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Effectiveness of the Problem-Posing Learning Model on the Learning Outcomes of Seventh-Grade Students at SMP Negeri 1 Palu

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A B S T R A C T

This study examines the effectiveness of the Problem Posing learning model on mathematics learning outcomes of seventh-grade students at SMP Negeri 1 Palu using a quasi-experimental method with a nonequivalent control group design. A sample of 64 students was selected through cluster random sampling from a population of 352 seventh-grade students across 11 classes at SMP Negeri 1 Palu, with class VII F as the experimental class and class VII J as the control class, each consisting of 32 students. Data were collected via essay-based pretest and posttest, then analyzed using the Kolmogorov-Smirnov normality test, Levene's homogeneity test, independent samples t-test, and N-Gain calculation. The results showed a significance value of 0.048 < 0.05, with the experimental group's N-Gain score (0.66) exceeding the control group (0.57), both in the medium category. Observational findings further confirmed that students in the experimental class were more actively engaged in analyzing mathematical situations, formulating problems, and collaborating with peers, contributing to their higher learning outcomes. Therefore, the Problem Posing learning model is effective in improving students' mathematics learning outcomes, and can serve as a practical alternative for mathematics teachers seeking to enhance student engagement and learning achievement.

1. Introduction

Mathematics is a discipline aimed at fostering investigative and creative thinking skills, as well as equipping individuals to address challenges in social life (Popescu, 2021) Mathematics instruction is not merely about enabling students to perform calculations but also about empowering them to solve problems, make decisions, and actively engage in the learning process. Vale and Barbosa, (2023) state that effective mathematics instruction requires the use of active learning strategies, which involve students intellectually, socially, and physically in completing tasks so that they are encouraged to think, make decisions, solve problems, and think

critically. Thus, mathematics learning emphasizes not only mastery of the subject matter but also the development of attitudes and skills that support the students' learning process.

In supporting the learning process, the role of teachers is crucial in creating a conducive learning environment, where the quality of the teacher-student relationship serves as the cornerstone of effective classroom management (Karagianni et al., 2023). In line with this, Ministry of Education, Culture, Research, and Technology Regulation No. 16 of 2022, Article 9, Paragraph (1), emphasizes that the implementation of learning must take place in an atmosphere that is interactive, inspiring, enjoyable, and challenging, while also providing space for students' initiative, creativity, and independence. To achieve this, one crucial aspect teachers must consider is selecting the appropriate instructional model to support the effectiveness of the teaching and learning process. Teachers are expected to adapt their instructional approaches to students' characteristics and the potential of the available learning environment to make the learning process more interactive and meaningful (Paramita et al., 2022). Active interaction between students and teachers is a crucial aspect of effective learning (Lathifah et al., 2024). Through this interaction, students can ask questions, express opinions, and engage in discussions forms of behavioral and affective engagement that have been shown to positively correlate with students' mathematics achievement (Maamin et al., 2021).

Based on direct observations and interviews with seventh-grade mathematics teachers at SMP Negeri 1 Palu, it was found that the mathematics learning process in the classroom still faces a number of challenges that impact student learning outcomes. Students tend to be passive during the learning process, both in asking questions and responding to questions posed by the teacher, which is largely attributed to shyness and a lack of self-confidence stemming from a fear of giving incorrect answers. This condition is consistent with findings from a study conducted at the same school, in which students were found to exhibit varying levels of mathematical self-efficacy, with many demonstrating low confidence in constructing and generalizing mathematical strategies, a disposition that underlies the passive behaviors observed in this study (Nurhidayah et al., 2026). This situation results in low student engagement in the learning process, preventing the optimal development of mathematical conceptual understanding. Consequently, the average student achievement scores remain below the Minimum Mastery Criteria. According to the teachers, the problem-posing learning model has never been implemented in seventh-grade mathematics instruction, making it one of the alternative approaches that can be explored to foster active student engagement while potentially improving their learning outcomes.

A number of studies have examined the effectiveness of the problem-posing learning model in mathematics education. Syamsuddin et al. (2022) investigated the application of problem posing among 11th-grade science students at State Senior High School 11 Makassar using a quasi-experimental design with a nonequivalent control group, and found that problem posing significantly improved students' mathematics learning outcomes by fostering their critical and creative

thinking skills. At the junior high school level, Wahyi et al. (2023) investigated the effect of problem posing on the motivation and learning outcomes of seventh-grade students at SMP Negeri 2 Pringgasela using a nonequivalent control group design, and found that the class implementing problem posing experienced a significantly higher improvement in learning outcomes compared to the control class. Furthermore, Yanti Siregar et al. (2025) examined the effectiveness of problem posing on the mathematical critical thinking skills of eighth-grade students at SMP Negeri 10 Padangsidimpuan using a one-group pretest-posttest design, with results showing an improvement classified as the high category based on N-Gain calculations.

Based on the actual conditions observed at SMP Negeri 1 Palu and supported by empirical evidence from previous studies, problem posing emerges as an alternative learning model that conceptually addresses both of these issues. Problem posing is a learning model that positions students as active agents by encouraging them to formulate and pose their own problems based on given situations or information (Silver, 1994). This characteristic is what makes it relevant: when students are no longer merely answering questions but also designing them, they are required to understand the structure of the problem, identify relevant information, and determine the appropriate solution strategy. This process directly fosters active intellectual engagement which has long been a weak point in classroom learning while also having the potential to enhance student learning outcomes in a more meaningful way.

Based on the foregoing discussion, this study aims to examine the effectiveness of the problem-posing learning model on the mathematics learning outcomes of seventh-grade students at SMP Negeri 1 Palu, as well as to determine whether there is a significant difference in learning outcomes between students who received problem-posing instruction and those who received direct instruction. The results of this study are therefore expected to provide concrete empirical evidence as a basis for mathematics teachers in considering the implementation of the problem-posing learning model, particularly in efforts to enhance students' active engagement and learning outcomes.

2. Methodology

This study employed a quantitative approach using a quasi-experimental design, specifically a nonequivalent control group design. This research design is illustrated in Table 1.

Table 1. Research Design

Group	Pretest	Treatment	Posttest
Expermental	O_1	X	O_2
Control	O_3		O_4

Note. X = treatment applied to the experimental group; O1 = pretest score of the experimental group; O2 = posttest score of the experimental group; O3 = pretest score of the control group; O4 = posttest score of the control group.

The experimental class received the problem-posing learning model, while the control class was taught using the direct instruction model. The population of this study consisted of all seventh-grade students at SMP Negeri 1 Palu for the 2025/2026 academic year, comprising 11 classes with a total of 352 students. Sampling was conducted using cluster random sampling. The sample consisted of two classes with a total of 64 students, with class VII F serving as the experimental class and class VII J serving as the control class, each consisting of 32 students.

The instruments used in this study included:

1. Pretest and posttest essay questions consisting of five items;
2. Observation sheets for monitoring the implementation of the learning model;
3. Learning materials comprising a teaching module and student worksheets (LKPD).

Data analysis in this study consisted of three stages. First, prerequisite testing was conducted, comprising a normality test using the Kolmogorov-Smirnov test and a homogeneity test using Levene's test, to ensure the data met the assumptions of parametric statistics. Second, hypothesis testing was performed using an independent samples t-test to compare the mean scores of the experimental and control classes at a significance level of $\alpha = 0.05$. Third, to measure the effectiveness of the treatment, the normalized gain (N-Gain) score was calculated using the formula proposed by Hake (1998), as follows:

$$\text{N-Gain} = \frac{S_{\text{post}} - S_{\text{pre}}}{S_{\text{max}} - S_{\text{pre}}} \times 100\%$$

where S_{post}= posttest score; S_{pre}= pretest score; and S_{max}= maximum possible score.

The interpretation of the N-Gain score refers to the classification presented in Table 2.

Table 2. Classification of N-Gain Value

N-Gain Score (g)	Category
g> 0.70	High
0.30 ≤ g ≤ 0.70	Medium
g< 0.30	Low

3. Results and Discussion

Result

The research data consist of pretest and posttest scores for the experimental and control groups. In this study, the experimental class was Grade 7F, while the control class was Grade 7J. The pretest results for students in the experimental and control groups are presented in Table 3.

Table 3. Pretest Results for the Control and Experimental Groups

Groups	N	Lowest	Highest	Rage	Mean	Standard Deviation
Expermental	32	10.81	43.24	32.43	30.57	9.42
Control	32	13.51	43.24	29.73	30.48	7.62

Based on Table 3, both classes showed relatively equivalent means, indicating that students' initial abilities were comparable prior to the administration of the treatment. Table 4 presents the posttest results for students in the experimental and control groups.

Table 4. Posttest Results for the Control and Experimental Groups

Groups	N	Lowest	Highest	Rage	Mean	Standard Deviation
Experimental	32	43.24	89.19	51.35	75.76	13.70
Control	32	40.54	91.89	48.65	68.83	13.80

Based on Table 4, the mean posttest score for the experimental class was 75.76, which was higher than that of the control class at 68.83. To ensure that the data met the necessary assumptions prior to hypothesis testing using an independent samples t-test, prerequisite tests were conducted, comprising normality and homogeneity tests.

Table 5. Results of the Kolmogorov-Smirnov Normality Test for *Posttest* Data of the Control and Experimental Groups

Groups	Statistic	df	Sig.
Experimental	.151	32	.061
Control	.130	32	.180

Based on Table 5, the Kolmogorov-Smirnov normality test results indicate that both the experimental and control groups obtained significance values > 0.05. Thus, the posttest data from both groups are considered to be normally distributed, and the homogeneity test was subsequently conducted. The results are presented in Table 6.

Table 6. Results of the Levene Homogeneity Test for the Control and Experimental Groups

Based On	Levene's Statistic	Sig.
Mean	.022	.884

Based on Table 6, a significance value of > 0.05 was obtained, indicating that the variance between the control and experimental groups is homogeneous. Thus, the assumption of homogeneity is satisfied. After the prerequisite tests were met, an independent samples t-test was conducted to test the following hypotheses:

H_0 : $\mu_1 = \mu_2$: There is no significant difference between the mean mathematics learning outcomes of seventh-grade students taught using the problem-posing learning model and those taught using the direct instruction model.

H_1 : $\mu_1 \neq \mu_2$: There is a significant difference between the mean mathematics learning outcomes of seventh-grade students taught using the problem-posing learning model and those taught using the direct instruction model.

Hypothesis testing was conducted using SPSS software. The results of the independent samples t-test are presented in Table 7.

Table 7. Independent Samples t-Test Results

Groups	Sig. (2-tailed)	Mean difference
Equal variances assumed	.048	6.92375

Based on Table 7, the significance value (2-tailed) is < 0.05, so H_0 is rejected. Thus, the problem-posing learning model has a significant effect on students' mathematics learning outcomes, as the *posttest* mean score of the experimental classes is higher than that of the control classes. To determine the magnitude of improvement in student learning outcomes from the *pretest* to the *posttest* in each group, an N-Gain calculation was performed. The results are presented in Table 8.

Table 8. N-Gain Score Results

Groups	N-Gain	Category
Experimental	0.57	Medium
Control	0.66	Medium

Based on Table 8, the N-Gain value for the experimental group was 0.66 and for the control group was 0.57 both fall within the medium category. However, the N-Gain value for the experimental group was higher than that of the control group by a margin of 0.09.

Discussion

This study involved 64 seventh-grade students at SMP Negeri 1 Palu, each class of which was heterogeneous in composition, assigned to two groups. The

experimental group consisted of 32 students from Grade 7F, comprising 18 female and 14 male students, while the control group consisted of 32 students from Grade 7J, comprising 16 female and 16 male students. Prior to the study, mathematics instruction in these classes generally employed the direct instruction model, in which the teacher played a central role in delivering content through explanation, demonstration, and guided practice, while students followed along and completed assigned exercises. Based on observations and interviews with the mathematics teachers, it was found that seventh-grade students tended to be passive during the learning process, both in asking questions and responding to questions posed by the teacher. This passivity was largely attributed to shyness and a lack of self-confidence stemming from a fear of giving incorrect answers, resulting in low student engagement and suboptimal development of mathematical conceptual understanding. The mean student learning outcomes also remained below the Minimum Mastery Criteria. In response to these conditions, the problem-posing learning model was introduced as an alternative approach with the potential to foster active student engagement and improve learning outcomes, particularly given that this model had never previously been implemented in seventh-grade mathematics instruction at the school.

The problem-posing learning model was implemented over four instructional sessions. The use of student worksheets (LKPD) as a structured learning tool in this study reflects findings that well-designed LKPD based on contextual problems can effectively facilitate students' mathematical abilities at the junior high school level (Pratiwi et al., 2025). Prior to the first session, all students completed a pretest to assess their initial abilities before the treatment was administered. The core learning activities at each session were carried out through problem-posing student worksheets (LKPD) completed in small groups. Group discussion played a central role in this process, as students collaboratively evaluated whether the problems they formulated were logical, solvable, and relevant to the given context. The following Table 9 presents an example of a problem-posing worksheet completed by students.

Table 9. Examples of problem-posing tasks used in the student worksheets (LKPD)

Strategies	Example
Structured	Pose a new problem by changing the numbers, expressions, or information in the given problem, or by adding new information to the given problem. A lift has a maximum capacity of 800 kg. The average weight of an adult is 60 kg and the average weight of a child is 30 kg. There are already 5 adults inside the lift. Pose a new problem using a linear inequality in one variable based on this situation.
Semi-Structured	Using the price information in the picture below, pose a word problem involving a linear equation in one variable.

At the end of each session, groups exchanged their worksheets with other groups to be solved. Upon completion of all four sessions, all students completed a *posttest* to measure their learning outcomes following the treatment. Throughout all four sessions, the learning process was monitored using structured observation sheets documenting both teacher and student activities, serving as supporting data to verify that instruction was carried out as planned.

The data analysis revealed a significant difference in learning outcomes between the experimental and control groups, with an independent samples t-test significance value of .048 ($p < .05$). The improvement in learning outcomes in the experimental group was further reflected in a higher N-Gain value compared to the control group, although both fell within the medium category. This improvement is closely linked to the nature of the activities that took place during the learning process. The National Council of Teachers of Mathematics NCTM (1991) asserts that cognitively challenging problem-posing activities can enhance students' conceptual understanding and foster their mathematical reasoning abilities. This is consistent with the observational findings of the present study, in which students were observed analyzing given mathematical situations, identifying relevant information, and determining relationships among concepts prior to formulating their own problems. Wang et al. (2022), through a meta-analysis of 21 studies, found that student engagement in problem-posing activities had a positive effect on academic achievement, particularly in problem-solving skills and mathematics learning outcomes.

In addition to promoting conceptual understanding, the problem formulation activity also required students to evaluate whether the problems they constructed were logical, solvable, and contextually relevant. Sarira et al. (2026), in a systematic review of 25 national and international articles, identified that the problem-posing model consistently enhanced students' conceptual understanding, critical thinking skills, and active participation in learning, all of which were observed in the present study when students discussed and questioned the validity of the problems they formulated before reaching group consensus. Baumanns & Rott (2022) identified that engagement in the problem-posing process elicited metacognitive behaviors among students, including planning, monitoring, and self-evaluation behaviors that reflect active student involvement in managing their own thinking processes.

This cognitive engagement was further reinforced through peer interaction as students discussed and assessed the validity of problems constructed within their groups. Gade & Blomqvist (2015) identified peer interaction as one of the most prevalent scaffolding strategies in problem-posing. Kontorovich et al. (2012) proposed a framework for analyzing students' problem-posing process comprising five aspects: task organization, knowledge base, problem-posing heuristics and schemes, group dynamics and interactions, and individual considerations of aptness. Collectively, these activities reflect the principles of constructivist learning, in which learning is understood as a process of knowledge construction that is both individual and social in nature. Students drew upon their own understanding of the problem-posing task to formulate mathematical problems, and subsequently reached shared agreement within their groups regarding the quality of

the problems produced (Li et al., 2020). This constitutes the link between the learning process and the improvement of learning outcomes, as demonstrated by Ran et al. (2025) through a meta-analysis of 26 studies confirming that problem-posing interventions have a significant positive effect on students' cognitive mathematics learning outcomes, with an effect size of 0.53.

These findings are consistent with those of Polii et al. (2024), who compared the learning outcomes of junior high school students taught using the problem-posing model and the direct instruction model, finding that the experimental class achieved a mean learning outcome score of 80.20, which was higher than the control class mean of 75.95, and concluded that the implementation of the problem-posing model had a significant effect on student learning outcomes. The consistency of these findings with prior research strengthens the conclusion that the problem-posing learning model is effective in improving the mathematics learning outcomes of seventh-grade students at SMP Negeri 1 Palu.

4. Conclusion

Based on the data analysis and hypothesis testing conducted in this study, it is concluded that the problem-posing learning model is effective in improving the mathematics learning outcomes of seventh-grade students at SMP Negeri 1 Palu. This is evidenced by the results of the independent samples t-test, which yielded a significance value of .048 < .05, leading to the rejection of H_0 and indicating a significant difference in learning outcomes between the class taught using the problem-posing learning model and the class taught using the direct instruction model. Furthermore, the N-Gain calculation revealed that the improvement in learning outcomes of the experimental group (0.66) was higher than that of the control group (0.57), although both fell within the Medium category. These findings collectively support the conclusion that the problem-posing learning model is effective in improving the mathematics learning outcomes of seventh-grade students at SMP Negeri 1 Palu.

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