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THE EFFECT OF PROBLEM-BASED LEARNING MODEL ON STUDENTS' LEARNING OUTCOMES: A CASE ON CENTRAL TENDENCY MEASURES

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ABSTRACT

This study investigates the low academic performance of eighth-grade students at SMP Negeri 2 Telaga, with an average score of 50.1. Effective learning requires the application of appropriate teaching models to foster active student participation and improve outcomes. The purpose of this research is to determine the difference in student achievement between those taught using the Problem-Based Learning (PBL) model and those taught through Direct Instruction, specifically on the topic of measures of central tendency. A quantitative approach was used with a Posttest-Only Control Group Design. The sample consisted of 16 students in the experimental group and 15 in the control group. Data were analyzed using both descriptive and inferential statistics. Descriptive analysis included measures such as mean, mode, median, variance, and standard deviation. Inferential analysis was conducted to test the normality and homogeneity of the data before performing hypothesis testing.The findings reveal that the average posttest score of students taught with the PBL model was higher than that of students taught using direct instruction. This difference was supported by a hypothesis test result of 555 at a 0.05 significance level and an effect size of 1.043, indicating a high level of impact.These results suggest that the Problem-Based Learning model significantly improves student learning outcomes in the topic of measures of central tendency for eighth-grade students at SMP Negeri 2 Telaga.

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INTRODUCTION

Based on the definition provided by the Kamus Besar Bahasa Indonesia (KBBI), education is interpreted as a process aimed at transforming the behavior of individuals or groups through systematic guidance in the form of training and teaching. This transformation is directed toward

the development and maturation of human beings so they can function effectively in society. Education is not merely about knowledge transmission; it involves cultivating attitudes, values, and competencies that enable a person to grow into a responsible and capable individual.

Furthermore, the legal foundation as outlined in the Law of the Republic of Indonesia Number 20 of the Year 2003 emphasizes that education is a deliberate and structured endeavor to create an environment conducive to learning. It is intended to empower learners to engage actively in self-regulation, improve their own capabilities, and contribute meaningfully to the wider community. The law articulates that education aims to nurture learners' inner potential so they may develop a strong moral foundation, intellectual capacity, spiritual awareness, and well-rounded character.

From the spirit of this legislation, it can be inferred that learners are expected to adapt to educational settings not just as passive recipients of information, but as active participants in shaping their own growth. This adaptation is essential in preparing them to face future challenges and to become individuals who play a constructive role in nation-building. Through quality education, it is hoped that students will evolve into competent and ethical citizens who contribute to the advancement of society and the creation of a progressive, knowledgeable, and dignified nation.

In every level of education, there is a compulsory subject known as mathematics. The word mathematics originates from the Latin term mathematike, which means "to study" (Rahmah, 2018). From an early age, students are taught to reason, to think logically, and to learn about counting (Mahmud et al., 2024). Mathematics as a subject helps shape students into individuals who are capable of thinking critically and analytically when faced with different situations and conditions. Through reasoning, learning outcomes can be achieved, which are part of mathematical science, where the topic being studied is knowledge itself (Zebua, 2021). In addition, objects considered abstract are often referred to as a distinctive feature of mathematics, as this subject follows a deductive-axiomatic thinking pattern that is based on truth. From this characteristic, it can be seen that the development of students' abilities is influenced by learning mathematics, so that in the field of Science and Technology, a student's character and competence can be formed (Suharto, 2017).

The subject of mathematics helps shape students into individuals who are capable of critical and high-level reasoning when observing various conditions and situations. Moreover, students are also trained to deal with real-life problems in a way that is efficient, honest, effective, accurate, critical, and rational (Suhartini & Martyanti, 2017). Based on this, it can be understood that mathematics offers positive opportunities and provides meaningful benefits for students in their future lives. Learning outcomes are defined as the result of achieving a change in behavior that tends to remain stable over time. This is in line with the opinion of Abín et al. (2020), which states that high achievement in mathematics is closely related to well-being, life satisfaction, income, and the potential for long-term physical and professional well-being.

Teachers serve as intermediaries in the educational process, acting as the ones who deliver knowledge, while students are the recipients or the ones being educated (Atalap et al., 2025). As motivators, educators are expected to instill a sense of motivation in students so that they are encouraged to learn with genuine effort. Without sufficient motivation from the beginning, students may become unmotivated, which can lead to laziness and difficulty in understanding the lessons being taught. The effectiveness of the learning process plays a vital role in determining whether learning objectives can be achieved (Ade et al., 2022).

Mathematics is often viewed by students as a boring subject, making it one of the subjects that frequently encounters learning challenges (Abdullah et al., 2021). A significant number of students show low interest in mathematics, which causes them to pay little attention during

class. As a result, their academic performance in mathematics tends to fall below the expected standards (Buyung, 2022).

The study conducted by Oribhabor (2020) identified various challenges encountered during mathematics learning, such as conceptual difficulties, math anxiety, ineffective teaching models, and socio-cultural factors that hinder the learning process of junior high school students in Indonesia. These issues can actually be addressed by implementing an appropriate learning model, as choosing a suitable approach not only facilitates effective delivery of the material, but also helps create a conducive learning environment, enhances active student participation, and encourages them to think critically, understand concepts deeply, and ultimately achieve optimal learning outcomes in line with the established educational goals.

Based on observations made by the researcher during the Teaching Program at SMP Negeri 2 Telaga in 2024, it was found that most students simply copied the material into their notebooks and completed a few practice questions while the teacher explained the content. This approach resulted in low test scores among Grade VIII students. During daily assessments, some students answered only one out of four questions, while others merely wrote the final answer without showing the steps involved. There were also students who left their answer sheets completely blank, often due to their lack of engagement during classroom instruction, which ultimately affected their academic performance.

Even when remedial sessions were conducted, many students were still unable to answer the same questions that had appeared on their previous exams. During regular lessons, several students made excuses to leave the classroom—for instance, asking permission to go to the restroom—but did not return until the end of the period, indicating a lack of seriousness and participation in the learning process.

The data on the learning outcomes of Grade VIII students at SMP Negeri 2 Telaga in the 2023/2024 academic year regarding the topic of measures of central tendency are as follows:

Table 1. Students' Learning Outcomes on the Topic of Measures of Central Tendency in Grade VIII of SMP Negeri 2 Telaga in the 2023/2024 Academic Year

Category KKTP	Number of Students	Percentage
Students who meet the criteria (≥ 70)	7 students	21,88%
Students who do not meet the criteria (< 70)	25 students	78,12%
Total number of students	32 students	100%
Average student score	50,1	

Based on Table 1, it can be seen that the learning outcomes of Grade VIII students at SMP Negeri 2 Telaga in the 2023/2024 academic year on the topic of measures of central tendency show that only 21.88% of students met the Minimum Mastery Criteria (KKTP). In the classroom, the teacher applied a direct instruction model during teaching, which led to students being mostly passive throughout the learning process. This condition highlights the importance of implementing an appropriate teaching method to encourage students to be more actively engaged and motivated to participate in class. Applying a suitable method is an important step in helping students grasp mathematical concepts and solve problems correctly (Wulandari et al., 2016).

To improve student learning outcomes, the use of the Problem-Based Learning (PBL) model can be considered as a solution. Based on observations, this learning model has not yet been implemented at SMP Negeri 2 Telaga. In PBL, the core focus lies in problem-solving, which drives the learning process and encourages students to engage in self-reflection with guidance from the teacher (Pratiwi et al., 2023). In simple terms, problem-based learning is a learning

approach that presents students with real-world problems to be solved through a process of inquiry and investigation (Abbas et al., 2021). The study conducted by Rasubala et al. (2023) states that the implementation of the Problem-Based Learning model significantly improves the mathematics learning outcomes of eighth-grade junior high school students, indicating that this model is effective in helping students achieve the Minimum Learning Outcomes (MLO).

This problem-centered learning model encourages students to take an active role in the learning process by engaging with real-world challenges, leading to a deeper understanding of concepts compared to conventional learning methods. A problem-oriented learning approach is particularly well-suited for teaching the topic of measures of central tendency, as it helps students grasp the concepts more thoroughly by working through realistic problem-solving situations.

Students are not only expected to calculate the formulas for mean, median, and mode, but through the use of the Problem-Based Learning (PBL) model, they also learn to apply these concepts in real-life situations. This makes the material easier to understand and has a positive impact on learning outcomes. It also helps develop skills such as evaluating, exploring, solving, and carrying out the steps involved in problem-solving. Therefore, this study plays a role in supporting the use of an appropriate learning model to improve the quality of education.

Based on the issues that have been outlined, the purpose of this study is to determine the differences in student learning outcomes between those taught using the Problem-Based Learning model and those taught using the Direct Instruction model on the topic of measures of central tendency in Grade VIII at SMP Negeri 2 Telaga. In line with this objective, the researcher intends to conduct an experimental study entitled "**The Effect Of Problem-Based Learning Model On Students' Learning Outcomes: A Case On Central Tendency Measures**".

METHOD

This study is categorized as experimental research employing a quantitative approach. According to Berlianti et al. (2024), quantitative research emphasizes the collection and analysis of numerical data and involves the use of controllable variables. This approach enables researchers to systematically and objectively examine phenomena and the relationships between variables through structured and measurable scientific procedures.

The study was conducted in two classes, with the Problem-Based Learning (PBL) model implemented in the experimental class and the Direct Instruction model applied in the control class. The research design used was a Post-test Only Control Group Design, in which the assessment instrument was an essay test administered after the completion of the instructional activities on the topic of measures of central tendency.

The sample was selected using cluster random sampling. The experimental group consisted of Class VIII-1 (16 students), taught using the PBL model, while the control group consisted of Class VIII-2 (15 students), taught using the Direct Instruction model. The research was carried out from May 15 to May 26, 2025, during the even semester of the 2024/2025 academic year.

To assess students' learning outcomes, five essay questions were used. The initial step involved scoring students' responses based on a predefined scoring rubric. Descriptive statistical analysis was then performed to present the overall learning outcomes using indicators such as the mean, median, mode, standard deviation, and variance, which were further illustrated through tables and histograms. Prior to hypothesis testing, a normality test was conducted to verify the distribution of the data, followed by a homogeneity test to confirm that the variances between the experimental and control groups were equal. Upon meeting the assumptions of normality and homogeneity, an Independent Samples T-Test was conducted to determine whether a

statistically significant difference existed between the learning outcomes of the two groups. Finally, to measure the magnitude of the effect of the instructional model employed, the effect size was calculated using Cohen's *d*. The results of this comprehensive analysis formed the basis for concluding the impact of the treatment applied in the study.

RESULTS AND DISCUSSION

Results

This research is a quantitative study aimed at determining the effect of applying the Problem-Based Learning model and the Direct Instruction model on students' learning outcomes, particularly on the topic of measures of central tendency in Grade VIII at SMP Negeri 2 Telaga. The selected classes were VIII-1 as the experimental group and VIII-2 as the control group. Data were collected through essay-type tests administered after the completion of all material on measures of central tendency. The following are the results of the descriptive statistical analysis from both classes:

Tabel 2. Data from the Descriptive Statistical Analysis

Group/Class	Experimental	Control
n	16	15
Min. Score	49	45
Max. Score	72	69
Mean	61,313	55,33
Mode	59,75	56,642
Median	61,5	56
SD	6,183	5,875
Variance	38,229	34,523

Based on Table 2, the average scores obtained by both groups can be seen, with the experimental group having a mean score of 60.875 and the control group having a mean score of 54.733. It can be observed that the experimental group achieved higher scores than the control group.

From the post-test results of 16 students in the experimental class, it was found that the highest score achieved was 72, while the lowest score was 49. The data distribution is presented in the following histogram:

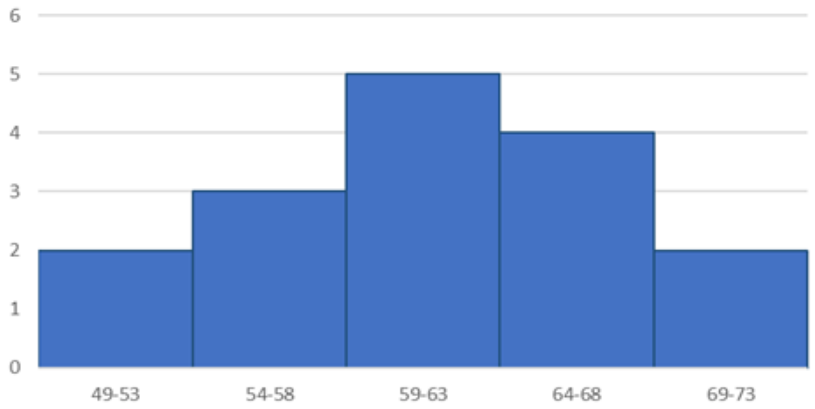

Figure 1. Histogram of the Learning Outcomes of Students Taught with the Problem Based Learning Model

Meanwhile, based on the post-test results of 15 students in the control class, it was found that the lowest score was 45, while the highest score reached 69. The data distribution is illustrated in the following histogram:

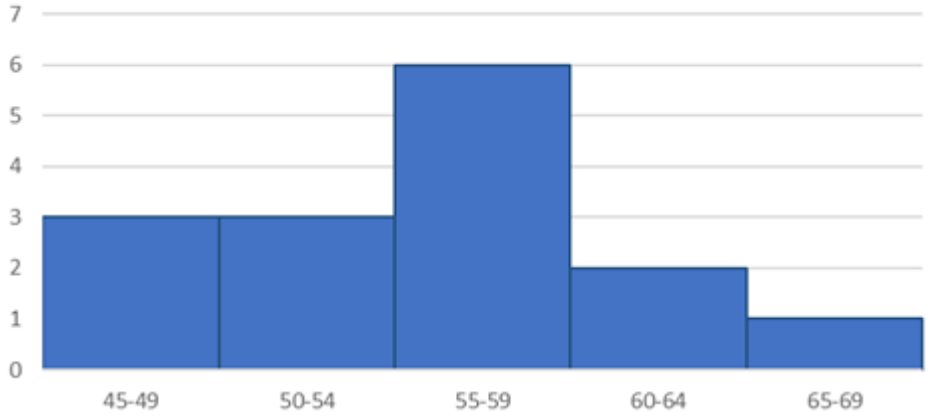

Figure 2. Histogram of the Learning Outcome Data of Students Taught Through the Direct Instruction Model

To determine the effect of the applied instructional models after six learning sessions using the problem-based learning model and the direct instruction model, a hypothesis test is necessary. This is done to clearly express, in statistical terms, whether the use of the PBL model has a positive influence on learning outcomes. However, before that, tests of normality and homogeneity will first be conducted on the two sample groups in the study.

The normality test is used to determine whether the data distribution follows a normal pattern or not. The Lilliefors test will be employed to assess the normality of the data. The decision criteria are: accept H_0 and reject H_1 if $L_{value} \leq L_{table}$ at a specified level of significance $\alpha = 0{,}05$, The null hypothesis (H_0) states that the data are normally distributed while the alternative hypothesis (H_1) hypothesis indicates that the data are not normally distributed. The following is the data distribution for both the experimental and control classes:

Table 3. Normality Test Results of the Student Learning Outcomes Data from the Two Groups

Class	n	L_{value}	$L_{(\alpha=0{,}05)}$	Conclusion
Ecperimental	16	0,1182	0,213	Normal
Control	15	0,1040	0,220	Normal

From Table 3, it can be seen that the data in both classes are normally distributed because the value of $L_{hitung} < L_{tabel}$ at a specified level of significance $\alpha = 0{,}05$.

The next test is the homogeneity test of the two sample groups, which is conducted if the data have been proven to follow a normal distribution. This study will employ an F-test with a significance level of $\alpha = 0{,}05$ With the criterion that the data from both groups have equal variances if the calculated $F_{hitung} \leq F_{tabel}$. The following are the results of the variance equality test for the two classes:

Table 4. Results of the Research Data Homogeneity Test Using the F-Test

Class	n	dk	F_{hitung}	$F_{(\alpha=0,05)}$	Conclusion
Ecperimental	16	15	1,196	2,460	Homogen
Control	15	14			

According to Table 4, the variance equality test shows that the calculated $F_{hitung} \leq F_{tabel}$ ($\alpha = 0,05$), indicating that the populations from both samples in this study have equal variances. The results of the assumption tests reveal that both samples exhibit normally distributed and homogeneous data, implying that the requirements have been met and the hypothesis testing can be conducted.

An independent samples t-test is employed for hypothesis testing with the aim of determining whether the application of different instructional models during the learning process leads to variations in student learning outcomes. The results of the test are as follows:

Table 5. Findings from the Independent Samples T-Test

Class	Mean	SD	Variance	dk	t_{value}	$t_{table(1-\alpha)}$
Ecperimental	60,875	6,182	38,229	15	2,833	1,699
Control	54,73	5,875	34,523	14		

Dari tabel 5, didapat hasil $t_{hitung} = 2,833$ pada taraf signifikan $\alpha = 0,05$ dari tabel distribusi t diperoleh $t_{tabel} = 1,669$. Karena $t_{hitung} \geq t_{tabel}$ yaitu $2,833 \geq 1,669$ maka diterimanya hipotesis H_1 yang diajukan dan H_0 ditolak.

Based on the data presented in Table 5, the calculated $t_{value} = 2,833$ at a significance level of α = 0.05 was compared with the critical value from the *t*-distribution table, which was found to be $t_{table} = 1,669$. Since the calculated $t_{value} \geq t_{table}$ ($2,833 \geq 1,669$), the alternative hypothesis (H_1) is accepted, while the null hypothesis (H_0) is rejected.

Based on the data analysis, it was found that in the topic of measures of central tendency, the average learning outcomes of students taught through the problem-based learning model were higher than those of students taught through the direct instruction model. This is evident from the mean score obtained by the experimental class, which was 60.875, while the control class achieved an average score of 54.733.

After conducting the t-test on the research data and obtaining the expected conclusion, the analysis was continued by measuring the magnitude of the effect of the PBL model using Cohen's d formula. The result of the calculation showed a value of 1.043, which falls into the category of having a strong effect based on the Cohen's d criteria table.

Discussions

This study aimed to investigate the effect of implementing the Problem-Based Learning (PBL) model compared to Direct Instruction on eighth-grade students' mathematics learning outcomes, specifically on the topic of measures of central tendency. Based on the data analysis, it was found that the average score of the experimental group (PBL) was 60.875, which was higher than that of the control group (Direct Instruction), which scored 54.733. The result of the independent samples t-test showed that the calculated t-value (t_{value} = 2.833) was greater than the critical t_{table} = (t_{table} =1.669), indicating a statistically significant difference between

the two groups. This suggests that the application of the PBL model has a positive impact on improving students' mathematics learning outcomes.

This result is consistent with the findings of Hildayanti et al. (2024), who also confirmed the positive effects of problem-based learning methods on students' mathematics performance. The presence of this effect underscores the importance of connecting lesson content with real-life problems and encouraging students to engage in group discussions and peer collaboration. As emphasized by Nasution et al. (2018), students with strong self-regulation skills tend to be better at identifying effective learning strategies to achieve their academic goals.

Nonetheless, Direct Instruction also possesses distinct advantages, particularly in delivering procedural and systematic content. According to Hattie (2009), Direct Instruction has a high effect size value (0.59), reflecting its effectiveness in building foundational understanding and clarifying step-by-step problem-solving procedures. In this context, Direct Instruction remains relevant, especially during the initial stages of learning mathematical concepts.

Interestingly, several studies suggest a blended approach combining DI and PBL. Research by Kirschner et al. (2006) indicates that problem-based learning becomes more effective when students have already established a strong foundation of prior knowledge. Therefore, a teaching strategy that begins with conceptual reinforcement through Direct Instruction, followed by the application of PBL, may lead to more optimal learning outcomes. This is in line with Arends (2012), who noted that beginning with explicit instruction can enhance students' readiness to engage in problem-based activities.

Additionally, the Cohen's d value obtained in this study was 1.043, indicating a strong effect size. This reinforces the conclusion that the PBL model not only yields statistically significant results but also has a practically meaningful impact on students' achievement in mathematics, particularly in topics requiring conceptual understanding and application. This finding is further supported by Dods (1997), who emphasized the effectiveness of PBL in enhancing students' analytical and reflective thinking skills.

In conclusion, the findings of this study provide meaningful contributions to the selection of appropriate instructional strategies in the context of mathematics education at the junior high school level. Teachers are encouraged to adopt the PBL model, particularly for content that requires active student engagement in problem-solving. However, the role of Direct Instruction remains essential as an initial foundation to ensure that students grasp the basic concepts before exploring their application in real-world contexts.

Efforts directed toward positive outcomes and carried out through conscious, structured actions can have an impact on student learning outcomes (Ariyani & Kristin, 2021). This process is undoubtedly influenced by several supporting factors, both internal and external. Ariyani & Kristin (2021) suggest that internal factors can influence student behavior, including aspects such as concentration and motivation, particularly during learning activities. On the other hand, Samsudin (2020) describes external factors as those originating outside the student, such as the community, classroom environment, school setting, and family background. These elements are interconnected and significantly contribute to the effectiveness of the instructional model applied by teachers. The level of success can be measured by the extent to which students achieve their learning outcomes. The higher the scores students obtain, the greater the indication of successful teaching practices.

CONCLUSION

Referring to the explanations provided in the results and discussion section, it can be concluded that the Problem-Based Learning (PBL) model has a significant impact on student learning outcomes. This conclusion is supported by the hypothesis test, which yielded a value of

$t_{hitung} = 2{,}833 > t_{tabel} = 1{,}699$ at a significance level of $\alpha = 0{,}05$. It was found that students taught using the PBL model achieved higher average scores in the topic of measures of central tendency compared to those taught through the direct instruction method. This difference is further supported by the effect size test result of 1.043, which falls under the category of a strong influence.

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