THE EFFECTIVENESS OF PROBLEM BASED LEARNING ON CONCEPTUAL UNDERSTANDING ABILITIES

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Abstract

This research aims to determine the effectiveness of the Problem Based Learning (PBL) model compared to the conventional model on students' conceptual understanding of probability at SMA Negeri 1 Pangkah, Tegal Regency. The research uses a quantitative approach with an experimental method, applying a True Experimental Design in the form of a Pretest-Posttest Control Group Design. The population of this study includes all tenth-grade students at SMA Negeri 1 Pangkah, with samples selected using purposive sampling technique. Data were collected using test methods, consisting of pretests and posttests. The results indicate that students taught using PBL have better conceptual understanding abilities than those taught using the conventional model. Therefore, it can be concluded that the PBL model is effective in enhancing students' conceptual understanding in the probability topic at SMA Negeri 1 Pangkah. The study recommends that students utilize the PBL model to develop their conceptual understanding in mathematics, and that mathematics teachers implement the PBL model in their teaching to improve students' conceptual understanding.

Keywords: Learning effectiveness, PBL, Conceptual understanding ability.

1 INTRODUCTION

Education is an effort to stimulate and advance individuals' inherent potential in accordance with the values of society and culture (Fuad Ihsan, 2005:1). Education functions as a means to enhance intelligence, character, personality, and skills. Quality education is education that can produce graduates with abilities or skills based on personal and social competencies, as well as high moral values (Hari Sudradjat, 2005:13). The improvement of education quality must be emphasized continuously so that the dream of quality education that meets the needs can be realized (Fadhli, 2017:215). The quality of education can be measured by how the provision or delivery of education is conducted, which includes various aspects such as student readiness, teacher availability, facilities and infrastructure, teaching models, and school atmosphere (Tabularasa & Unimed, 2009:87).

In the context of education in Indonesia, mathematics plays an important role from the basic education level to tertiary education. The importance of mathematics education is reflected in its presence across various fields of daily life. Mathematics is defined as the study of logic, form, sequence, and interrelated concepts (Cahyono et al., 2018:22). Given its significance, students at every educational level should be able to master the subject.

Conceptual understanding is very important in mathematics learning. Conceptual understanding plays a crucial role as it is a basic ability needed by students to understand more complex mathematical concepts (Aledya, 2019:2).Conceptual understanding in mathematics learning is the key to mastering the material deeply. It is not just about memorization but rather about understanding the fundamental concepts that serve as the foundation for comprehending more complex material. Students with a strong conceptual understanding tend to be more successful in solving various mathematical challenges. The development of conceptual understanding not only impacts academic achievement but also equips students with the thinking skills necessary to face real-world challenges.

However, observations and interviews with Mrs. Yuni Astuti, S.Pd at SMA Negeri 1 Pangkah indicate that mathematics learning still predominantly uses conventional teacher-centered models, resulting in students being passive and merely memorizing formulas without understanding the concepts. This leads to students struggling to solve varied mathematical problems and lacking in conceptual understanding.

From the above description, it is apparent that there is a lack of conceptual understanding among students, indicating the need for improvement in the instructional models used in the classroom. A learning model that can support the enhancement of conceptual understanding abilities is the PBL

model. According to Wahyuningsih (2019:69), PBL is considered an effective instructional model for teaching mathematics because it integrates mathematical concepts with practical applications in daily life. Based on previous research (Yulianti & Gunawan, 2019:399), the implementation of the PBL model has a positive effect on conceptual understanding and critical thinking. Through PBL, students are encouraged to actively seek solutions to problems, build concepts, and optimize critical thinking skills. Conversely, conventional learning tends to lack stimulation for critical thinking practice and independent conceptual understanding in students. PBL also provides opportunities to formulate mathematical solutions in real-life contexts, bridging the gap between theory and practical application, and developing relevant problem-solving skills for life.

Therefore, the existing conditions indicate the need for the implementation of more effective instructional models such as PBL to improve students' conceptual understanding. This research aims to determine whether the Problem-Based Learning model is effective in enhancing students' conceptual understanding of mathematics regarding probability topics in class X at SMA Negeri 1 Pangkah. The benefits of this research are expected to contribute to the development of knowledge, particularly in school management to enhance school quality.

2   METHODOLOGY

This research employs a quantitative approach with experimental methods and implements a True Experimental Design in the form of a Pretest-Posttest Control Group Design. The quantitative approach is chosen to ensure that the data obtained are objective and measurable in relation to concept comprehension. The use of the Pretest-Posttest Control Group Design allows for a comparison between the experimental and control classes, aiding in drawing conclusions about the impact of PBL on conceptual understanding abilities. This study consists of two variables: Problem-Based Learning as the independent variable (X) and Concept Comprehension Ability as the dependent variable (Y). The population in this study includes all 10th-grade classes at SMA Negeri 1 Pangkah, with purposive sampling selecting class X.6 as the control group, X.7 as the experimental group, and X.8 as the trial class.

The data collection methods used in this research include documentation and tests. Documentation is used to obtain data on student names, worksheets or teaching modules, and photos of mathematics learning activities from the sampled classes. Tests are used to collect data on concept comprehension abilities, consisting of pre-tests and post-tests to assess changes or improvements in students' concept comprehension. Before being implemented in the control and experimental classes, instrument testing is conducted in the trial class. The tests consist of essay questions related to simple event probability, complement event probability, and expected frequency, with a total of 5 written essay questions.

The data analysis used includes the One-Sided Right Proportion Test to determine whether the concept comprehension ability of students taught using PBL meets the target or not, the One-Sample Right-Sided t-test to determine whether the scores of students taught using PBL reach 70 or not, and the Independent Sample t-test to determine whether the average concept comprehension ability of students using PBL is better than those using conventional methods. From these three tests, conclusions can be drawn to determine the effectiveness of PBL on concept comprehension abilities.

3   RESULTS

The data on concept comprehension ability in this research focuses on understanding relational mathematical concepts, obtained through two stages of testing: pretest and posttest administered to the control class (X.6) and the experimental class (X.7). This data is described in the following information.

Table 1. *Description of Concept Understanding Ability Data Before Treatment*

No	Size	Experimental Class	Control Class
1	Maximum Value	63	67
2	Minimum Value	28	25
3	Mean	49,0833	45,2778
4	Median	50	44
5	Mode	53	38
6	Variance	67,85	100,6635
7	Standard Deviation	8,2371	10,0331
8	Reach	35	42

The description of data on concept comprehension ability before treatment shows that, although there are some differences in the mean, median, mode, and distribution of scores between the experimental and control classes, these two classes are fairly equivalent in terms of concept comprehension ability. The experimental class has slightly higher mean and median scores, indicating a slight initial advantage, but the variation in scores in the control class is greater. Therefore, it can be concluded that both classes have a relatively equal level of initial ability, despite some minor differences.

Table 2. Description of Concept Understanding Ability Data After Treatment

No	Size	Experimental Class	Control Class
1	Maximum Value	100	95
2	Minimum Value	45	40
3	Mean	75,0833	62,75
4	Median	73	60,5
5	Mode	73	45
6	Variance	259,1643	317,336
7	Standard Deviation	16,0986	17,8139
8	Reach	55	55

Based on the description of the concept comprehension ability data, it can be seen that the experimental class using the PBL model has a higher average compared to the control class using the conventional learning model. The average concept comprehension in the experimental class is 75,0833, while in the control class it is 62,75. Meanwhile, the experimental class has a maximum value of 100 and a minimum value of 45, whereas the control class has a maximum value of 95 and a minimum value of 40.

Thus, based on this data, it can be concluded that the use of the PBL learning model in the experimental class provides better concept comprehension ability to students compared to the conventional learning model used in the control class. This is also indicated by the higher median value in the experimental class, which is 73, compared to the control class, which is 60,5. Additionally, the variance and standard deviation in the experimental class are lower compared to the control class, indicating that the data in the experimental class is more concentrated around the mean, while the data in the control class is more dispersed.

3.1 Data Analysis

Hypothesis testing was conducted by performing the One-Sided Right Proportion Test, the One-Sample Right-Sided t-test, and the Independent Sample t-test.

3.1.1 One-Sided Right Proportion Test

Before conducting the One-Sample Right-Sided t-test, the One-Sided Right Proportion Test was performed first to determine whether the concept comprehension ability taught using the PBL model met the target. The data used were the posttest scores of the experimental class students' concept comprehension abilities. The summary of the One-Sided Right Proportion Test analysis is as follows.

Table 3. Results of One-Sided Right Proportion Test

Z_{count}	Z_{table}	Conclusion
3	1,65	rejected

Based on the results obtained from the analysis of the one-sided right proportion test for mathematical concept comprehension ability data, Z_{count} = 3 and Z_{table} = 1,65. Because $Z_{count} > Z_{table}$, then H_0 is rejected, meaning that the comprehension ability of the concepts taught using the PBL model has reached the target.

3.1.2 One-Sample Right-Sided t-test

After conducting the one-sided right proportion test, a one-sample t-test was performed to conclude that the overall scores of students taught using the PBL model reached 70. The summary of the one-sample t-test analysis is as follows.

Table 4. Results of One-Sample Right-Sided t-test

t_{count}	t_{table}	Conclusion

1,8946	1,6896	rejected

Based on the calculation results using the one-sample t-test analysis for concept comprehension ability, t_{count} = 1.8946 and t_{table} = 1.6896. Because $t_{count} > t_{table}$, then H_0 is rejected, meaning that students taught using the PBL model have reached a score of 70.

3.1.3 Independent Sample t-test

Next, an Independent Sample t-test was conducted to determine whether the PBL model is superior to the conventional model in terms of concept comprehension ability. The data used includes the posttest scores of concept comprehension ability for the experimental and control classes. The summary of the analysis is as follows.

Table 5. *Results of Independent Sample t-test*

t_{count}	t_{table}	Conclusion
3,082	1,9944	rejected

Based on the results obtained from the Independent Sample t-test analysis for concept comprehension ability data, t_{count} = 3.082 and t_{table} = 1.9944. Because $t_{count} > t_{table}$, then H_0 is rejected, meaning that the average concept comprehension ability of those applying the PBL model is better than those applying the conventional model.

The results of the tests using the One-Sided Right Proportion Test, One-Sample t-test for the right side, and Independent Sample t-test have proven that students' concept comprehension abilities taught using the PBL model are more effective than those taught using conventional learning models. This is because through PBL, students are not only asked to memorize information, but they are also given the opportunity to explore concepts comprehensively, understand their underlying aspects, and relate them to broader contexts. Consequently, students can develop deeper and more sustainable understanding of the subject matter, enabling them to apply these concepts in various situations. This is supported by previous research conducted by Yulianti & Gunawan (2019:399), which explains that the implementation of the PBL model has a positive effect on concept comprehension. Through PBL, students are encouraged to actively seek solutions to problems and build concepts. Conversely, conventional learning tends to stimulate less independent concept comprehension practice among students.

4   CONCLUSIONS

The concept comprehension abilities taught using the PBL model achieved scores reaching the minimum passing grade.This was evidenced by the One-Sided Right Proportion Test and the One-Sample t-test for the right side. Furthermore, from the analysis of the Independent Sample t-test results, it is known that the concept comprehension abilities of students taught using PBL are better than those taught using the conventional model. Therefore, it can be concluded that the PBL learning model is effective in enhancing the concept comprehension abilities of students in Grade X at SMA Negeri 1 Pangkah, specifically in the topic of probability sub-topics: simple event probability, complementary event probability, and expected frequency.

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