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The Influence of the Problem-Based Learning Model on Students' Ability to Understand Mathematical Concepts

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Abstract- This research is motivated by students' ability to understand mathematical concepts, which is still relatively low. This research aims to determine the positive and significant influence of the Problem-Based Learning learning model on students' ability to understand mathematical concepts. This research method is quantitative research with a pre-experimental design research type with a one-group pretest-posttest design. The sampling technique used a saturated sampling technique with a sample of 21 students. The instruments used were concept understanding ability tests and observation sheets on implementing teacher learning and student activities. The research results show that students' understanding of mathematical concepts using the Problem-Based Learning learning model has increased significantly.

1. Introduction

One of the most critical aspects of learning mathematics is understanding concepts. Understanding concepts is a student's ability to convey the concepts they have learned, both in writing and orally, to other people so that they can understand what is being communicated (Rachmania & Wahidin, 2017).

Mathematics is an orderly structure with structured, logical, and systematic concepts, from the simplest to the most complex (Suardiana, 2021). This illustrates that understanding concepts plays a vital role in learning mathematics. When the basic concepts students get are wrong, it will be difficult to correct them again, mainly when applied to solving mathematics problems.

Understanding concepts is an essential aspect of learning because by understanding concepts, students.

RANGKIANG MATHEMATICS JOURNAL
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They can develop their abilities in each subject matter (Heriyaman, 2022). Understanding concepts

involves memorization and students' ability to restate concepts in other forms that are easy to understand. Understanding mathematical concepts can help students solve problems and master subject matter. According to Yuliani, Zulfah, & Zulhendri (2018), understanding mathematical concepts is an ability to master the material and a student's ability to understand, absorb, master, and apply it in mathematics learning. According to Marbun, Elindra & Harahap (2022), indicators of understanding mathematical concepts are 1) the ability to restate a concept, 2) the ability to mention examples and non-examples of a concept, 3) the ability to present concepts in various forms of mathematical representation, 4) the ability to apply concepts to solution to problem.

However, the results of a survey conducted by the Program For International Student Assessment (PISA) in 2022 show that Indonesian students' ability to understand mathematical concepts is still low compared to other countries. Indonesian students have not yet reached international standards in mathematics ability. The results of PISA 2022 show a decline in learning outcomes internationally, especially in understanding mathematical concepts. Indonesia's average mathematic ability score fell 13 points to 366, from the result in the previous edition of 379.

Based on the results of interviews with mathematics teachers who teach in class, Students' understanding of mathematical concepts is low because learning is still teacher-centered, and student involvement is not optimal. This happens because teachers delivering lessons only monotonously use lecture and question-and-answer methods, making students less enthusiastic and unmotivated to follow the lessons.

This can be seen from the scores obtained in the odd semester of the 2023/2024 academic year, showing that around 38.1% or 8 out of 21 students from class XI Science passed the KKM in mathematics with a KKM of 75. The low ability to understand mathematical concepts can be seen in students who experience difficulties in conveying concepts again in the learning process. For example, if an example question is given, the student can solve it, but if the question is changed, the student will have difficulty solving it. Students also have difficulty expressing ideas and completing examples and non-examples of a mathematical concept. Mathematics is considered difficult because teachers often focus more on teaching formulas than explaining concepts, so students have difficulty understanding the material.

The problem-based learning model is one learning model that can improve students' ability to understand mathematical concepts. According to Ismaimuza (Yulianti & Gunawan, 2019), the PBL learning model is learning that focuses on problem-solving activities. This means that students can actively find answers to the problems the teacher gives. Meanwhile, according to Rugayah (2020), the PBL learning model emphasizes daily issues. It is also an innovative type of learning that can help students understand the material and improve their critical thinking skills.

The results of research conducted by Yelvalinda, Pujiastuti & Fatah (2019) show that the increase in the ability to understand mathematical concepts of students who received the PBL learning model was higher than that of students who received the expository. The average N-gain score of students' conceptual understanding ability with PBL learning is greater than that of students with expository learning. Furthermore, research conducted by Yanti, Anwati & Wijaya (2019) showed that the PBL model affected the understanding of mathematical concepts of class VII students at SMP Negeri 1 Terbanggi Besar, even in the semester of the 2018/2019 academic year. This is shown by the increased understanding of mathematical concepts for students who follow the PBL model, which is higher than the increase in knowledge of mathematical concepts for students who follow conventional learning.

Based on what has been described above, this article examines: 1) What is the ability to understand students' mathematical concepts in class XI Science at SMA Negeri 1 Sesenapadang before and after implementing the Problem-Based Learning learning model? 2) Is there a positive and significant influence of the problem-based learning model on students' ability to understand mathematical concepts in class XI Science at SMA Negeri 1 Sesenapadang?

2. Methods

The approach used in this research is a quantitative approach with a pre-experimental design, while the type of research used is one group pretest-posttest. The population in this research was students of class XI Science at SMA Negeri 1 Sesenapadang for the 2023/2024 academic year, consisting of 21 students. Sampling was carried out using a saturated sampling technique, part of Nonprobability Sampling, where each member of the population is selected as a sample. The research instrument tests students' ability to understand mathematical concepts, an observation sheet on the implementation of learning by the teacher, and student activities. Data collection techniques include observation, initial test (pretest),

and final test (posttest)

Students' understanding of mathematical concepts was analyzed using descriptive and inferential analysis. The descriptive analysis used the maximum, minimum, mean, median, mode, and standard deviation values, while the inferential analysis used the paired sample t-test first. The prerequisite tests are the normality test and homogeneity test using SPSS version 25.00

The category of students' ability to understand mathematical concepts used, according to Wulandari & Munandar (2020), can be seen in Table 1.

Table 1. Categories of students' level of ability to understand mathematical concepts

Assessment Category	Value Interval
0 – 20	Very Low
21 – 40	Low
41 – 60	Medium
61 – 80	High
81 – 100	Very High

The manual paired sample t-test calculation formula, according to Asmaul, Hasan & Nurjanna (2021), is:

$$T_{(hitung)} = \frac{\overline{x} \cdot \overline{y}}{\sqrt{\left(\frac{sx^2}{n} + \frac{sy^2}{n}\right) - 2r\left(\frac{sx^2}{\sqrt{n}}\right)\left(\frac{sy^2}{\sqrt{n}}\right)}}$$

$$SD = \sqrt{var}$$

$$Var\ (s^2) = \frac{\sum(x-\bar{x})^2}{n-1}$$

Where:

(calculate): T(calculated) value

SD: Standard deviation of the difference between measurements 1 and 2

n: Many samples

Decision-making criteria by comparing the t count and t table according to Susilo & Ernawati (2018) are as follows.

H_0: accepted if $t_{count} < t_{table}$ or

H_0: accepted if sig ≥ 0.05

Observation sheets on the implementation of learning by teachers and student activities were analyzed using the formula according to Mariana, Aji & Sutrisno (2020)

$$N = \frac{\text{Acquisition score}}{\text{Total score}} \times 100\%$$

The categories of learning implementation by teachers and student activities used, according to Azizah & Wardani (2023), can be seen in Table 2.

Table 2. Categories of Teacher Learning Implementation and Student Activities

Percentage (%)	Criteria
86 - 100	Very Good
71 - 85	Good
56 - 70	Fairly Good
41 - 55	Not Good
25 - 40	Not Good

3. Results and Discussion

The results of the descriptive analysis, which includes a test of students' ability to understand mathematical concepts when taught using the problem-based learning model, are higher compared to before being taught using the problem-based learning model, where the average pretest score of 50.38 is in the medium category while The posttest average was 75.33 in the high category.

Students' ability to understand mathematical concepts can be seen from the percentage of concept

math.ppj.unp.ac.id Rangkiang Mathematics Journal Vol 3, No2 2024

understanding scores, which shows that there were no students with very high criteria in the pretest. A total of 6 students (28.6%) were in the high criteria, where these students answered the questions correctly but did not include conclusions in their answers. Nine students (42.9%) were in the medium criteria who responded to questions without including the information they knew and what was asked. Five students (23.8%) were in the low criteria, where they only wrote down known information and what was asked. One student (4.8%) was in the shallow criteria, had difficulty restating concepts, could not understand the meaning of the question, and could not write down what was asked of the question, so it wasn't easy to solve the question.

Students' ability to understand mathematical concepts on the posttest significantly increased. There were five students (23.8%) with very high criteria, and these students could answer questions correctly and include conclusions. A total of 14 students (66.7%) were in the high criteria, where they answered the questions correctly but did not include findings in their answers. 2 students (9.5%) were in the medium criteria, who responded to questions without including the information they knew and what was asked. Apart from that, no students are on the low criteria.

Analysis of the observation sheet obtained on student activities shows that meeting 1 was in the outstanding category, meetings 2 to 4 were in the exceptional category, while the implementation of learning by the teacher obtained from meetings 1 to 4 was in the outstanding category.

Next, for calculations for hypothesis testing, prerequisite tests are first carried out, namely normality and homogeneity tests, with the help of the SPSS version 25.00 application. Based on the normality test, it was found that the significant value in the pretest was 0.418, and the posttest was 0.316, which was more critical than 0.05, so the data was normally distributed. The homogeneity test obtained a significant value of 0.094, greater than 0.05, which means the data distribution is homogeneous. The hypothesis test was then carried out after carrying out the normality test and homogeneity test. The results of the hypothesis calculation obtained a significance value of 0.000, which is smaller than the significance level of 0.05, thus indicating that H_0 was rejected and H1 was accepted, which means there is a positive and significant influence between the implementation problem-based learning model on students' ability to understand mathematical concepts.

The teacher divides students into four groups using the problem-based learning model with a discussion method on algebraic function limits material. After the groups are formed, the teacher provides problems in the form of student worksheets and directs students to understand the issues in the student worksheets. Students then work with their respective group members to solve the problems.

After the discussion in the group is finished, representatives of each group are asked to present the results of the debate they have worked on with their group friends, and other groups can ask or respond to the group that presented the results of their discussion. After finishing, the teacher and students conclude the material learned today.

Syuhada, Suyono & Wiraningsih (2022) said that the PBL model is a learning model that can help mathematics learning because it allows students to be more visible in learning activities and encourages them to be active and enthusiastic in class, which has a positive impact on students' understanding of concepts. Simanjuntak, Tambunan & Sauduran (2022) argue that the Problem-Based Learning (PBL) learning model also makes the student learning process meaningful, namely that students become able to think critically to develop mathematical concepts in solving given problems and problems found in student learning resources.

According to Rubianti, Priyatni, & Supriati (2019), the advantages of Problem-Based Learning (PBL) are as follows: 1. Increasing learning activities, PBL can increase student learning activities in a pleasant atmosphere. In this learning process, students are actively involved in thinking and looking for resources to solve problems. 2. Develop Critical Thinking Skills. PBL encourages students to practice critical thinking skills. Problem-solving activities in PBL depend on one scientific discipline and require a connection with the knowledge that students already have. 3. Applying Knowledge in Real Life. The problems faced in PBL are related to students' daily lives, so they learn to solve these problems in a natural context during the learning process. 4. Directing Students to Become Independent Learners. In PBL, students are often faced with various issues. By learning to solve problems, students get used to applying their knowledge and finding the necessary information independently.

The results of this research align with research conducted by Fransisca, Malawi, & Prasetyowati (2023), which shows that students' understanding of mathematical concepts after being taught using the PBL learning model experienced a significant increase. This can be seen from the results of the students' initial tests before using the PBL learning model. Out of 15 students, as many as nine did not meet the KKM pass; after learning using the PBL model, students' understanding of mathematical concepts increased to 12 students who successfully passed the KKM.

Other research conducted by Marliana, Sunaryo & Zamnah (2023) shows differences in students' ability to understand mathematical concepts between classes that apply the PBL learning model and classes that apply the direct learning model. This research showed that the increase in students' understanding of mathematical concepts with the PBL model was higher than in students' knowledge of mathematical concepts with conventional learning. Furthermore, research conducted by Linsida et al. (2022) found that the PBL learning model can improve the ability to understand mathematical concepts for class VII students. It can be seen from the recapitulation of the average achievement scores for indicators of the ability to understand mathematical concepts; it can be seen that out of 35 students, 18 students have not met the KKM pass in the pretest after being given learning using the PBL model, the number of students who passed the KKM on the posttest score increased to 28 students.

4. Conclusion

1. Students' ability to understand mathematical concepts before applying the problem-based learning model is in the medium category. After using the problem-based learning model, it is in the high category.
2. A positive and significant influence exists between applying the problem-based learning model and students' ability to understand mathematical concepts.

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