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Research Article

# Improvement of student's mathematical understanding ability through problem based learning

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## ABSTRACT

The understanding mathematics ability is important for high school students. However, the reality that happened at SMAN 6 Banda Aceh, students' mathematical understanding still has not reached completeness so that it affects the final score of mathematics subjects. The cause of the problem is due to teacher-centered learning which makes learning meaningless. Therefore, a meaningful learning model is needed so that it can improve students' mathematical understanding ability. One of the meaningful learning models is the Problem Based Learning model. Based on this background, this research aims to:to find out the increase in students' mathematical understanding skills with the Problem Based Learning modelat SMAN 6 Banda Aceh. This study is a quasi-experimental design with non-equivalent control group design. The research sample consisted of two classes, namely class XI IPA-2 as the experimental class consisting of 30 students with the PBL model and class XI IPA-1 as the control class consisting of 29 students with the conventional model. The data collection technique is done by test. The research instrument used is a test of mathematical understanding ability. The data analysis technique used independent sample t-test. The results showed that the value of sig. count more than sig. alpha, so it can be concluded that the increase in students' mathematical understanding through the PBL model is better than the mathematical understanding of students who get conventional learning.

**Keywords:** mathematical understanding; problem-based learning; mathematics learning; meaningful learning

## 1. INTRODUCTION

Mathematics education in schools is very necessary so that students have the ability to understand mathematical concepts better, especially when students solve mathematical problems. Mathematics is still considered a difficult-subjects, because in addition to having an abstract nature, mathematics also re-quires a good understanding of concepts. Like the opinion of Hudojo (2016) which states the need for a good understanding of concepts in learning mathematics. However, it is often encountered by students who do not understand the concept well when finding problems in mathematics. In learning mathematics, there are several mathematical abilities in terms of material content or in terms of mathematical processes, namely the ability to understand mathematical concepts.

The reality found in the field is very contrary to what the teacher expects. Not all students who experience learning mathematics get maximum learning outcomes, in fact there are still many students who feel that they are wrong so they are reluctant to learn. Learning errors can be sourced from the learning process carried out by the teacher that is not in accordance with the curriculum and learning objectives of mathematics. In accordance with the results of Fariana's re-search (2017) which concludes that the understanding of concepts is still low due to the non-optimal learning process. As a result, students are not able to be independent so that it affects the results of mathematics lessons that do not achieve minimum completeness.

According to NCTM (2000), the objectives of learning mathematics are focused on the ability to use concepts in-cluding solving problems, conveying ideas, and providing inductive and deductive reasoning in reasoning. Meanwhile, according to Afgani (2011), the ability to restate mathematical concepts; classifying objects based on whether or not the re-quirements are met to form the concept; apply concepts, principles (properties, formulas, procedures); provide an ex-ample or not from the concept being studied; presenting con-cepts in the form of mathematical representations; linking various mathematical concepts; and develop the necessary or sufficient conditions of a concept. In learning, aspects of un-derstanding the concept and its application are very important things that students must have. However, the problem that often occurs and is faced by students at SMAN 6 Banda Aceh is that there are still many students who experience errors in learning mathematics and have not completed the questions given properly. Facts show that when researchers give a preliminary test to ensure the results of mathematical understanding abilities. Initial obser-vation test questions were given to 30 class XI students in the 2020/2021 Academic Year. From the results of the initial ob-servation test, 11 students out of 30 students obtained a minimum score of 65, while the rest did not achieve com-pleteness. The percentage of completeness obtained based on the results of the initial observation test is 36.7%, so it can be concluded that students' mathematical understanding is still low. Such as the research conducted by Salsinha, Amsikan, & Siahaan (2021) which found the fact that students' errors in understanding high school level material were caused by low mathematical understanding. Another study by Zebua (2020) found that the low grades in high school level material were caused by students' understanding of concepts that were not optimal .

Based on these problems, it provides an illustration that the problem is very urgent and needs to be immediately found a solution. Students' mathematical understanding ability is an aspect that contributes to the success of learning mathematics. If one of them is not met, it is feared that the learning objectives of mathematics will not be achieved according to the demands of the curriculum. So we need a suitable learning model to improve these aspects. So we need a suitable learning model to improve these aspects. In accordance with the opinion of Hudojo (2016), it is necessary to have the right learning model to achieve the objectives of learning mathematics according to the curriculum.

The learning model that is in accordance with students' understanding is the problem based learning (PBL) model. The PBL model is suitable to be applied because this model can make students understand the interrelationships between concepts and apply these concepts in everyday life. In ac-cordance with the results of research Alan & Afriansyah (2017) concluded that PBL can improve students' mathematical un-derstanding and motivation. The constructivism component of PBL emphasizes the formation of students' understanding abilities little by little by emphasizing the process of involving students in finding material (constructing ideas) so that stu-dents can meet the indicators of ability to relate various con-cepts in mathematics or outside mathematics.

The results of research by Nuriza, Saminan, & Abidin (2019), through the PBL stage students can find the relationship of the material being studied with real-life situations so that they can achieve indicators of applying concepts or algorithms in problem solving. Students also present answers by working in groups to discuss and exchange opinions so that they meet the indicators of students' ability to classify objects based on the fulfillment of the requirements that form mathematical con-cepts. The results of the research by Safangatil and Suhendra (2020) which conclude that the evaluation stage in the PBL model, students get the opportunity to issue all understandings of the material so that they meet the indicators of the ability to restate a concept and develop the necessary and/or sufficient requirements of a concept. Based on these conditions, the researchers are interested in applying PBL to high school students to find out the increase in the mathematical understanding ability of students who getlearning with the PBL modelbetter than the mathematical understanding ability of students who get conventional learning .

## 2. RESEARCH METHOD

The approach in this study is a quantitative approach with an experimental design of Nonequivalent Control Group Design (Arikunto, 2016). This design was chosen because the research sample involved two sample groups, namely the experimental and control groups. The research sample is class X I IPA-2 as the experimental class as the class thatgain learning with the PBL modeland class XI IPA-1 as a control class whichacquire learning with conventional models. After learning with the PBL model in the experimental class and the conventional model in the control class, then each class is given a final test/posttest with the aim of knowing the increase in students' mathematical understanding abilities from each class. This experiment is in the form of treatment or intervention on a variable. The quantitative approach was used because this research was conducted to prove the research hypothesis that had been formulated based on the existing theory. The research instrument is a test of mathematical understanding ability. Meanwhile, for learning activities, a Learning Implementation Plan and Student Student Work-sheets are made. The data to be analyzed came from the results of the pretest and posttest which were analyzed quantitatively. To test the hypothesis, it will be done by testing the average difference of two samples. Prior to statistical analysis, normality and homogeneity tests were carried out. The hypothesis of this research is that there is an increase in students' mathematical understanding ability through PBL model learning which is better than students' mathematical under-standing ability through conventional learning models.

## 3. RESULTS AND DISCUSSION

The data obtained from the research results are in the form of quantitative data. is data on the mathematical under-standing ability of experimental class students consisting of 30 students and control class consisting of 29 students. The data were analyzed using normality, homogeneity, n-gain, and the average difference test of two samples. The following is an analysis of students' mathematical understanding abilities.

### *3.1 Analysis of Students' Mathematical Understanding Ability Before Learning*

Descriptive statistical analysis of the initial test data for the mathematical understanding ability of experimental and control class students is presented in **Table 1**.

Based on **Table 1**, it can be concluded that the average pre-test score of the mathematical understanding ability of the two classes is relatively different. The control class has a relatively higher average than the experimental class. Meanwhile, from the value of the standard deviation of the two research classes, it can be concluded that the distribution of the initial data on the mathematical understanding ability of the two classes is relatively different. However, to find out whether the mathematical understanding abilities of the two classes before learning were the same or not, a statistical analysis test was carried out which included tests of normality, homogeneity of variance, and average differences.

**Table 1**. List of Initial Data Recapitulation of Mathematical Understanding Ability

| Class | N | Min | maks | ($\bar{x}$) | S |
|---|---|---|---|---|---|
| Experiment | 30 | 43 | 88 | 64,40 | 9,47 |
| Control | 29 | 44 | 84 | 65,31 | 8,75 |

## *3.2 Preliminary Data Assumption Test*

The results of the normality analysis of students' initial data using the Kolmogorov-Smirnov presented in **Table 2.**

**Table 2**. Normality Test Results of Initial Data on Mathematical Understanding Ability

| Class | Kolmogorov-Smirnova | | |
|---|---|---|---|
| | Statistic | df | Sig. |
| Control | .104 | 29 | .200* |
| Experiment | .092 | 30 | .200* |

Based on **Table 2**, it shows that the results of the pretest of the control and experimental class students' mathematical understanding abilities have a sig value. greater than the value of = 0.05, i. e. 0.2 > 0.05.H0, was accepted or in other words, the initial data on the mathematical understanding ability of the experimental and control classes came from a normally distributed population. The normality of the initial data of students' mathematical understanding abilities from both classes can also be seen in **Figure 1**.

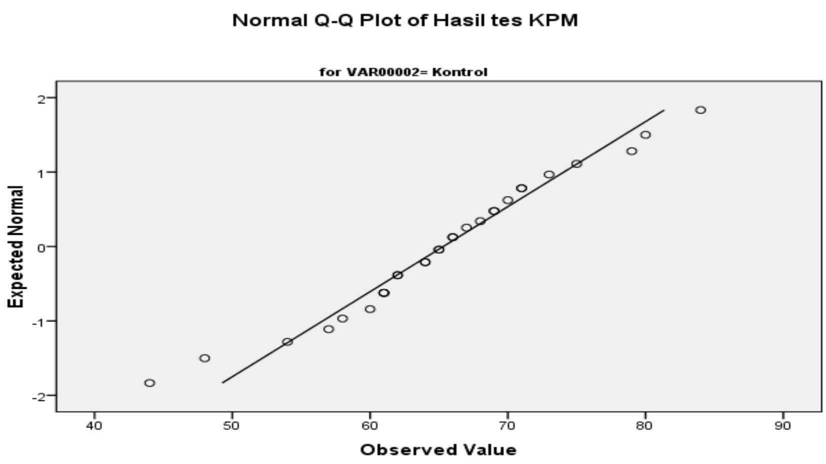


**Figure 1**. Normal QQ Plot of preliminary data in control class

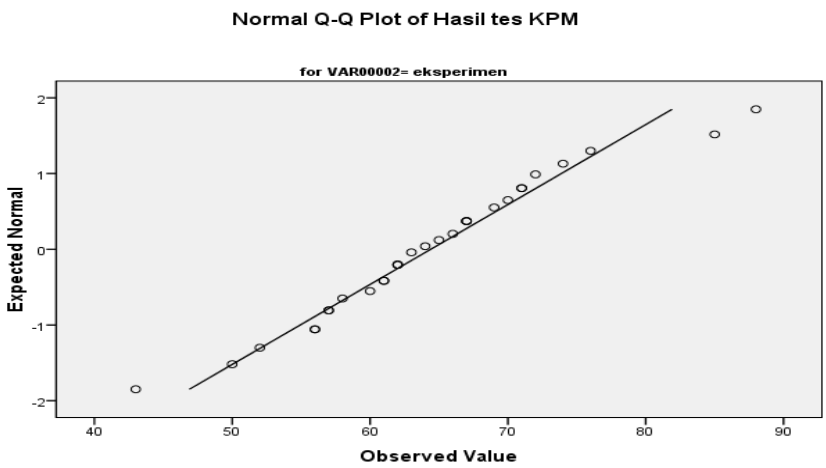


**Figure 2**. Normal QQ Plot of preliminary data in experimen tal class

The results of the analysis of homogeneity of variance for initial data of mathematical understanding ability of the experimental class and control class are presented in **Table 3**.

**Table 3**. Homogeneity Test of Variance of Initial Data on Mathematical Understanding Ability

| | Levene Statistic | df1 | df2 | Sig. |
|---|---|---|---|---|
| Based on Mean | .167 | 1 | 57 | .684 |

Based on **Table 3**, it shows that the value of sig. The pretest of the mathematical understanding of the two classes was more than = 0.05, which was 0.684 > 0.05.H0, is accepted or in other words, the initial data on the mathematical understanding ability of the two classes has a homogeneous variance.

## *3.3 Test of Differences in the Average of Initial Data on Mathematical Understanding Ability*

The results of the previous test showed that the initial data on the mathematical understanding ability of the experimental class and control class were normally distributed and the variance of the two classes was also homogeneous, so that the statistical test that would be used to test the difference in the mean of the two samples was a parametric test, namely the two-party t-test. The average difference test of the pretest score was carried out to prove whether there was a difference or the same between the initial ability of the experimental class and the control class on the ability of mathematical understanding. The test criteria at the significant level /2 = 0.025 are accept H0 if sig. 0.025 (Uyanto, 2009).

**The testing hypothesis is as follows:**

$H_0$ : Improving the ability of mathematical understanding of students who receive learning through the application of the PBL model is the same as the ability of mathematical understanding of students who receive learning with conventional models

$H_1$ : The improvement of students' mathematical understanding ability who gains learning through the application of the PBL model is better than the mathematical understanding ability of students who gain by conventional models

The analysis of the results of the test of the difference in the mean of the pretest of mathematical understanding abilities is presented in **Table 4.**

**Table 4**. Test the Difference in Average Pretest of Mathematical Understanding Ability

| | t-test for Equality og Means | | |
|---|---|---|---|
| | t | df | Sig. (2-tailed) |
| Equal Variances Assumed | .383 | 57 | .703 |

**Table 4** shows that the value of sig. (2-tailed) the initial data of mathematical understanding ability is 0.703 which means more than 2 = 0.025. So H0is rejected. This means that there is no significant difference between the experimental class and the control class. So, it can be concluded that these two classes have the same initial ability.

## *3.4 Analysis of Increasing Mathematical Understanding Ability After Learning*

After learning with the PBL model in the experimental class and conventional in the control class, then each class is given a final test/posttest with the aim of knowing the increase in students' mathematical understanding abilities from each class. The following is a descriptive statistical analysis of the final test data for the mathematical understanding ability of the experimental and control class students.

**Table 5**. List of Final Data Recapitulation of Mathematical Understanding Ability

| Class | N | Min | maks | ($\bar{x}$) | S |
|---|---|---|---|---|---|
| Experiment | 30 | 61 | 89 | 80,17 | 6,41 |
| Control | 29 | 62 | 83 | 73,79 | 6,60 |

Based on **Table 5**, that average scores of the pre-test and post-test obtained by students in the experimental and control classes, in general it can be said that there was an increase in the ability of mathematical understanding in both classes. However, further statistical testing is necessary to determine the difference in the increase in mathematical understanding ability in the two classes. Tests on improving students' mathematical understanding skills in the experimental and control classes were conducted by analyzing normalized gain (N-gain) data. The average normalized gain is a description of the increase in students' mathematical understanding abilities after participating in learning, both those who follow the PBL model of learning and those who follow the conventional approach of learning. To find out with certainty the significance of the difference in increasing the mathematical understanding ability of the experimental and control class students, further statistical tests are needed.

## *3.5 Assumption Test for N-Gain Data*

The results of the normality analysis of the Kolmogorov-Smirnov for the experimental and control class N-gain data are presented in **Table 6.**

**Table 6**. Normality Test of N-Gain Data for Mathematical Understanding Ability

| Class | Kolmogorov-Smirnova | | |
|---|---|---|---|
| | Statistic | df | Sig. |
| Control | .099 | 29 | .200* |
| Experiment | .151 | 30 | .078 |

Based on **Table 6**, it shows that the results of the N-gain mathematical understanding ability of experimental and control class students have a sig value. greater than the value of = 0.05. H0, was accepted or in other words, the N-gain data on the mathematical understanding ability of the experimental and control classes came from a normally distributed population. The normality of the N-gain data for students' mathematical understanding abilities from both classes can also be seen in the following figure.

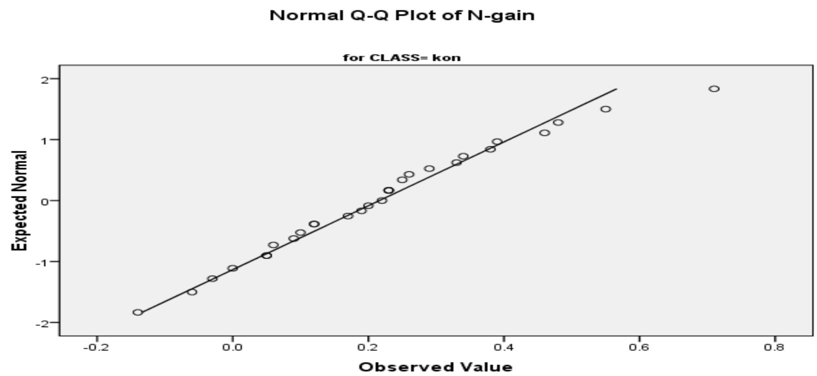


**Figure 3**. Normal QQ Plot Data N-Gain Control Class

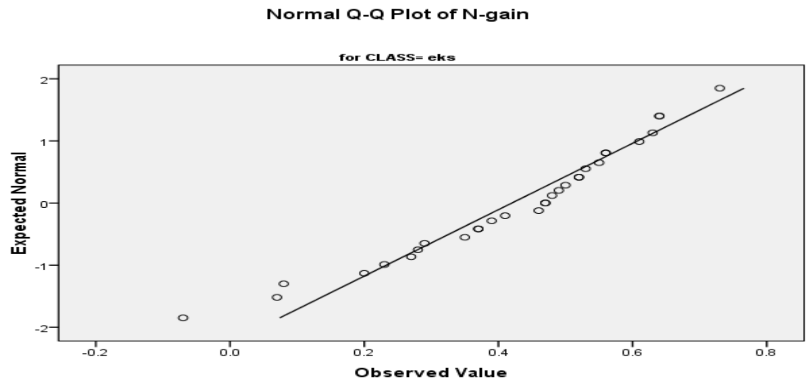


**Figure 4**. Normal QQ Plot Data N-Gain Experiment Class

Furthermore, the results of the analysis of the homogeneity of variance for the N-gain data on the mathematical understanding ability of the experimental class and control class are presented in **Table 7**.

**Table 7**. Test of Homogeneity of Variance Data N-gain Mathematical Understanding Ability

| | Levene Statistic | df1 | df2 | Sig. |
|---|---|---|---|---|
| Based on Mean | .008 | 1 | 57 | .929 |

Based on **Table 7**, it shows that the value of sig. the N-gain data of the mathematical understanding ability of the two classes is more than = 0.05, which is 0.929 > 0.05.H0, is accepted or in other words, the N-gain data on the mathematical understanding ability of the two classes has a homogeneous variance.

## *3.6 Test the Average Difference of N-gain Data on Mathematical Understanding Ability*

The statistical test used to test the difference in the mean of the two samples is the t-test. The test of the difference in the average N-gain score was carried out to prove the increase in the mathematical understanding ability of students who received learning with the PBL model better than students who get learning with conventional models. The test criteria at a significant level = 0.05 is to accept H0 if sig. 0.05 (Uyanto, 2009).

**The testing hypothesis is as follows:**

H0 : Increasing the ability of mathematical understanding of students who gain learning through the application of the PBL model is the same as the ability of mathematical understanding of students who receive learning by conventional models

H1 : The improvement of mathematical understanding abilities of students who gain learning through the application of the PBL model is better than the ability of mathematical understanding of students who acquire with conventional models

The analysis of the test results of the average difference in the N-gain data on mathematical understanding abilities is presented in **Table 8**.

**Table. 8**. Test the difference in the mean of N-gain data on mathematical understanding ability

| | t-test for Equality og Means | | |
|---|---|---|---|
| | t | df | Sig. (2-tailed) |
| Equal Variances Assumed | -4.141 | 57 | .000 |

**Table 8** shows that the value of sig. (2-tailed) N-gain data on mathematical understanding ability is 0.000 which means less than = 0.05. So H0 is rejected, as a result H1 is accepted. This shows that the improvement of students' mathematical understanding abilities who receive learning with the PBL model is better than students who receive conventional learning in terms of overall students. The results obtained are in accordance with the research results of Safangatil and Suhendar (2020) which concluded that increasing students' mathematical understanding skills taught by the PBL model was better than increasing students' mathematical understanding taught by conventional learning. The results of Wahyuni & Rahmadhani's (2020) research also concluded that increasing students' mathematical understanding skills using the PBL model was better than increasing students' mathematical understanding abilities using direct learning, and students' attitudes towards the application of the PBL model showed a positive attitude.

Based on the research results that have been obtained, there is a uniqueness of the PBL model, namely students with low abilities can be more independent in understanding the material being studied. The activity can be seen in stages, namely the orientation of students to problems, with the efforts made by the teacher, namely orienting the problem so that students can understand the concept correctly. The teacher motivates students by displaying pictures about events related to the material in everyday life. The results of Lee & Blanchard's research (2018) conclude that the problem orientation stage in the PBL model is effectively applied in learning as a way of providing good motivation. These results are similar to the research of Andini, Susanto, & Hobri (2017), namely at this stage it provides an initial view for students in understanding the material or concept to be taught.

The stages of organizing students to learn, there are student activities in the class who are more active in making ideas in understanding concepts. such as giving questions and responses related to the material of sequences and series. The teacher provides opportunities for students to provide opinions about the importance of the material being taught and students are given time to discuss the LKPD provided. Like the results of Firdaus, & Herman (2017) which concluded that the PBL model can stimulate students' understanding so that they can relate to some of the ideas/concepts that have been studied. However, there are also students who have not been able to relate the questions given to the concepts to be studied. Similarly, what was obtained in Alan & Afriansyah's research (2017) that when students were in group discussions, students understood the concept better.

The stages of guiding individual and group investigations, namely the teacher provides problems to discuss in groups and provide opportunities for students to get the right solution to the problems given. With the opportunity given, students are more creative in linking the relationship between the concepts they have learned and the new concepts. This result is supported by Farihah's research (2018) which concludes that in the implementation of the PBL model, there are students who need to be more comprehensively given the opportunity by the teacher to be able to understand the problem and determine what concept to use. The results obtained are the same as the research by Lestari & Luritawaty (2021) that PBL has stages, namely guiding student activities in solving given problems so that students have good motivation and can recall concepts that have been studied together.

The stages of developing and presenting the work, with efforts including the teacher giving in the form of questions that make students understand the problem to find answers to the problem and facilitate students who have difficulty in mathematical understanding. Students seemed enthusiastic in finding solutions despite difficulties at the beginning. As well as the results of research by Surya & Syahputra (2017) concluded that through the PBL model, students can reconstruct concepts that have been studied and then developed to solve mathematical problems.

The last stage is analyzing and evaluating the problem-solving process, with efforts including the teacher asking students to show the method and conclude the results obtained with the right concept. At this stage there are students who do not conclude the concepts obtained correctly, because they do not carry out the analysis process properly. In accordance with the results of Fariana's research (2017) which concludes that the last stage in PBL provides an increase in student understanding for the better because students have not been able to conclude the concepts learned correctly. The results of research by Ramadhani, et.al (2019) also concluded that the understanding of concepts was better through the PBL model, even in solving more complicated problems.

## 4. CONCLUSION

From the analysis and discussion that has been described, it can be concluded that the increase in the mathematical understanding ability of students who receive PBL learning modelsbetter than the improvement of students' mathematical understanding abilities who received conventional learning models.

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## AUTHOR'S CONTRIBUTIONS

The authors discussed the results and contributed to from the start to final manuscript.

## CONFLICT OF INTEREST

There are no conflicts of interest declared by the authors.

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