The Effect of Problem-Based Learning Model Assisted by Star Tree Media on Learning Outcomes on The Material of Adding Numbers 1-10 Grade One Elementary School

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ABSTRACT: Learning (PBL) assisted by Star Tree media on learning outcomes on the material of adding numbers 1-10 in grade one elementary school. The background of the study is based on the low achievement of learning outcomes in learning mathematics in low grades, especially in addition material. This research used quasi-experiment method with posttest control group design. The research subjects were first grade students of SDN Senduro 01 consisting of 45 students, with details of 22 students as the experimental group and 23 students as the control group. The instruments used were learning outcomes test. The data were analyzed using Independent Samples t-test. The results of the analysis showed that there was a significant effect of the application of PBL model assisted by Star Tree media on learning outcomes. This finding shows that the integration of the PBL model with concrete visual media such as Star Tree can increase the effectiveness of mathematics learning in early grades. This research provides a theoretical contribution to the development of learning models that are in accordance with the cognitive development stage of elementary school students and provides practical alternatives for teachers in improving the quality of learning.

KEYWORDS: Problem Based Learning, Star Tree, learning outcomes, elementary school.

INTRODUCTION

Mathematics constitutes one of the fundamental subjects essential for developing students' logical and systematic thinking abilities from an early age. At the elementary school level, particularly in first grade, mastery of basic operations such as addition of numbers 1–10 becomes a crucial foundation for building numerical literacy. However, field observations reveal that numerous students continue to experience difficulties in comprehending addition concepts meaningfully. This aligns with Van de Walle et al. (2019), who assert that addition serves as the foundation for all arithmetic operations, and failure to understand this concept can have long-term implications for students' mathematical development.

Initial observations at SDN Senduro 01 in Senduro District disclosed that over 55% of first-grade students have not achieved the Minimum Mastery Criteria (KKM) in addition material. Similar phenomena were also identified by Rosliani et al. (2024) and Wulandari & Rahayu (2022) in other elementary schools, demonstrating low student learning achievement in comparable materials. These findings highlight a significant gap between ideal mathematics learning conditions and actual classroom practices.

To address these challenges, contextual and student-centered learning approaches are necessary. One widely recommended model in the literature is Problem-Based Learning (PBL). Hmelo-Silver (2004) notes that PBL is designed to engage students in solving real-world problems as a means of developing critical thinking skills and learning independence. Previous research has demonstrated that PBL can enhance student learning outcomes and motivation (Apriani et al., 2024; Tambunan et al., 2024). However, PBL effectiveness for early-grade students requires adaptation to their cognitive developmental characteristics, which remain in the concrete operational stage (Piaget in Komariah, 2023).

One risk of implementing PBL with young students involves presenting overly abstract problems. Rusman (2010) cautions that when problems are not connected to concrete contexts, students may lose direction in their learning. To overcome these limitations, concrete and visual learning media are needed to help students understand problem-solving stages gradually and enjoyably.

In response to these needs, researchers designed the Star Tree Media, a visual aid based on adventure stories packaged through a narrative titled "Magical Water Drops and the Withered Star Tree." In this story, students are invited to assume the role of main characters who must revive the star tree's light by collecting numbered water drops and completing addition operations. This medium enables students to learn through play while understanding addition concepts concretely and enjoyably. Maharani (2024) in her

research also demonstrates that similar media such as number trees have significant impact on children's early counting abilities. Support for visual media is also expressed by Mayer (2005), who states that well-designed visual media can reduce cognitive load and enhance student absorption of abstract material.

Therefore, this research aims to empirically examine the influence of Problem-Based Learning models assisted by Star Tree media on learning outcomes in addition of numbers 1–10 material. Beyond providing theoretical contributions regarding the effectiveness of integrated models and learning media, this study is also expected to offer practical recommendations for designing meaningful mathematics learning appropriate to elementary school students' developmental stages.

RESEARCH METHODS

This study employed a quasi-experimental approach using a posttest-only control group design. The research involved two groups: an experimental group that received treatment through a Problem-Based Learning (PBL) model supported by Star Tree media, and a control group that was taught using a Direct Instruction model with picture media support. The intervention was conducted across three sessions, each lasting 70 minutes.

The study population comprised all first-grade students at Senduro 01 Elementary School. The sampling technique utilized was cluster random sampling, whereby two existing classes were randomly selected to serve as the experimental and control groups. The experimental group consisted of 23 students, while the control group comprised 22 students.

Data collection was conducted using a mathematics achievement test. The achievement test contained 6 short-answer items, designed to measure students' comprehension, application, and analytical abilities in solving addition problems involving numbers 1-10. The items were constructed based on learning indicators that referenced the cognitive domain framework of Anderson and Krathwohl (2001). This instrument underwent expert validation and empirical testing, yielding a validity coefficient of $r = 0.734$ and reliability (Cronbach's Alpha) = 0.81, indicating high internal consistency and suitability for classroom evaluation.

The intervention implementation spanned three sessions, with identical content, duration, and learning objectives for both groups. In the experimental group, students participated in problem-based learning through a storyline entitled "The Magic Water Drops and the Withering Star Tree", where they were engaged in solving addition problems by collecting numbered water drop images and matching them with numbers on star images to revive the star tree. This activity aimed to stimulate engagement, conceptual understanding, and foster independent learning attitudes. Meanwhile, the control group received instruction through the Direct Instruction model, where the teacher delivered content directly using picture media, followed by individual practice exercises. Both groups received equivalent time allocation and teacher support, ensuring that any emerging differences could be validly attributed to the instructional model and media employed.

The collected data were analyzed using SPSS version 27. The initial step involved descriptive statistical analysis to obtain mean values, standard deviations, and minimum and maximum scores. Subsequently, data normality testing was conducted using the Shapiro-Wilk test, along with homogeneity testing using an independent samples t-test to examine between-group differences. This analytical approach was employed to determine whether significant differences existed in learning outcomes between the experimental and control groups following the intervention.

RESULT

Descriptive analysis of learning outcomes was used to see student achievement in experimental and control groups after learning. The data included mean, standard deviation, and minimum and maximum values. These results provide an initial picture before inferential statistical tests are conducted. Descriptive statistics of learning outcomes are presented in the following table

Table 1 Descriptive Statistics

Kelas	N	Mean	Std.Dev	Min	Max
Eksperimen	22	55,2727	3.07342	48	60
Kontrol	23	49,4348	2,46477	43	53

The results of the descriptive analysis showed a striking difference between the experimental and control groups. The experimental group achieved an average score of 55.27, about 5.84 points higher than the control group which achieved 49.43. The distribution of scores in the experimental group was also wider but still reasonable. The experimental score range (48-60) surpassed the control (43-53), indicating an overall superior distribution of achievement. This finding indicates that the Problem Based Learning model assisted by Bintang Tree media is effective in improving student learning outcomes.

After conducting descriptive analysis, the next series of tests starts from the normality test. The normality test is carried out to ensure that the learning outcomes data are normally distributed before inferential analysis. This study used the Shapiro-Wilk method because the number of samples was less than 50. The data is declared normal if the p-value ≥ 0.05, and abnormal if < 0.05. The results of the normality test are presented in the following table.

Table 2 Tests of Normality

Class	Shapiro-Wilk		
	Statistic	df	Sig.
experimental class	,952	22	,350
control class	,936	23	,145

Based on the table of normality test results on posttest data, in the experimental class, the significance value (Sig.) obtained was 0.350, while in the control class it was 0.145. Both values are greater than the significance limit of 0.05, so it can be concluded that the data in both groups are normally distributed.

The next step, namely the homogeneity test, is carried out to ensure that the variance of learning outcome data between the experimental and control groups is equal. This is important so that comparisons between groups can be considered valid. This study uses Levene's Test, with the criterion that the data is considered homogeneous if the significance value> 0.05. The results of the homogeneity test are presented in the following table.

Table 3 Test of Homogeneity of Variances

		Levene Statistic	df1	df2	Sig.
Posttest Learning Outcomes	Based on Mean	1,194	1	43	,281
	Based on Median	,920	1	43	,343
	Based on Median and with adjusted df	,920	1	41,164	,343
	Based on trimmed mean	1,177	1	43	,284

Prior to conducting parametric statistical analysis, the assumption of homogeneity of variance was rigorously examined using Levene's Test for Equality of Variances. The statistical examination yielded significance values consistently exceeding $\alpha = 0.05$ across all computational approaches, including mean-based, median-based, and trimmed mean methodologies. These findings demonstrate that the learning outcome data from both experimental conditions satisfy the fundamental assumption of variance homogeneity.

The satisfaction of this critical statistical prerequisite permits the utilization of parametric testing procedures, specifically the independent samples t-test. This analytical approach is warranted given that both essential assumptions—normality of data distribution and equality of variances between groups—have been empirically verified through appropriate diagnostic testing procedures.

The investigation employed a hypothesis-testing framework utilizing the independent samples t-test to examine potential differences in learning outcomes between experimental conditions. The research hypotheses were formulated as follows:

Null Hypothesis (H_0): No statistically significant difference exists in learning outcomes between the experimental group and control group populations.

Alternative Hypothesis (H_1): A statistically significant difference exists in learning outcomes between the experimental group and control group populations.

This two-tailed hypothesis testing approach adheres to conventional statistical methodology, wherein the null hypothesis assumes no population mean differences, while the alternative hypothesis postulates the existence of significant between-group differences in learning outcomes.

The comprehensive results of the hypothesis testing procedure are systematically presented in the subsequent tabular format. The statistical output encompasses critical inferential parameters, including the calculated t-statistic, degrees of freedom, exact probability values, confidence intervals for mean differences, and effect size measures where applicable. The results of the hypothesis test are presented in the following table.

Table 4 Independent Samples T Test

		Levene's Test for Equality of Variances		t-test for Equality of Means					95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Posttest Learning Outcomes	Equal variances assumed	1,194	,281	7,045	43	,000	5,83794	,82866	4,16679	7,50910
	Equal variances not assumed			7,010	40,246	,000	5,83794	,83276	4,15519	7,52070

Based on the independent samples t-test results table, it shows that the significance value of Levene's Test is 0.281, which means that the data variance is homogeneous because it exceeds 0.05. Therefore, the analysis uses the "Equal variances assumed" line. In this row, the t value is 7.045 with 43 degrees of freedom and a significance value (Sig. 2-tailed) of 0.000. Since this value is smaller than 0.05, H_0 is rejected and H_1 is accepted. That is, there is a significant difference between the learning outcomes of the experimental and control groups. The average difference of 5.84 points indicates that the experimental group obtained higher learning outcomes. The 95% confidence interval is in the range of 4.16679 to 7.50910 and does not include zero, which further strengthens that the difference is statistically significant. Thus, the Problem Based Learning model assisted by star tree media is proven to have a significant effect in improving student learning outcomes on the material of adding numbers 1-10.

DISCUSSION

According to the constructivism perspective, PBL allows students to build knowledge through direct experience with authentic problems that are meaningful in everyday life. In learning the addition of numbers 1-10, students do not simply memorize, but understand concepts through problem solving, in line with Bloom's revised taxonomy which emphasizes higher-level cognitive processes (Anderson & Krathwohl, 2001). The integration of star tree media in PBL becomes a bridge between abstract concepts and concrete visualizations, helping students understand mathematics more tangibly. Research shows that innovative learning media can improve student learning scores (Teme, 2024), and the star tree media facilitates the transition from concrete to abstract thinking in accordance with the cognitive development stage of elementary school children.

The findings of this study are in line with various previous studies that show the consistency of the effectiveness of PBL models in improving student learning outcomes. Research by Mulya et al. (2024) revealed that PBL has a positive and significant effect on student learning outcomes in Civics subjects, where the experimental group significantly outperformed the control group. Similar support was provided by Maisaroh et al. (2023) who also noted the positive impact of PBL on student learning outcomes. Furthermore, research by Fauziah et al. (2024) showed that PBL assisted by Nearpod media not only had a positive and significant impact on geography learning outcomes of secondary school students, but also improved their critical thinking skills. This finding is highly relevant to this study as both explore the integration of PBL with learning media. Maryam (2017) also found that PBL had a positive

and significant effect on student learning outcomes, while Apriani et al. (2024) showed that the problem-based learning approach significantly improved math scores. The findings of Tri Apriani et al. are highly relevant as they both focus on mathematics learning, thus strengthening the evidence that PBL is effective in improving learning outcomes across different levels and materials. Overall, the convergence of these research results with the findings in this study confirms that PBL is a consistent and reliable approach in improving student learning outcomes.

The PBL model is able to increase students' learning motivation because the problems presented are relevant to everyday life and challenge students to think critically. As emphasized by Hasan et al. (2024), motivation is strongly correlated with improved learning outcomes, and PBL is inherently able to arouse students' intrinsic motivation through providing authentic problems that require creative solutions. From the perspective of Bloom's taxonomy revised by Anderson & Krathwohl (2001), the results showed that PBL assisted by star tree media was able to facilitate the achievement of various cognitive dimensions simultaneously. Students not only remember mathematical facts, but also understand concepts, apply procedures, analyze problems, evaluate strategies, and even create new solutions.

CONCLUSION

Based on the results of the research and discussion that has been carried out regarding the effect of the Problem Based Learning model assisted by star tree media on learning independence and student learning outcomes on the material of adding numbers 1-10 in elementary schools, it can be concluded that the Problem Based Learning model with the help of star tree media is proven to be effective in increasing student learning independence on the material of adding 1-10. This learning model encourages students to develop metacognitive skills, take responsibility for their own learning process, and be able to design and evaluate problem-solving strategies. Star tree media serves as a tool that supports independent understanding of concepts through exploration of authentic problems, without full dependence on the teacher.

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