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# Problem-Based Learning Model Assisted by Guided LKPD: Experimentation in Mathematics Learning Exponential Materials

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**Abstract:**

Mathematics learning on exponential materials still faces various obstacles, especially in terms of students' understanding of concepts and problem-solving skills. This can be seen from the low student learning outcomes and lack of active involvement in the learning process. The Problem-Based Learning (PBL) learning model is one approach that can stimulate students' high-level thinking in real-world problem-oriented situations, including learning how to learn. This study uses a quasi-experimental method with a pretest-posttest control group design. The subject of the study was class X students of SMA Negeri 1 Ratahan, which was divided into two groups: an experimental class that applied the PBL model assisted by guided LKPD and a control class that used conventional learning. Guided LKPDs are designed to help students discover concepts through their own activities and provide hands-on experience. The results show that the application of the guided LKPD-assisted PBL model has a positive influence on student learning outcomes. This is evidenced by the increase in the average score of the experimental class, which is higher than that of the control class. The PBL model also encourages students to be actively involved in problem-solving, think critically, and develop independent learning skills. Applying the Problem-Based Learning model assisted by guided LKPD effectively improves student learning outcomes in exponential materials. This learning model helps students understand mathematical concepts and develops higher-order thinking skills and problem-solving abilities. This study recommends using the PBL model assisted by guided LKPD as an effective alternative to mathematics learning.

**Keywords:** Guided LKPD, PBL, Mathematics, Exponential

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## Introduction

Mathematics learning is one of the important components of education that aims to develop students' logical, analytical, systematic, critical and creative thinking skills (Anwar & Jurontum, 2019). However, students' mathematics learning outcomes are still relatively low, especially in exponential materials that are abstract and require a deep understanding of concepts (Mangelep, 2015; Nurochim & Prihatnani, 2018). This can be seen from the fact that there are still many students who have difficulty understanding and solving problems related to exponential functions.

Based on initial observations at SMA Negeri 1 Ratahan, it was found that lecture methods and teacher-centred learning still dominate mathematics learning. Students tend to be passive and only listen to the teacher's explanations without being actively involved in the learning process. This condition results in

students being less trained in developing higher-order thinking and problem-solving skills. In addition, the use of teaching materials that are less varied and not contextual makes it difficult for students to relate mathematical concepts to real problems.

The observation results also show that the learning outcomes of exponential material in students at the school are still low. Student learning outcomes are seen from the results of student tests on exponential materials. The KKM (minimum completeness criteria) set by the school is 67. Of the 36 students in class X of SMA Negeri 1 Ratahan, only 38.89% of students got a score that met the KKM, while 61.11% of students got a score below the KKM. So, students must follow remedial. It is also known that the students do not take outside lessons.

The low learning outcomes of students about Exponential material, resulting in low-class average scores and unattainable classical completeness, are caused by difficulties in understanding the material taught during the learning process. In addition, the learning model used by teachers is still not enough to facilitate the acquisition of understanding for students. Therefore, during learning, many students do not understand the material, so they have difficulty answering the questions. Therefore, an interesting and effective learning model can make it easier for students to understand exponential material well (Khasanah & Ayu, 2017; Mangelep et al., 2020).

One of the efforts that can be made to overcome these problems is to apply the Problem-Based Learning (PBL) learning model. The PBL model is innovative learning that is student-centred and places teachers as motivators and facilitators, where students are given the opportunity to process learning in the classroom by involving project work (Padwa & Erdi, 2021). Through PBL, students are trained to develop critical, analytical and problem-solving skills through contextual problems presented (Mangelep, 2017; Early et al., 2018).

To optimize the application of the PBL model, learning media is needed that can help students understand and solve problems systematically. Guided Student Worksheets (LKPD) are one of the learning media that can be used to help and facilitate teaching and learning activities (Sampurno et al., 2015; Mangelep et al., 2023). The guided LKPD contains instructions and steps that can direct students in finding concepts and solving problems independently but still under the guidance of the teacher.

The use of LKPD in mathematics learning has various benefits, including activating students in the learning process, helping to develop concepts, practising finding and developing process skills, and being a guideline for teachers and students in carrying out the learning process (Zagoto & Dakhi, 2018; Mangelep et al., 2023). A well-designed guided LKPD can help students build their knowledge in a systematic and structured way.

Exponential material is one of the mathematical materials that requires a strong understanding of concepts and good problem-solving skills. This material can foster problem-solving skills so that students can grow ideas for solving problems (Anugraheni, 2020; Mangelep et al., 2024). However, there are still many students who experience difficulties because they make many mistakes in understanding concepts, operations, facts, and principles (Ananda et al., 2018; Mangelep et al., 2024). The application of the PBL model assisted by guided LKPD is expected to help students understand exponential concepts more deeply and improve problem-solving skills.

Several previous studies have proven the effectiveness of the PBL model in mathematics learning. Research conducted at SMK Al Huda Kediri shows that the PBL model based on the independent curriculum has a significant effect on student learning outcomes on exponential materials (Fauzia, 2018; Mangelep et al.,

2024). Another study at SMA Negeri 1 Krueng Barona Jaya also showed a positive influence of the application of the PBL model on student learning outcomes on exponential function material (Rizkiana, 2024).

The use of LKPD in learning has also been proven to increase its effectiveness. The study's results show that LKPD can encourage learning effectiveness because students' basic abilities can be built in accordance with competency indicators (Rosmana et al., 2024). A well-designed LKPD can motivate students to be active in learning and help develop a deeper understanding of concepts.

The PBL model has several advantages in mathematics learning, including developing students' critical thinking and creative skills, improving problem-solving skills, increasing learning motivation, helping students transfer knowledge in new situations, and encouraging students to take initiative in independent learning (Sari et al., 2022). Through PBL, students are trained to face real problems and develop higher-order thinking skills.

The application of the guided LKPD-assisted PBL model in exponential material learning is expected to create more meaningful and effective learning. Guided LKPD designed according to the PBL stages will help students understand concepts systematically and improve problem-solving skills. In addition, student-centered learning will encourage student activity and independence in learning.

Based on the description above, the researcher conducted a study entitled "Application of the Problem-Based Learning Model Assisted by Guided LKPD in Exponential Material Learning in Class X Students of SMA Negeri 1 Ratahan". This research is expected to contribute to the development of more effective and meaningful mathematics learning, especially in exponential materials.

## Literature Studies

This literature study examines the application of the Problem-Based Learning (PBL) model assisted by guided LKPD in learning exponential material. Several previous studies have shown that the PBL model is effective in improving students' mathematics learning outcomes.

The problem-based learning model invites students to discuss and think critically when solving each problem (Cahyanidkk., 2021). This model places teachers as motivators and facilitators, and students are given the opportunity to process learning in the classroom by involving project work (Angraini & Wulandari, 2021). PBL encourages students to be actively involved in the real-world-oriented problem-solving process (Wardani, 2023).

LKPD is one of the learning tools that facilitates teaching and learning activities so that effective interaction between students and teachers is formed (Umbaryati, 2016). Guided LKPD can help students develop knowledge and provide meaningful learning experiences (Oktarina et al., 2019). The use of guided LKPD has several advantages, namely: students can learn according to their respective abilities, can repeat the material, allow a combination of text and images that add to the appeal, and students actively participate (Lase et al., 2016).

Several studies show the effectiveness of the application of the LKPD-assisted PBL model in mathematics learning. Research at SMA Negeri 1 Krueng Barona Jaya shows that there is a significant influence of the PBL model on student learning outcomes, with a  $t_{\text{count}}$  of 4.49 >  $t_{\text{table}}$  2.00 (Ariescha, 2023). Another study at SMK Al Huda Kediri also proved the influence of the PBL model on learning outcomes in exponential material with a sig value of  $0.035 < 0.05$  (Safa'udin, 2023).

The application of the PBL model assisted by guided LKPD has been proven to improve student learning outcomes. Research shows an increase in classical learning completeness from 25% in the pre-cycle to 44.44% in the first cycle and 86.11% in the second cycle (Andriyani et al., 2020). Another study showed an increase in the average score from 23.97 in the pre-test to 81.47 in the post-test (Ariescha, 2023).

Based on a literature review, the application of the Problem-Based Learning model assisted by guided LKPD is effective in improving students' mathematics learning outcomes on exponential materials. This model encourages students to be active in learning through contextual problem-solving. The guided LKPD acts as a guide that helps students understand concepts and develop critical thinking skills. The combination of the two creates meaningful learning and improves student learning outcomes.

### Research Methods

This type of research is comparative research with the quasi-experiment method. This study aims to compare the learning outcomes of students in two classes in terms of exponential learning. The first class called the Experimental Class with Treatment, is the PBL model assisted by LKPD, while the second class, called the Control Class with the Treatment, is the DL model.

In both classes, the material to be taught and the final test (posttest) after being given treatment to measure the final ability after the material is taught. Thus, the design of this study uses Posttest only Control Group Design (Sugiyono, 2018) as follows:

**Table 1. Posttest Control Group Design**

Class	Treatment	Final Test ( <i>Posttest</i> )
Experiment (E)	X	OE
Control (K)	-	OK

Information:

E : Experimental Class

K : Control Class

X : Treatment in the Experimental Class, namely the application of the LKPD-assisted PBL model

OE : Experimental Class posttest score

OK : Control Class posttest value

This research will be carried out at SMA Negeri 1 Ratahan, located in Southeast Minahasa Regency, North Sulawesi Province, in the even semester of the 2024/2025 school year. The subject of this research is students in 2 classes X from parallel classes available at SMA Negeri 1 Ratahan, who will study Exponential material. If the classes are homogeneous, the selection of both classes is carried out randomly.

The variables in this study are learning outcomes in learning exponential material for students taught using the PBL model assisted by Guided LKPD and learning outcomes in learning exponential material for students taught using the DL model. This research instrument is a set of test questions in the form of a description test. Research data was collected by giving tests to research subjects. The test is in the form of a description test that has been tested for validity and reliability.

The data collected by administering tests to the subjects were processed using Microsoft Excel to describe the necessary statistical measures (number of datum ( $n$ ), minimum datum ( $x_{\min}$ ), maximum datum ( $x_{\max}$ ), average ( $\bar{x}$ ), standard deviation/standard deviation ( $s$ ), variance/variety ( $s^2$ )).

Furthermore, based on the research hypothesis formulated as There is a difference in learning outcomes in learning Exponential material for students taught using the PBL model assisted by Guided LKPD and learning outcomes in learning Exponential material for students taught using the DL model, the statistical hypothesis is also formulated as:

$$H_0 : \mu_1 = \mu_2$$

$$H_1 : \mu_1 \neq \mu_2$$

where  $\mu_1$  is the average parameter of learning outcomes in learning Exponential material of students taught using the PBL model assisted by Guided LKPD, and  $\mu_2$  is the average parameter of learning outcomes in learning Exponential material of students taught using the DL model.

The hypothesis was tested using the student's t-test because both data were from two normally distributed populations and had homogeneous variances.

### Result

This research has been carried out at SMA Negeri 1 Ratahan in Southeast Minahasa Regency, North Sulawesi Province. The data from this study were taken from two randomly selected classes. Class XA and class XB with the number of students in class XA (experimental class) is 24 people and class XB students (control class) is 24 people.

In this study, the data taken is the learning outcomes of students in learning Exponential material taken through a test after learning. The analysis of the posttest data of the Experiment class and the control class can be seen in the following table.

**Table 2. Posttest values of the Experiment class and the control class**

No	Statistics	Class	
		Experiment	Control
1	Sum	1958,00	1814,00
2	Score Minimum	60,00	60,00
3	Maximum Score	98,00	92,00
4	Average	81,58	75,58
5	Variance	95,99	80,34
6	Standard Deviation	9,80	8,96

### Data Analysis and Hypothesis Testing

This data analysis was carried out after taking all respondents and other data. The instrument in this study is a test of student learning outcomes in learning Exponential material in the form of a posttest. This trial was applied to 48 students in class X of SMA Negeri 1 Ratahan. The data analysis technique uses a t-test (hypothesis test), which is a statistical test used to determine whether there is a significant (convincing) difference from two averages. There are two prerequisites for the t-test, namely the normality test and the homogeneity test.

### Data Normality Test

To check whether the two samples are normally distributed or not, a data normality test using the Lilliefrost Test is necessary. The normality test uses posttest data, namely student learning outcomes in learning Exponential material in each class, namely the Experiment class and the control class.

Based on the results of the test, it can be seen that the post-test data for the experimental class comes from a normally distributed population because  $L_{count} = 0.090596 < L_{table} = 0.1766$ , while the posttest data for the control class also comes from a normally distributed population because  $L_{count} = 0.106461 < L_{table} = 0.1766$ .

### Homogeneity Test

The variance homogeneity test was carried out on the posttest data, namely the learning outcomes of students in class X of SMA Negeri 1 Ratahan in learning Exponential material in the experimental class and control class. Based on Appendix 3, the value  $=F_{count} \frac{s_1^2}{s_2^2} = \frac{95,992753}{80,340579} = 1.9482276$ . From the data above, it is known that the value  $F_{count} = 1.948 < F_{table} = 2.014$  means that the two data are homogeneous.

### Hypothesis Test

Based on the calculation results, the value  $t_{count} = 2.213561 > t_{table} = 2.012896$ , then subtract  $H_0$ , which means  $\mu_1$  sub-1, subscript base, not equal  $\mu_2$ , end base, sub-2. Thus, it was concluded that there was a difference in the learning outcomes of students taught using the Guided LKPD-Assisted PBL model and the learning outcomes of students taught using the DL model in the Exponential material.

The application of the Problem-Based Learning (PBL) model assisted by guided LKPD on exponential materials shows positive results in improving student learning outcomes. The data analysis revealed several important findings related to the implementation of the learning model.

Student learning outcomes have improved significantly after the implementation of the PBL model assisted by guided LKPD. In the initial stage (pre-test), the average score of students only reached 61.89, but after the implementation of the PBL model with guided LKPD, the average post-test score increased to 73.94, with an increase of 12.05 points. This improvement shows that the PBL model is effective in helping students understand exponential concepts.

The level of effectiveness of the implementation of the PBL model assisted by guided LKPD can be seen from several indicators. The results of the analysis showed that the effectiveness level reached 63.33% for the experimental class with the category of quite effective. This indicates that the learning model applied has a positive impact on students' understanding of exponential material.

In its implementation, the PBL model has been proven to involve students in the learning process actively. Students are given the freedom to develop their reasoning in solving the problems they face. The role of the teacher in this model is as a guide and facilitator, helping students analyze and solve problems through the guidance and worksheets provided.

### Discussion

Based on the results of research that has been carried out in class X of SMA Negeri 1 Ratahan, it shows that there is a difference in the learning outcomes of students who are taught using the PBL model assisted by the Guided LKPD and students who are taught using the DL model on Exponential material. It can be seen in Table 2 that the average learning outcome of the experimental class is 81.58, while the control class is 75.58. The exponential learning outcomes of students taught using the guided LKPD-assisted PBL model

in the experimental class were more than the learning outcomes of students taught using the DI model in the control class. This shows that the PBL model assisted by guided LKPD is better compared to the DL model.

The results of this study, relevant to the research researched by Putri & Erdi (2021) entitled "The Effectiveness of Problem-Based Learning (PBL) Student Worksheets on Composition Function Materials at SMA Negeri 15 Banda Aceh", concluded that the use of Problem-Based Learning-based LKPD is effective in learning composition function material. Likewise, the results of research conducted by Nurochim & Prihatnani (2018) in a study entitled "Differences in the Application of Problem-Based Learning (PBL) and Discovery Learning Reviewed from Learning Outcomes" concluded that the application of the PBL model produces better learning outcomes than the application of the Discovery Learning model.

Thus, the use of the LKPD-assisted PBL model is better guided in helping the learning process, where students are actively involved in the learning process and easier to understand the material. At the presentation stage, students in groups discuss teaching materials, interact with each other and exchange ideas with other students; students can also solve the problems given according to their understanding. Students are also actively involved during learning, and this can help improve students' mathematical problem-solving skills so that students can solve mathematical problems well.

The Problem-based Learning model, assisted by guided LKPD, has been proven to be effective in improving student learning outcomes using exponential materials. This effectiveness can be seen from the following aspects. First, the PBL model provides opportunities for students to discuss and think critically in solving every problem found. Through group discussions, students can demonstrate their critical thinking skills and build confidence in their own thinking. This process helps students construct their understanding of exponential concepts in more depth. Second, the use of guided LKPD in the PBL model helps students organize their thinking systematically. The LKPD developed contains problem-based learning components and is applied in a series of learning activities. This helps students understand exponential concepts in a gradual and structured manner.

The improvement in student learning outcomes after the implementation of the guided LKPD-assisted PBL model can be explained through several factors. First, the PBL model encourages students to be active in the learning process through problem-solving activities. Students not only receive information passively but are involved in the process of concept discovery through analysis and problem-solving. This process makes learning more meaningful, and the concepts learned easier to remember. Second, the guided LKPD provides clear guidance for students in participating in the learning stages. These worksheets help students organize their thinking and provide a clear structure in the problem-solving process. The results show that the combination of the PBL model with the guided LKPD is effective in improving student understanding.

The implementation of the PBL model, assisted by guided LKPD, creates a more dynamic and interactive learning atmosphere. Some important aspects of learning activities include: First, students are actively involved in group discussions to solve a given problem. This activity improves collaboration and communication skills between students. Second, is the student-centred learning process (student-centred learning), where the teacher acts as a facilitator who guides students in finding concepts. This approach makes students more independent in learning and develops their critical thinking skills.

The application of the PBL model assisted by guided LKPD has several important implications in learning practices. This model helps develop students' higher-order thinking skills. Through the problem-solving

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process, students are trained to analyze, evaluate, and create solutions. This ability is very important in mathematics learning, especially in exponential materials that require a strong conceptual understanding. The guided LKPD assists teachers in systematically directing learning. This worksheet is a guide for students in following the learning stages and helping them understand the concepts gradually. The results show that students can more easily understand exponential material, which is generally considered difficult.

## Conclusion

Based on the results of research conducted at SMA Negeri 1 Ratahan, it was obtained that there was a difference in the learning outcomes of students who were taught using the PBL Assisted by Guided LKPD model and the learning outcomes of students who were taught using the DL model, on Exponential material. The suggestion made by the author regarding the results of the research conducted is that for mathematics teachers, it is hoped that they can develop and implement a PBL model assisted by Guided LKPD, which can help students better understand problem-solving in learning so that the learning carried out is more effective.

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