender, ethnicity and Monthly Family Income was better than the traditional strategy or the typical way on dealing with worded problems in mathematics.

RECOMMENDATIONS

In light of the findings and conclusions, the following recommendations are hereby offered:

1. Students may need proper assistance to develop favorable attitude toward reading various reading materials and constant practice on solving worded problems in mathematics.
2. Teachers may adapt or integrate the Polya;s Problem Solving Strategy(PPSS) to improve the worded problem-solving skills of the students.
3. Administrators may provide seminars and workshops about the utilization of PPSS as well as other reading and mathematical problem-solving.
4. Similar studies may be replicated to confirm the findings of the present study. However, the word problems used in this study contained permutation, combination and probability only for the period of 4 weeks not in a consecutive order in accordance with MELCs'. Thus, other areas in Mathematics like algebra and geometry may be used and the period of study may be extended in further studies.
5. The present study was carried out on Mathematics subject. However, it may not be confined to this subject only. The utilization of Polya;s Problem Solving Strategy(PPSS) may be investigated in other disciplines of sciences with diverse sample size and grade levels for more reliable and generalize results.
6. With permission from the researcher, future researchers may test the validity and reliability of the results of this study through employing a true experimental research design.
7. For deeper analysis, each step of Polya;s Problem Solving Strategy(PPSS) may be investigated individually and results be interpreted separately.

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