STRENGTHENING THE STUDENTS' ACHIEVEMENT IN MATHEMATICS THROUGH PROBLEM POSING

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ABSTRACT: *This study aimed to further clarify the claim by several authors that problem posing provides positive outcome on students' mathematical learning. It utilized a quasi-experimental pretest-posttest control group design to gather the data. The researcher made use of the teacher-made test with a Cronbach alpha reliability coefficient of 0.849. Two sections of grade 8 students at Bugo National High School, Bugo Cagayan de Oro City, Philippines were assigned randomly as the control and the experimental group. The analysis of covariance (ANCOVA) was used to analyze the data collected. Results revealed that there is a significant difference between the scores of the two groups. Thus, the researcher recommends that mathematics teachers in the Philippines may embrace problem posing so that students will perform better in mathematics tests.*

Key Words*: problem posing; mathematics achievement; perception*

1. INTRODUCTION

How to improve students' performance in mathematics is a hot issue among mathematics educators in the country. For many years, students' scores in the National Achievement Test (NAT) were far below the standard [1]. The NAT is a Philippine-standardize test given at the end of the school year to determine the students' level of achievement in Science, Mathematics, English, Filipino, and Hekasi. The poor rating in NAT is alarming so a considerable action must be taken.

In response, this researcher as a mathematics teacher believes that there must be a change in the teaching-learning process from engaging students in lower-order-thinking to higher-order-thinking mathematical tasks to help students develop their full potential. It has been observed that mathematics teachers teach mathematics with more practice. They demonstrate each step and then require the students to answer several similar examples following the given procedure. Most students do not have the opportunity to explore the mathematical concepts by themselves. The contemporary method of teaching mathematics has lost the element of challenge [2] and did not nurture the students' critical thinking ability [3- 5]

Conceding to reforming the methods of teaching mathematics, the National Council of Teachers of Mathematics [6] emphasized the use of problem posing as a classroom intervention. Problem posing means the creation of new problems or modification of the conditions of a given situation [7]. Teachers may ask students to pose mathematical problems in conjunction with problem solving [8] either before, during or after problem solving activity [9].

Several authors have acknowledged that problem posing is a worthy intellectual activity [10]. It is a tool for understanding mathematics [11] which resulted into improved reasoning skills such as mathematical [12-13], and logical reasoning [14]. Researchers noted that problem posing enhanced students' conceptual learning [15-17] and problem solving ability [18-19]. Also, when teachers incorporated a problem-posing intervention, classrooms became more student-centered [20] and re-engage underachieving students [21].

In spite that problem posing has received increasing attention in the field of mathematics teaching and learning, similar studies conducted in the Philippines is limited if there's any. On this lies the overall inspiration of this present study. The purpose of this study is to further support the claim by several authors that problem posing provides positive outcome on students' mathematical learning by conducting a similar study in the Philippines. Specifically, this study investigated the effect of problem posing on students' mathematics achievement and perception on problem posing in mathematics class.

2. METHODOLOGY

2.1 Research Design

This study used a quasi-experimental pretest-posttest non-equivalent control group design. This method was used to examine the students' achievement on special products, factoring, and rational algebraic expression. The extent of the significant difference in the performance of the two groups was tested using their scores in the Pretest and Posttest.

2.2 The Instruments

The researcher made a 40-item test with a table of specification on the topics: special products, factoring and rational algebraic expression of which 25 items were multiple-choice and 15 were open-ended. A group of mathematics educators and research experts evaluated the questionnaire for face and content validity. The experts suggested some corrections, changes, and modification of the test items. Then, the researcher administered the final draft to the grade 9 students of this school for the item analysis and reliability test. The multiple-choice format was scored using two scales, 0 or 1. 0 if the response was wrong, and 1 if it was correct. The open-ended format was scored using the researcher's developed holistic scoring rubric with four-point scales. 0 if no work has shown, 1 if few part of the response is correct, 2 if half of the response is correct, 3 if the answer is correct but not complete with some minor error in the notation or computation, 4 if the solution is complete and correct. The researcher requested three mathematics teachers to rate the students' answers to avoid bias. The mean score of the three ratters was the final score of the students. The researcher then proceeds to item analysis and reliability test. After item analysis, only 15 items in the multiple-choice test and 6 in the open-ended test found acceptable. Employing Cronbach alpha, the reliability coefficient of the pretest-posttest instrument is 0.849. Another instrument used in this study was the survey questionnaire on students' perception on problem posing in mathematics. This questionnaire used the 5-point Likert scale, which is (1) strongly disagree; (2) disagree; (3) undecided; (4) agree; and (5) strongly agree. The scale for score mean interpretation is shown in table 1 below [22]. This questionnaire was also validated by experts in research in this university.

Table 1. Mean Score and Qualitative Interpretation of the Data

Mean	Qualitative Interpretation
4.50-5.00	Highly Positive
3.50-4.49	Positive
2.50-3.49	Fair
1.50-2.49	Negative
1.00-1.49	Highly Negative

2.3 The Participants

The participants of this study were the two sections of grade 8 in Bugo National High School, Bugo, Cagayan de Oro city. The researcher chose randomly the participants from the four heterogeneous classes of the said grade level. The experimental group had 53 students while the control group had 45. The students are between 13 to 15 years old. However, only 41 students in the experimental group took the posttest. To have an equal number of participants per group, the researcher randomly removes 12 students from the control group.

2.4 Data-Gathering Procedure

Before the experiment, the teacher-researcher gave the pretest to the two groups. This test was the teacher-made test, 15-item multiple-choice and 6-item open-ended test. On the following day, the experiment begins. The topic under study was the special product, factoring, and rational algebraic expression.

In both groups, the teacher did the preliminary routine to prepare the class like prayer, greetings, and checking of attendance. The teacher started the class with a short lecture to equip the students on the basic facts about the topic. After the equipping, the teacher gave activity for the students to be answered by group. Each group had 3 to five members.

After the given time allotment for the activity, in the experimental group, the teacher asked the students to pose their problem with the answer. On the contrary, in the control group, the teacher provided problems for the students to solve. Then, a random of students in both groups were asked to present their work before the class. The experimental group presented their problem and the solution to their problem while the control group presented their solution to the problem posed by the teacher. This manner continued until the end of the experiment. After the experiment, teacher-researcher administered the posttest to the two groups.

1. RESULTS AND DISCUSSIONS

This section presents the analysis and interpretation of the data obtained from the study.

Table 2. Mean and Standard Deviation of Students' Pretest and Posttest on Special Products, Factoring and rational Algebraic Expression

	Experimental Group		Control Group	
	Pretest	Posttest	Pretest	Posttest
Mean	1.98	22.83	2.51	17.10
SD	1.26	9.34	1.45	7.84

Table 1 shows the pretest and posttest scores of the experimental and control groups. It can be seen in the table that the pretest scores are very low. Out of 39 points, the experimental group got 1.98, and the control group got 2.51.These scores indicate that both groups do not have prior knowledge on the topic. Nevertheless, after instruction, both groups increased their scores. In the posttest, the experimental group got 22.83, and the control group got 17.10. The experimental group gained 20.85 while the control group gained 14.59. Also, the standard deviation in the pretest is small. The experimental group got an SD of 1.26, and the control group got 1.45 which means that the scores are homogeneous, all the participants got very low score. In the posttest, the SD of the control and experimental group increased to 9.34 and 7.84, respectively, an indication that the dispersion of the scores became wider, that some students got a high score but others got low. The extent of the difference in the performance of the two groups was analyzed using the Analysis of Covariance (ANCOVA). The result of the analysis is presented in table 2.

Table 3. One-Way ANCOVA Summary Table for Students' Pretest and Posttest

Source of Variation	DF	AdjSS	AdjMS	F	P
Treatment Effect	1	634.13	634.13	8.24	0.005*
Error Within	79	6082.56	76.99		
Total	80	6716.69			

*Significant at 0.05 level

Table 3 shows the one-way Analysis of Covariance of students' pretest and posttest scores. The analysis yielded an F-ratio of 8.24, and the probability value is 0.005 which is lesser than the 0.05 level of significance. Hence, there is enough evidence to reject the null hypothesis and conclude that there is a significant difference in the achievement of the experimental and control group. The students exposed to problem posing improved their posttest score significantly as compared to those exposed to the conventional method of teaching. This finding supports that problem posing is more effective than traditional approach to solving problems [23]. It also supports that students exposed to problem problem-based learning performed better than those students exposed to the traditional method of teaching [24]. This researcher believed that the significant difference in the performance of the two groups was due to the activity done in the classroom. Problem posing requires students to be well versed in how concepts apply across a wide range of problem context. Students in this group were required to explain their solution to the problem they posed and the meaning of every notation they used. Problem posing provides more opportunity for students to demonstrate their mathematical understanding and it fosters the development of critical thinking [25]; [26]. Hence, problem posing strengthens problem solving abilities [27]. Moreover, problem posing is highly motivating. Asking students to pose their problem has an impact on their intrinsic motivation [21]; [28]. It helps them develop ownership of the problem they are going to solve [29]. During the experiments, the participants are active in the learning process they express their thoughts and gain insight while working with their groups.

Table 4. Students' Perception of Problem Posing in Mathematics

No.	STATEMENTS	Mean	SD
1	Problem posing helps me recall the concepts, rules and other details I already learned.	4.24	0.70
2	Usually, I have difficulty understanding mathematical concepts but being forced to pose my problem and solve it help me understand better.	4.17	0.80
3	It is interesting to pose my problem; it helps me become critical thinkers.	4.32	0.88
4	I find problem posing thought-provoking and exciting.	3.54	1.03
5	Problem posing in mathematics help me make connections among mathematical concepts.	3.80	1.10
6	I think problem posing through group discussion or with a partner make mathematics enjoyable and fun.	3.85	0.69
7	I enjoy the challenges presented during group discussion.	4.02	0.85
8	When my teacher returned our test papers, I find my grades have increased.	3.49	1.19
9	The activities change my perceptions that anything I do in mathematics is just numbers.	3.44	0.87
10	Problem posing helps me assess myself and recognize my strengths and weaknesses.	4.07	0.91
Mean		3.90	0.15

Table 4 shows the mean and standard deviation of the students' responses to each statement on their perception on problem posing in mathematics class. It can be gleaned in the table that the students exposed to the problem posing had a positive impression on the activity with the total mean value of 3.90. In particular, they found problem posing interesting and it helped them become better thinkers with a mean score of 4.32. They supposed that problem posing helped them recall the concepts, rules and other details they already learned with mean equal to 4.24.These students confirmed that they have difficulty understanding mathematical concepts but being forced to pose their problem and solve it help them understand better with the inherent mean of 4.17. They also agreed that problem posing helped them assess themselves and recognized their strengths and weaknesses with the mean 4.07. Participants in the experimental group enjoyed the challenges during group discussions with mean equal to 4.02.They think that problem posing through group discussion or with a partner make mathematics enjoyable and fun with mean value of 3.85. Another statements which obtain a positive response are problem posing in mathematics helped them make connections among mathematical concepts, and problem posing is thought-provoking and exciting with the mean score of 3.80 and 3.54, respectively. On the other hand, two statements had a fair rating. These are "When my teacher returned our test papers, I find my grades have increased" and "The activities change my perceptions that anything I do in mathematics is just numbers" with a corresponding mean score of 3.49 and 3.44.

Moreover, table 4 shows that the standard deviations of each statement is small. These numbers describe the homogeneity of the responses. The smaller the value is, the homogeneous the responses are. It can be gleaned in the table that statements with positive response had a small standard deviation, less than 1.0 except statements 4 and 5. This means that the students' responses on these items are homogenous. Most of the participants gave a positive rating, and none of them gave a negative rating. However, on statements 4 and 5, the responses vary. Some of the participants gave a positive rating, but others gave a negative rating. Similarly, for the statement "When our teacher returned our test papers, I find my grades have increased", the scores are heterogeneous. Some students gave a positive rating and some gave negative ratings with standard deviation equal to 1.19

4. CONCLUSION AND RECOMMENDATION

Based on the above findings, the researcher concluded that problem posing is effective in enhancing the achievement of grade 8 students of Bugo National High School, Bugo Cagayan de Oro City. The students acknowledged that problem posing is a good method of teaching mathematics because it had a positive effect on them. Thus, the researcher recommends that teachers may embrace problem posing to enhance students' performance in mathematics. She also encourages the school principals and supervisors to support the implementation of problem posing in mathematics classrooms to motivate the teachers to employ this activity in their class. She also recommends that similar studies may be conducted in the Philippines setting to widen the scope and promote the generalizability of the results.

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