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Problem-Based Learning Model: Its Influence on Learning Straight Line Equations

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ABSTRAK
Inovasi dalam pembelajaran matematika telah dilakukan oleh banyak peneliti dan pengajar matematika. Akan tetapi, masih terdapat banyak kendala yang dihadapi oleh guru bahkan siswa itu sendiri, terutama terkait hasil belajar pada materi persamaan garis lurus. Studi ini bertujuan untuk mengetahui perbedaan hasil belajar siswa yang diajarkan dengan menggunakan model problem-based learning dan model direct instruction pada materi persamaan garis lurus. Metode yang digunakan adalah metode kuantitatif dengan desain posttest only-control group design. Subjek penelitian adalah siswa kelas VIIIB dan siswa kelas VIIIC SMP Negeri 3 Tondano. Instrumen yang digunakan berupa tes berbentuk uraian untuk menilai hasil belajar siswa pada materi persamaan garis lurus. Hasil perhitungan statistic menunjukkan bahwa diperoleh thitung = 3,808 dan ttabel = 1,682 untuk db = 42 dan α = 0.05. Sehingga thitung > ttabel dengan demikian berdasarkan kriteria pengujian, jika thitung > ttabel maka tolak H0, artinya rata-rata hasil belajar siswa pada materi PGL yang diajar menggunakan model PBL lebih dari rata-rata hasil belajar PGL siswa yang diajar menggunakan model DI.Oleh karena itu, model PBL dapat dijadikan rujukan utama bagi guru dalam mengembangkan pembelajaran matematika khususnya pada materi PGL.

KATA KUNCI
problem based learning; persamaan garis lurus; hasil belajar

ABSTRACT
Many mathematics researchers and teachers have carried out innovations in mathematics learning. However, there are still many obstacles faced by teachers and even students themselves, especially regarding learning outcomes in straight-line equations. This study aims to determine the differences in student learning outcomes taught using the problem-based learning model and the direct instruction model on straight-line equation material. The method used is a quantitative method with a posttest-only-control group design. The research subjects were class VIIIB students and class VIIIC students at SMP Negeri 3 Tondano. The instrument used is a test in a description to assess student learning outcomes in straight-line equation material. The results of statistical calculations show that t_count=3.808 and t_table=1.682 for db=42 and α=0.05. So that t_count>t_tabel is thus based on the testing criteria, if t_count>t_tabel, then reject H_0, meaning that the average student learning outcomes in PGL material taught using the PBL model are more than the average PGL learning outcomes for students taught using the IN models. Therefore, the PBL model can be used as the primary reference for teachers in developing mathematics learning, especially in PGL material.

KEYWORDS
problem based learning; straight line equations; learning outcomes

INTRODUCTION

Mathematics is a ubiquitous subject in the Indonesian education system, including all levels of schooling from primary to postsecondary education. Mathematics is a systematic study of quantities and concepts that are interconnected with each other. It is separated into three main fields: algebra, analysis, and geometry (Syaiful & Aswan, 2014; As'ari, 2017; Mangelep et al., 2023). Even though mathematics has a vital role in all aspects of life, there are still many students who are not interested in studying mathematics because it is considered a subject that is difficult to understand (Ulfah & Arifudin, 2021; Domu & Mangelep, 2024). This is caused by students' need to understand mathematical concepts regarding the material being studied.

In mathematics learning, apart from having an abstract nature, a good understanding of concepts is fundamental because to understand new concepts, the prerequisite for understanding previous concepts is required. When students have good concepts, students can see relationships between concepts or learn new ideas by connecting ideas they did not know before (Mangelep, 2017; Wuwumbene et al., 2018; Eismawati et al., 2019) and can provide arguments according to their abilities without changing their meaning (Fathurrahman, 2015; Mangelep et al., 2023).

This is because the mathematical ideas that students gain by understanding are interrelated (Mangelep et al., 2017; Kuswadi et al., 2022), so it is easier for students to remember and use them again when they forget (Lakumani et al., 2017; Mangelep et al., 2024). Understanding mathematical concepts should make it easier for students to achieve the Minimum Learning Completeness (KBM) criteria set by the school (Mandey, 2021).

Straight Line Equations (PGL) is one of the mathematics learning materials that students must master. Questions regarding PGL are often found in the National Examination (UN), State University Entrance Selection Examination (SNMPTN), and other examinations. Therefore, students are required to understand PGL material well (Mangelep, 2015). However, many students still need help understanding PGL material (Mokoginta et al., 2023).

Students' difficulties in studying PGL include a need for more understanding of the concept, so students experience difficulty drawing graphs from PGL (Mangelep et al., 2020) and determining gradients and equations from a straight-line graph (Mega, 2017). The role of students in the mathematics learning process is very lacking (Mulyani, 2021), where students only listen to the explanations given by the teacher and work on questions based on the formulas that have been given without spending more effort to gain knowledge, especially in understanding concepts related to the material being studied (Rusman, 2016).

The same problem also occurred at SMP Negeri 3 Tondano. Based on researchers' observations, it was found that students' achievement of mathematics learning outcomes still needed to be improved. This is because understanding concepts in mathematics learning, especially in PGL material, still needs to improve, so students find it challenging to solve problems.

In the 2021-2022 academic year, data on student learning outcomes in PGL material shows that around 64% of students still need to reach the Minimum Learning Completeness (KBM) determined by the school of 75. Students who have yet to reach the KBM must be remedied so that teachers and students can increase their study time to catch up. The average student learning result for the Mathematics subject is 65, which is also still below the KBM, and this indicates that the percentage of completeness for other materials still needs to be higher.

Low student learning outcomes are also caused by several factors, including (1) Students being less active during the learning process, (2) students' lack of concentration and interest in studying PGL, and (3) the model used in learning tends to be teacher-centered. The learning model that teachers often use during the learning process is the Direct Instruction (DI) model. This is a learning model dominated by the teacher and results in students not playing an active role, students needing help understanding the material, and students getting bored quickly during the learning process.

Students learn individually, and students are less involved in the learning process, causing ineffective learning, which impacts student learning outcomes that could be more optimal. To overcome this problem, teachers need to apply an appropriate, fun, varied, and not monotonous learning model so that students can be involved in learning, make students more active, and learn in groups. They can exchange ideas/opinions so that student learning outcomes can improve. One of them is the Problem-Based Learning (PBL) model.

Problem-Based Learning (PBL) is an educational approach that utilises authentic, real-world challenges to foster the development of critical thinking and problem-solving abilities in students. Through this method, students not only gain knowledge and grasp important concepts related to the subject matter, but also acquire the necessary skills to apply their learning in practical situations (Shoimin, 2014). Students in this scenario engage in problem-solving investigations that incorporate skills and concepts from multiple topic areas (Sopiah, 2019). In other words, learning with this model is expected to stimulate students to think critically, be more active in analyzing, and solve existing problems more efficiently based on understanding concepts to improve learning outcomes (Suyono & Hariyanto, 2014).

METHOD

This research employs a comparative approach and utilises a quasi-experimental methodology. The objective of this study is to examine the learning results of students in two courses using two different models, specifically an experimental class and a control class, in the context of PGL. The initial class is referred to as the Experimental Class, where learning takes place through the Problem-Based Learning (PBL) methodology. Meanwhile, the second class is the Control Class, which utilises the Direct Instruction (DI) paradigm for learning. Following the treatment, both groups were administered a posttest to assess the learning results of the students.

This study used a Posttest Only-Control Group Design. The research randomly allocated two groups to carry out the study. Specifically, the experimental class and the control class. The research design might be illustrated in the subsequent table 1.

Table 1 Posttes Only-Control Group Design

Class	Treatment	Posttest
Experiment (E)	X	O_2
Control (K)	-	O_4

Information:

E : Experimental Class

K : Control Class

X : Implementation of learning using the PBL model

O2 : Final observation or posttest score for the Experimental Class

O4 : Final observation or posttest score for Control Class

$O_2 \equiv O_4$

This research was carried out at SMP Negeri 3 Tondano on May 11 – May 31 and in stages in the even semester of the 2022-2023 academic year. The research subjects were all students in class VIIIB as the experimental class and class VIIIC as the control class at SMP Negeri 3 Tondano, registered in the 2022-2023 academic year. The variables in this research are experimental variables and control variables. The experimental variable is PGL learning taught using the PBL model, while the control variable is PGL learning taught using the DI model. Meanwhile, the instrument researchers use in this research is a set of tests in the form of essays with PGL material, which will be given at the end of the meeting. The data collection technique is to give students a posttest in the Experiment and Control Class. The test given is an Essay test, which has been tested for validity and reliability.

FINDINGS AND DISCUSSION

Findings

Description of Reasearch Results

This research was conducted at SMP Negeri 3 Tondano, in Jl. Tomohon-Tondano No. 12, Masarang, District. West Tondano, Minahasa Regency, North Sulawesi. The data shows that class VIII consists of class VIIIA, class VIIIB, and class VIIIC. Two classes were taken from the three classes: Class VIIIB as the experimental class and Class VIIIC as the control class. The experimental class uses the PBL learning model, while the control class uses the DI learning model. The number of students in each class is 22.

The data analyzed in this study came from student learning outcome data obtained from posttest scores, both in the experimental and control classes. The following table 2 provides descriptive statistics of posttest data.

Table 2 Descriptive statistics of posttest data for PBL Class and DI Class

No	Statistics	PBL class	DI Class
1	Minimum Datum (X_{min})	65	60
2	Maximum Datum (X_{max})	100	95
3	Total score ($\sum$)	1880	1645
4	Average ($\bar{X}$)	85,45	75
5	Standard Deviation (S)	9,37	8,79
6	Variance (S^2)	87,88	77,33

Based on the data table for both classes measured at intervals 0-100, the total score achieved by PBL 1880 class students was obtained with an average of 85.45. Meanwhile, the total score obtained in the DI class was 1645, averaging 75. This shows that the average score for the PBL class is higher than that for the DI class. Furthermore, the results of calculating the standard deviation in the PBL class were 9.37, with a variance of 87.88. Meanwhile, in the DI class, the standard deviation is 8.79, with a variance of 77.33.

Test the Analysis Prerequisites

Data Normality Test

Data normality testing uses the Liliefors test with the help of the Excel program. The statistical hypothesis in testing the normality of this data is:

$$H_0 : X_i \sim N(\mu_i, \sigma_i)$$

$$H_1 : X_i \nsim N(\mu_i, \sigma_i)$$

With:

i : index; i=1 for the experimental class and i=2 for the control class

X_i : Posttest data

N : normal distribution with parameters μ and σ

μ_i : parameter of the average PGL learning outcomes of students in each class.

σ_i : standard deviation parameter for each class

The following are the recapitulation results of testing normality data for the experimental class and control class, which can be seen in the following table 3.

Table 3 Results of Data Normality Test Analysis for PBL Class and DI Class

The calculation results				
Variable Type	Real Level (α)	*Lcount*	*Ltable*	Information
Experimental Group	0,05	0,0949	0,184	Normally distributed
Control Class	0,05	0,1609	0,184	Normally distributed
Conclusion	$L'Count < L'Table$ **(H0 Accepted)**			**Normally distributed**

Based on the table above, it can be concluded that $L_{count} < L_{tabel}$ then H_0 is accepted. Thus, the posttest data for classes taught using the PBL model and classes taught using the DI model come from a normally distributed population.

Homogeneity of Variance Test

Testing data homogeneity uses the F-test. The statistical hypothesis in testing homogeneity of variance is:

$$H_0: \sigma_1^2 = \sigma_2^2$$

$$H_0: \sigma_1^2 \neq \sigma_2^2$$

With:

σ_1^2 : The first population variance parameter, namely all students taught using the PBL model.

σ_2^2 : The second population variance parameter, namely all students taught using the DI model.

The following are the recapitulation results of testing normality data for the experimental class and control class, which can be seen in the following table 4.

Table 4 Results of Data Homogeneity Test Analysis for PBL Class and DI Class

The calculation results					
Variable Type	Real Level (α)	Variance (S^2)	$Fcount$	F_{table}	Information
Experimental Class	0,05	87,88	1,136	2,05	Homogeneous
Control Class	0,05	77,33			
Conclusion	$\boldsymbol{Fcount < Ftable\ (H0\ Accepted)}$				**Homogeneous**

Based on the table above, it can be concluded that $F_{count} < F_{table}$ then H_0 is accepted. Thus, the posttest data for classes taught using the PBL model and classes taught using the DI model come from a normally distributed population.

Based on testing the analysis requirements (variance homogeneity test and data normality test), it turns out that the requirements for analyzing research hypotheses meet the requirements. Therefore, research hypothesis testing can be continued.

Hypothesis Testing

The statistical hypothesis in this test is formulated as follows:

$$H_0: \mu_1 \leq \mu_2$$

$$H_1: \mu_1 > \mu_2$$

With:

μ_1 : Parameters of the average PGL learning outcomes for students taught using the PBL model.

μ_2 : Parameters of average PGL learning outcomes for students taught using DI.

Based on hypothesis testing, $t_{count} = 3.808$ and $t_{table} = 1.682$ for $db = 42$ and α=0.05. So $t_{count} > t_{table}$ is thus based on the testing criteria, if $t_{count} > t_{tabel}$ then reject H_0, meaning that the PGL learning outcomes of students taught using the PBL model are more than the PGL learning outcomes of students taught using the DI model.

Discussion

BAccording to the findings of an experiment conducted at SMP Negeri 3 Tondano, employing Problem-Based Learning (PBL) on PGL material, there were noticeable disparities in the academic performance of students between the experimental class and the control class. The data presented in Table 6 demonstrates a notable disparity in the mean learning outcomes between the two classes. Specifically, students instructed with the PBL model exhibited higher average learning outcomes compared to those taught with the DI model in PGL learning.

The findings of this study have implications for the research conducted by Firginia Kuswadi (2022). Kuswadi's research determined that students taught using the Problem-Based Learning (PBL) approach achieved greater learning outcomes compared to students taught using Direct Instruction (DI) in the context of Social Arithmetic subject. Similarly, a study conducted by Lakumani et al. (2017) found that students taught using the Problem-Based Learning model had a greater average number of pattern learning outcomes compared to students taught using the Direct Instruction methodology.

In addition, the findings of this study are applicable to the research conducted by Wuwumbene et al. (2018), which demonstrates that students taught using PBL achieve learning outcomes that exceed the minimum requirements set by the school, specifically 67. According to Mokoginta et al.'s (2023) research, there are variations in SPLDV learning results between students who are taught using the PBL model and those who use the DI model for SPLDV material.

Hence, the utilisation of the Problem-Based Learning (PBL) model seems to be more effective in facilitating the learning process, as it engages students in active participation, particularly during the presenting phase. During the presenting stage, students collaborate, engage in dialogue, and share ideas with their peers. In addition, students have the opportunity to solve issues based on their comprehension. Active student engagement during the learning process is beneficial for their ability to effectively solve mathematical issues.

CONCLUSIONS

Based on the research and discussion above, the average learning outcomes of students taught using the PBL model are higher than those taught using the DI model. The results show that the PBL model is more effectively used to improve student learning outcomes in mathematics, especially in PGS material. Existing theory and research also support these results. Therefore, these results contribute to the development of mathematics learning for teachers, where teachers need to develop mathematics learning using the PBL model to improve the quality of mathematics learning, especially student learning outcomes. Apart from that, further studies need to be carried out regarding applying the PBL model to other mathematics topics to get more accountable results on other mathematics topics.

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