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# The influence of the problem based learning model on students' mathematical problem solving ability in mathematical induction material

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**ABSTRACT**

The problem of low problem solving abilities of students in Mathematics subjects are due to the learning process in the classroom only directed at students' ability to memorize information, more lots of listening and writing, memorizing formulas and working on problems with formulas that have been memorized so that students have difficulty solving problems when finding differences from the example questions. This research aims to determine the use of the Problem Based Learning learning model and the problem solving abilities of class XI students at Muhamadiyah 10 Rantauprapat Private High School. This research is a type of quantitative research, with a research population of 120 students from 4 classes. Data collection techniques in this research used two methods, namely observation of teacher activities and tests in the form of descriptions. With research results tcount is greater than ttable. So it can be concluded that the Problem Based Learning (PBL) learning model has a very significant influence on the mathematical problem solving abilities of students in class This is strengthened because the Problem Based Learning (PBL) model has advantages and goals that are able to encourage students to learn more effectively because they focus on problem solving and students are able to develop themselves.



## INTRODUCTION

Current developments, especially in the 21st century and the age of knowledge, require technical skills and adaptability from each individual. Currently, a country's progress is measured by its ability to master science and technology. The national education system faces challenges that hinder the availability of high-quality talent with equal, innovative and competitive skills and the ability to collaborate. The aim is to make it easier for HR to absorb new information and adapt to rapidly changing times. To improve learning outcomes, many education professionals have introduced various learning models to improve student skills. Education is considered the right initiative to produce quality human resources (Sihombing et al., 2023; Situmorang, 2017). According to Panjaitan (2016), education can be understood as interaction between teachers and students which is not limited to the school environment, but also involves family and community. This interaction is considered an important factor in the implementation of education, because without this interaction, education cannot be achieved . Society needs education to achieve better overall development, including mental, physical, emotional, social and moral aspects (Permatasari & Marlina, 2023).

The implementation of the teaching and learning process aims to ensure the achievement of educational goals through changes in student behavior. It is the hope of all educators that students can achieve the most appropriate learning outcomes according to their abilities and achieve the expected educational goals. In relation to learning, it is important to provide an introduction, understanding and training in the methods, approaches and thought processes that form the basis of knowledge acquisition. The teaching and learning process is considered the focus of the entire educational process. Teachers act as teachers with duties, responsibilities and teaching initiatives, and students are expected to actively participate in learning activities (Syarifuddin et al., 2021).

Transportation is critical to achieving students' educational goals. In other words, mathematics learning is an educational process that uses mathematics as a means of transportation to achieve certain goals. In this context, mathematics is one of the subjects taught at all levels of education. It plays an

important role in developing logical thinking and reasoning skills, as well as stimulating creativity and problem-solving skills in the learning process (Panjaitan, 2018).

Mathematics is a science that helps describe and explain situations and conditions by using abstract, idealistic and general concepts in solving problems (Situmorang, 2017). Solving mathematical problems requires various teaching approaches from a teacher so that they can be applied effectively in the learning process. The use of innovative learning methods is a suitable choice for teachers and students to face the evolution of education that prioritizes quality (Siwa et al., 2018). Because of its importance, students are expected to have a good understanding of mathematics topics. According to Cokraft (Kusmanto & Marliyana, 2014), the importance of mathematics education lies in the consistent use of mathematics education in everyday life, the need for relevant mathematics skills in various areas of learning, and the need for literacy provisions from mathematics (Nisak & Istiana, 2017).

Mathematics should be taught in a meaningful context that connects it to other subjects and is relevant to students' interests and experiences. The opinion about the role of teachers and students in mathematics research was expressed by Panjaitan (2016) who noted that modern mathematics education in our country officially began with the introduction of the curriculum in 1975. In the traditional era of mathematics, teachers were seen as repositories of knowledge, which carried out authoritarianism. and dominate the class, which means that the teacher controls the students and always gives "straight" answers to their questions. The teacher is responsible for transmitting knowledge, directly proving mathematical axioms, giving examples of problems. On the other hand, students need to sit neatly, listen, imitate the patterns taught by the teacher, and watch the teacher solve problems.

Based on observations in class problems, guidance, and moderation for students to overcome these problems. They were then asked to complete the exercises at the end of the training session. However, there are several weaknesses in the learning flow, which seems monotonous, rigid and less systematic, and tends to follow the steps of the book text, sometimes not being suitable for students' thinking stages. As a result, the learning process has not reached a level that meets the expectations of the 2013 curriculum.

From interviews with mathematics teachers in class XI MIPA SMAS Muhammadiyah 10 Rantauprapat, it is clear that introductory mathematics material is a topic that is confusing for students. This is due to the nature of mathematical induction, which is a method of proof that requires high thinking skills and broad application in various contexts, such as series and sequences of numbers, division of numbers, and differences in numbers. From teachers' experiences, it is clear that when teaching mathematical induction material, students are often taught only the principles of inductive proof, which does not guarantee understanding of the concept. The teacher then immediately begins to apply the concept of induction. Therefore, students' understanding of mathematical induction is not completely complete.

Various studies on mathematical induction show that many students have difficulty solving induction problems, so they tend to make mistakes in the solving process. A study by Ernavati and Ilhamuddin (2020) found that the types of errors commonly observed in students when solving inductive problems include errors in understanding concepts, processes and methods. Fitriani et al. (2021) showed that procedural errors were the most common type of error in middle school students when proven by mathematical induction. In addition, Ashkenazi and Itzkovich (2014) explained that there are three main problems that students face when proving with mathematical induction: not understanding deductive proof, not understanding the basic concept of induction, and not understanding the concept of increment, where if a statement is proven in natural numbers n, then the increase is 1. Dewi et al. (2019) on the analysis of mathematical proof errors in mathematics of secondary school students found that the majority of students made errors starting from the third stage (conversion, procedural skills, and written answers). The main reason for the difficulties faced by students is the lack of implementation of initial stage assumptions (Kurniawan et al., 2022).

Students often face other difficulties in solving mathematical induction problems, namely errors in understanding the basic concept of induction. Most students believe that the foundation of integration must start with n = 1. This belief comes from the fact that several textbooks on mathematical induction

used by students state that the process of proving mathematical induction consists of three steps: (a) proving the truth of the inductive basis P (1); (b) assume that P(k) is true; (c) P(k+1) test phase. However, it is important to note that in the basic induction step, the value of n does not need to start with n = 1. This interpretation is different from Larson and Pettersson (2018), who say that the fundamental induction step in mathematical induction problems is generally related to n = 0 or n = 1, but this depends on what is being proven. Additionally, different questions can be adapted to appropriate starting points (n-values) or even more than one step can be added to the basic inductive steps.

Therefore, it is necessary to develop learning tools that can encourage students' active involvement in the teaching and learning process, so that it can facilitate their understanding of the concept of mathematical induction. The learning tools developed include a Syllabus, Learning Implementation Plan (RPP) based on Problem Based Learning (PBL) and Worksheets for Students (LKPD) based on Problem Based Learning (PBL). It is hoped that the development of lesson plans can be an alternative choice for teaching staff as a guide in implementing PBL-based learning, especially on the topic of mathematics induction in the classroom. Meanwhile, the development of PBL-based LKPD is expected to provide opportunities for students to build knowledge and understanding of mathematical induction concepts through everyday contextualization (Yusri, 2018). Problem-Based Learning (PBL) Refers to problem situations that are relevant to students' real or contextual experiences. The problems encountered are not well structured, not presented fully, and are not tied to a particular method. During the process of finding a solution, perceptions of the problem and solution may change when new information appears (Pamuji, 2021)

The choice of the Problem Based Learning (PBL) model in developing learning tools was chosen because the problem-based learning model has the potential to develop students' critical thinking, problem solving and intellectual abilities (Siwa et al., 2018). The PBL model can also encourage students to be more proactive in problem solving, acquiring knowledge, and being able to assess their learning progress (Deka & Tasman, 2023). Mastering these skills is essential in the inductive learning process of mathematics, which often requires superior reasoning and problem-solving skills.

Based on the description above, the author is interested to know the influence of the Problem Based Learning learning model on students' mathematical problem solving abilities in mathematical induction material at Muhammadiyah 10 Rantauprapat Private High School TA 2022/2023

## RESEARCH METHODS

Data analysis techniques used to process research data The type of research used in this research is quasi experimental design. Quasi experimental design is intended to determine the effect of students' problem solving abilities taught using the Problem Based Learning (PBL) model (Sugiyono, 2019). The population in this study was all classes XI and simple random sampling technique where each class has the same ability to become a research sample. From 4 classes totaling ± 120 students at Muhammadiyah 10 Rantauprapat Private High School, a sample of one class was selected, namely class XI-IPA, taken for the experimental class using the Problem Based Learning model (PBL). Before being given treatment, the class was first given a pretest which aims to see students' basic abilities before treatment, and after treatment they were given another posttest. The number of 10 pretest and 10 posttest questions was the same, the amount of time used was also the same. The difference in scores between the pretest and the posttest is the final score used to see the increase in students' problem solving abilities after treatment.

From the description above, the research design can be described as follows:

**Table 1 Research Design**

| Class | Pretest | Treatment | Postest |
|---|---|---|---|
| Experiment | $O1_E$ | X | $O2_E$ |

Sumber: Modifikasi Setyosari, 2013: 186

Information :
O1E : Experimental class pretest results
X : Problem-based learning
O2E : Experimental class posttest results

## RESULTS AND DISCUSSION

This research was carried out in class XI of Muhammdiyah 10 Rantauprapat Private High School. The aim of this research is to see the effect of the Problem Based Learning (PBL) learning model on students' mathematical problem solving abilities using one experimental class, namely class XI Science which consists of 30 students. Class XI Science as an experimental class uses the Problrm Based Learning (PBL) learning model. This research was conducted in 3 meetings, 1 meeting for the pretest, 1 meeting used to carry out treatment and 1 meeting to provide a post-test. The instrument in this research is a mathematical problem solving ability test which consists of 20 questions in essay form. In this study, variable X is the result of the pretest score and variable Y is the result of the posttest score.

### Analysis of Trial Results Data

The research test trial was carried out on November 20 2023 at Muhammadiyah10 Rantauprapat Private High School. And the trial was carried out in class XII of Muhammadiyah 10 Rantauprapat Private High School. The test instrument test was carried out in class XII because class XII students already understood the mathematical induction material because they had studied it first in class The research test was tested by paying attention to the reliability of the test items, the level of difficulty of the test items, the reliability of the test and the differentiating power of the test items.

1. Reliability By using the Cronbach's alpha formula in CHAPTER III, a test reliability coefficient of 0.761 is obtained. Calculations to see in full at. The test reliability coefficient of 0.761 is compared with the product moment critical rtable value for $\alpha = 0.01$ and n = 30, namely rtable = 0.463, so rcount > rtable or 0.761 > 0.463. So it can be concluded that the test is reliable.

**Table 2. Reliability Statistics**

| Cronbach's Alpha | N of Items |
|---|---|
| .761 | 13 |

2. Validity The results of the instrument trial validation were carried out according to the design which was then consulted with the supervising lecturer to be checked and suggestions for improvement were given. After that the trial was validated by two mathematics teachers at Muhammadiyah 10 Rantauprapat Private High School until it was declared suitable for testing.
3. Test Item Difficulty Index By using the difficulty level formula for each test item, it shows that the twenty questions are valid and fall into the difficult and medium question groups.

**Table 3. Statistics**

| | | s1 | s2 | s3 | s4 | s5 | s6 | s7 |
|---|---|---|---|---|---|---|---|---|
| N | Valid | 30 | 30 | 30 | 30 | 30 | 30 | 30 |
| | Missing | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Mean | | .37 | .27 | .40 | .33 | .23 | .40 | .40 |

**Table 4. Statistics**

| | | s8 | s9 | s10 | s11 | s12 | s13 | s14 |
|---|---|---|---|---|---|---|---|---|
| N | Valid | 30 | 30 | 30 | 30 | 30 | 30 | 30 |
| | Missing | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Mean | | .27 | .30 | .20 | .43 | .33 | .30 | .30 |

**Table 5. Statistics**

| | | s15 | s16 | s17 | s18 | s19 | s20 |
|---|---|---|---|---|---|---|---|
| N | Valid | 30 | 30 | 30 | 30 | 30 | 30 |
| | Missing | 0 | 0 | 0 | 0 | 0 | 0 |
| Mean | | .43 | .20 | .50 | .27 | .27 | .30 |

4. Differentiating Power of Test Items By using the differentiating power formula for each test item, the differentiating power of test items is obtained, indicating that the test for student ability has differentiating power of questions. Of the 20 items, the number of questions in the description has differentiating power, namely 6 items have differentiating power in the good category and 8 questions have enough differentiating power, while for the very good and bad categories there is none. From the validity coefficient of the test items, the reliability of the test items, the level of difficulty of the test items, and the differentiating power of the test items, it can be concluded that the test of students' mathematical problem solving abilities meets the requirements for use in data collection.

**Table 6. Item-Total Statistics**

| | Scale Mean if Item Deleted | Scale Variance if Item Deleted | Corrected Item-Total Correlation | Cronbach's Alpha if Item Deleted |
|---|---|---|---|---|
| s1 | 6.13 | 10.947 | .458 | .654 |
| s2 | 6.23 | 12.599 | -.040 | .703 |
| s3 | 6.10 | 11.886 | .157 | .686 |
| s4 | 6.17 | 11.040 | .440 | .656 |
| s5 | 6.27 | 11.513 | .334 | .669 |
| s6 | 6.10 | 11.334 | .325 | .668 |
| s7 | 6.10 | 11.334 | .325 | .668 |
| s8 | 6.23 | 11.840 | .203 | .681 |
| s9 | 6.20 | 12.441 | .004 | .700 |
| s10 | 6.30 | 10.907 | .595 | .645 |
| s11 | 6.07 | 12.616 | -.055 | .708 |
| s12 | 6.17 | 11.178 | .394 | .661 |
| s13 | 6.20 | 11.200 | .402 | .661 |
| s14 | 6.20 | 11.545 | .287 | .673 |
| s15 | 6.07 | 11.582 | .244 | .677 |

| | Scale Mean if Item Deleted | Scale Variance if Item Deleted | Corrected Item-Total Correlation | Cronbach's Alpha if Item Deleted |
|---|---|---|---|---|
| s16 | 6.30 | 11.390 | .407 | .663 |
| s17 | 6.00 | 11.448 | .281 | .673 |
| s18 | 6.23 | 12.047 | .135 | .687 |
| s19 | 6.23 | 12.461 | .003 | .699 |
| s20 | 6.20 | 11.200 | .402 | .661 |

**Research Data Analysis**

Based on the research data, the statistical data results are as follows

**Tabel 7. Data Statistics**

| Types of Statistics | Experimental Class | |
|---|---|---|
| | X (PreTest) | Y (Postest) |
| N (Multiple Data) | 30 | 30 |
| Average | 38,00 | 85,33 |
| Standard Deviation | 12,704 | 14,320 |
| Highest Score | 50 | 100 |
| Lowest Score | 10 | 60 |

**Table 8. Descriptive Statistics**

| | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|
| PreTest Eksperimen | 30 | 10 | 50 | 38.00 | 12.704 |
| PostTest Eksperimen | 30 | 60 | 100 | 85.33 | 14.320 |
| Valid N (listwise) | 30 | | | | |

**Simple Regression**

Simple linear regression analysis is used to test the influence of one independent variable on the dependent variable.

**Table 9. Coefficients[a]**

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | |
| 1 | (Constant) | 54.316 | 5.877 | | 9.242 | .000 |
| | Problem Based Learning | .816 | .147 | .724 | 5.556 | .000 |

a. Dependent Variable: Mathematical Problem Solving

- Based on the significance value: from the Coefficients table, a significance value of 0.000 < 0.05 is obtained, so it can be concluded that the Problem Based Learning variable (X) has an effect on the Mathematical Problem Solving variable (Y)
- Based on the t value: it is known that the t value is 5.556 > t table 2.048, so it can be concluded that the Trust variable (X) has an effect on the Participation variable (Y).

**Uji Normalitas**

The research data to be analyzed has a normal distribution or not. To find normality of data in this research, the Basic Decision Making formula was used.

if the significance value is > 0.05, then the residual value is normally distributed,

if the significance value is <0.05, then the residual value is not normally distributed

for n = 30.

The results of the data normality test can be seen from the following table:

**Table 10. One-Sample Kolmogorov-Smirnov Test**

| | | Unstandardized Residual |
|---|---|---|
| N | | 30 |
| Normal Parameters [a,b] | Mean | 0E-7 |
| | Std. Deviation | 9.87618605 |
| Most Extreme Differences | Absolute | .244 |
| | Positive | .244 |
| | Negative | -.156 |
| Kolmogorov-Smirnov Z | | 1.338 |
| Asymp. Sig. (2-tailed) | | .056 |

a. Test distribution is Normal.

b. Calculated from data.

From the data above, it can be seen that 0.56 < 0.05, thus it can be concluded that the Problem Based Learning (PBL) model data comes from a normally distributed population.

This research was found that students were able to solve the questions given by the researchers quite well. This is because the learning process uses a Problem Based Learning learning model where students will actively think, communicate, search, process data and finally conclude the knowledge they have to solve problems in the form of questions given by researchers.

The Problem Based Learning learning model also develops students' abilities to actively develop their own knowledge. PBL is also intended to develop students' learning independence and social skills. Independent learning and social skills can be formed when students collaborate to identify information, strategies and learning resources that are relevant to solving students' mathematical problems.

Based on the data from the t-test analysis carried out, the tcount was 5.556 and ttable was 2.048. Where the criteria for calculating the t-test, if tcount > ttable then there is an influence of the Problem Based Learning learning model on mathematical problem solving abilities in class XI students of Muhammadiyah 10 Rantauprapat Private High School. Based on the data obtained $t_{count}$ (5.556) > $t_{table}$

(2.048). So it can be concluded that there is an influence of the Problem Based Learning learning model on students' mathematical problem solving abilities in class XI of Muhammadiyah 10 Rantauprapat Private High School.

**Discussion**

Based on the results of statistical data analysis that has been carried out, it is known that learning ability mathematical students who receive learning treatment using the approach problem based learning is better than students who receive regular learning. This is in line with the results of research carried out by Sari et al. (2014) stated that the increase in mathematical KPM for students taught using the PBM approach is higher than students taught conventionally.

After conducting research at SMA Muhammadiyah 10 Rantauprapat, taking the population of all class XI students at SMA Muhammadiyah 10 which consisted of 4 classes with a total of 120 students. The Problem Based Learning Model (Group Learning) is used as an experimental class, and mathematical problem solving material is used as a control class. Based on the results of observing teacher activities in the experimental class during the learning process, it is guided by the teacher activity observation sheet using a problem-based learning model. Observers provide assessments based on observation criteria on aspects of the internal observation teacher observation sheet, with an assessment range of 1 – 4, namely 1 (not good), 2 (fair), 3 (good), 4 (very good). Results of teacher activity observation sheets using problem-based learning models. Based on observer calculations, the average teacher activity score using the problem-based learning model was 80.12%. in the very good category. So it can be concluded that the use of the problem-based learning model in the experimental class went very well according to the steps of the learning model.

Increased Mathematical Reasoning Capability The results of data analysis both descriptive analysis and statistical tests showed that the increase in mathematical abilities of students who obtained learning with PBL approach was better than students who obtained conventional learning. This is very possible, because presenting contextual problems at the beginning of learning is one of the stimuli and triggers of students to think (Sugandi, 2013). PBL learning is a teaching approach that is emphasized in students. So students must be given the opportunity to construct mathematical knowledge, students rediscover mathematical ideas and concepts through exploration of problems in real contexts.

## CONCLUSION

Based on the results of the research and discussion, it was concluded that learning by implementing Problem Based Learning (PBL) in class XI of Muhammadiyah 10 Rantauprapat Private High School could be categorized as successful. Problem solving skill students' mathematics before being taught with using the PBL learning model obtained tcount > ttable. Can be concluded PBL learning model towards problem solving abilities have significant positive influence on mathematics class XI students of Muhammadiyah Private High School 10 Rantauprapat.

Based on previous findings and conclusions, it is implemented in This research is as follows : Selection of a learning model in the learning process is something that is very important in the learning process at school. To apply a model in learning, you need to look at the student's condition first. One learning model that can be used for improving students' mathematical problem solving abilities is by using a problem-based learning model (problem based learning). In the learning process using a problem-based learning model (problem-based learning) in addition to covering a wide range of social goals, as well improve student achievement or academic tasks in learning other. Apart from this, researchers see that the learning model is based on problems (problem-based learning) with problem solving Students' mathematical problems are still quite foreign to teachers and students, because still considered difficult to implement. Teachers should be able to do it bringing innovative learning so that learning mathematics is no longer leaving a boring and difficult impression for students. From the model problem-based learning, students are more active and understand more deeply the material taught.

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