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The Effect of PBL Model on Students' Mathematical Problem-Solving Ability Based on HOTS Questions

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ABSTRACT

Problem-solving is a practical approach to stimulating higher-order thinking skills. The strategy that can be used is to apply a learning model, one of which is Problem-Based Learning (PBL). This study aimed to determine the effect of PBL on the ability to solve mathematical problems based on higher-order thinking Skills (HOTS) at SMA Negeri 1 Baturraden. This study used a quantitative approach with a quasi-experimental method. The research design used was post-test-only. The research sample was taken using the cluster random sampling technique. The research instrument used was a mathematical problem-solving ability test based on HOTS questions. Data analysis was conducted using an independent sample t-test. The results showed that students who participated in PBL learning had better mathematical problem-solving skills based on HOTS questions than students who participated in conventional learning. In PBL learning, students will be able to (1) Students better understand the concept; (2) in learning activities, students are actively involved; (3) the learning process is more meaningful; (4) Can motivate and increase student interest in the material being studied; (5) Can emphasize positive social attitudes towards other students, such as accepting other people's opinions; (6) There is interaction between learners and their friends to achieve learning completeness; (7) Able to foster student creativity both individually and in groups.

Keywords: Problem-Based Learning, Mathematical Problem-Solving Abilities, Higher Order Thinking Skills

ABSTRAK

Pemecahan masalah menjadi pendekatan yang efektif dalam merangsang kemampuan berfikir tingkat tinggi, strategi yang dapat digunakan adalah menerapkan model pembelajaran salah satunya Problem Based Learning (PBL). Tujuan dari penelitian ini ialah untuk mengetahui pengaruh PBL terhadap kemampuan memecahkan masalah matematis berbasis Higher Order Thinking Skills (HOTS) di SMA Negeri 1 Baturraden. Penelitian ini menggunakan pendekatan kuantitatif dengan metode quasi eksperimen. Desain penelitian yang digunakan adalah post-test only design. Sampel penelitian diambil menggunakan teknik cluster random sampling. Instrumen penelitian yang digunakan adalah tes kemampuan pemecahan masalah matematis berbasis soal HOTS. Analisis data dilakukan dengan menggunakan uji independent sample t-test. Hasil penelitian ini menunjukkan bahwa siswa yang mengikuti pembelajaran PBL memiliki kemampuan memecahkan masalah matematis berbasis soal HOTS lebih baik dari pada siswa yang mengikuti pembelajaran konvensional. Sebab dalam pembelajaran PBL siswa akan dapat lebih : (1) Siswa lebih memahami konsep; (2) dalam kegiatan pembelajaran siswa terlibat secara aktif; (3) proses pembelajaran lebih bermakna; (4) Dapat memotivasi dan meningkatkan minat siswa terhadap materi yang di pelajari; (5) Dapat menekankan sikap sosial yang positif terhadap siswa lainnya, seperti menerima pendapat orang lain; (6) Adanya interaksi antara pembelajar dan temannya untuk mencapai ketuntasan belajar; (7) Mampu menumbuhkembangkan kreativitas siswa baik individual ataupun kelompok.

Kata kunci: Problem Based Learning, Kemampuan Pemecahan Masalah Matematis, Higher Order Thinking Skills

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Introduction

In everyday life, people are not free from problems. Therefore, problem solving skills are very necessary so that someone can overcome the problems or difficulties they face. Likewise, in the world of mathematics education, when studying mathematics one cannot avoid problems, because everything studied in mathematics is focused on problem solving.

Problem solving according to (Ahdhianto et al., 2020) is students' ability to evaluate and solve mathematical problems in real world problems, to achieve the expected goals. On the other

hand, (Tussholeha et al., 2023) define students' ability to understand a problem, design a solution procedure, apply a solution procedure, and re-check the solution results as the scope of mathematical problem-solving abilities.

This is in line with Fauziah's opinion in (Lastuti, 2018) which states that the ability to solve problems mathematically is the student's ability to solve mathematical problems based on solution steps. In measuring students' ability to solve problems, (Polya, 1973) recommends several indicators that can be used, namely: (1) understanding the problem, (2) making a resolution plan, (3) implementing the plan, (4) reviewing what has been done. From this opinion it can be understood that the ability to solve problems is an important ability that must be achieved by a student. To improve problem solving abilities, pedagogical strategies are needed to improve mathematical problem-solving skills/abilities (Silver-Hmelo, 2004).

Therefore, the researchers are of the opinion that to improve the mathematical problem-solving abilities of students studying mathematics is to develop mathematics teaching materials based on Higher Order Thinking (HOTS). This solution was chosen because generally problem-solving abilities are caused by ignorance, so it requires students to think at a high, critical and creative level. According to (Abduh, 2019), HOTS indicators and cognitive processes consist of 3, namely analyzing (C4), evaluating (C5) and creating (C6). Therefore, HOTS is the ability to connect, manipulate, transform, analyze systematically, and think complexly in solving mathematical problems (Setiawati et al., 2019).

However, from the results of interviews with mathematics teachers at SMA Negeri 1 Baturraden it is known that the learning model used is still conventional with an expository method in the form of lectures. As a result, learning still tends to be centered on the role of the teacher, and some students experience difficulty in solving problems systematically, especially when faced with questions that require the use of HOTS abilities. The ability to solve mathematical problems based on HOTS questions can be trained through the Problem Based Learning (PBL) approach where students are required to play a more active role, think at a higher level, and are given space to develop creativity and thinking patterns in solving problems (Ningsih et al., 2020).

Problem Based Learning (PBL) is a model that focuses on real world problems, which requires students to be able to solve them. According to (Isrok'atun & Rosmala, 2018), the PBL approach focuses students on real world problems that require them to be able to find the right solution. This is in line with the opinion of Yusri who believes that PBL is an approach where students are directed to real world problems which become the starting point and challenge for them to find the right solution (Yusri, 2018). Bruner's theory and discovery (Arends et al., 2008) learning in emphasize active learning activities that are centered on students in finding their own ideas and meanings who are accompanied by teachers in the process of finding ideas and meanings to help the process of solving the problems presented (Silver-Hmelo, 2004).

The characteristics of Problem Based Learning (PBL) are student orientation towards problems and student-centered learning with several advantages, including (1) Students understand concepts better; (2) in learning activities students are actively involved; (3) the learning process is more meaningful; (4) Can motivate and increase students' interest in the material being studied; (5) Can emphasize positive social attitudes towards other students, such as accepting other people's opinions; (6) There is interaction between students and their friends to achieve learning completion; (7) Can develop students' creativity both individually and in groups (Putra,

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2013). Thus, the PBL model is a model that focuses on real world problems and requires students to be able to solve problems and have goals so that they can improve students' abilities in higher order thinking and Higher Order Thinking (HOTS) abilities in solving problems.

Strengthened by (Nur Aisyah et al., 2018) research, it shows a significant increase in mathematical problem-solving abilities in experimental classes that apply the PBL model, from an average of 32.7 to 77.28. Research results (Arni & Sari, 2022) also support this finding, showing an average increase from 73.33 to 83.83 after using the PBL model. However, in Aisyah and Arni's research, they have not developed HOTS-based questions in solving mathematical problems. To show the superiority of the PBL model, researchers want to compare it with conventional learning models regarding students' abilities in solving mathematical problems based on HOTS questions. So, to show the superiority of the PBL model, researchers want to compare it with conventional learning models regarding students' mathematical problem-solving abilities based on HOTS questions (Yara, Y.S. & Taufik, 2021).

Research Methods

This type of research is quantitative research that uses a quasi-experimental method with a comparative approach. The design used is posttest-only. With sampling, selected randomly using the cluster random sampling method. The population of this research is all students of SMA Negeri 1 Baturraden for the 2022/2023 academic year, even semester. The sample consists of three classes, where three classes are selected randomly after the clustering stage. The three classes are divided into experimental class, control class, and instrument testing class. Class XI MIPA 3, totaling 35 students, is the experimental class, XI MIPA 5, totaling 34 students, is the control class, and Class.

The teaching material used in this research is polynomial material. The independent variables of this research are the PBL model which will be applied to the experimental class and the conventional model which will be applied to the control class. Meanwhile, the dependent variable used in this research is students' problem solving abilities based on HOTS questions. This research uses a test instrument with 3 questions as data collection. Before the test was used, a validity test was carried out with an Xtotal sig value of 0.00, and a Cronbach's Alpha reliability test of 0.675. Data analysis was assisted by the IBM SPSS Statistics 25 program. Furthermore, before the test data is analyzed to test the hypothesis, it is necessary to do a prerequisite test first, namely (1) the normality test using a significance level (α) = 0.05 if the sig. > α, meaning that the data is normally distributed and vice versa. (2) homogeneity test using a significance level (α) = 0.05 if the sig. > α, meaning that the variance of the data is homogeneous and vice versa.

After the prerequisite test is carried out, it is followed by a hypothesis test or comparative test with the following provisions: (1) if the data is normally distributed and homogeneous, the test used is the *Independen sample t-test* on column *equal variances assumed* using a significant level (α) = 0.05 if the value is sig , then it is rejected and accepted and vice versa. (2) if the data is normally distributed and not homogeneous, the test used is the test *Independen sample t-test* on column*equal variances not assumed* using a significant level (α) = 0.05 then it is rejected and accepted and vice versa. (3) if the data is not normally distributed and homogeneous then the test used is the test *statistic non-parametik* with test testing *Mann Whitney*, using a significant level (α) = 0.05, if the sig value is < α = 0.05, it means that it is rejected and accepted and vice versa. The hypothesis as follows:

H_0 : The HOTS problem-based mathematical problem-solving abilities of students participating in PBL learning were not better or the same as students participating in conventional learning

H_a : The mathematical problem solving abilities of students based on HOTS questions who take PBL learning are better than students who take conventional learning

Result and Discussions

Before being analyzed to test the hypothesis used for decision making. the data must first pass the prerequisite test, namely the normality and homogeneity tests.

Table 1. Tests of Normality

Class	Kolmogorov-Smirnov		
	Statistic	Df	Sig.
XI MIPA 3	0.145	35	0.060
XI MIPA 5	0.133	34	0.135

The sig value in table 1, which is greater than 0.05. Then the data is normally distributed. Next is the homogeneity test to see the variance of the sample class. The following results are obtained:

Table 2. Tests of Homogeneity of Variance

Value	Levene Statistic	df1	df2	Sig.
Based on Mean	0.434	1	67	0.512
Based on Median	0.280	1	67	0.599
Based on Median and with adjusted df	0.280	1	62	0.599
Based on trimmed mean	0.294	1	67	0.589

Based on the output table 2 results obtained sig. 0.512 which is the sig value > 0.05. Then the data obtained is homogeneous. After the data is tested prerequisites, then tested the hypothesis. Because the data is normally distributed and homogeneous, the test used is the independent sample t-test, the following results are obtained:

Table 3. Independent Sample T-test

		F	Sig.	t	df	Sig.2-tailed
Value	Equal variances assumsed	0.434	0.512	30.476	67	0.000
	Equal variances not assumsed					0.000

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In the output table 3 above, the sig value is obtained. 0.000 which is the sig value obtained <0.05. Thus it can be concluded that rejected and accepted in other words the mathematical problem solving abilities of students based on HOTS questions participating in learning *Problem Based Learning* better than students who follow conventional learning can be accepted. Based on the research results of the experimental class by applying the PBL model, it has a better effect than the control class. The results of descriptive statistical analysis showed that the average value of the experimental class was 86.76 and that of the control class was 66.99. However, the descriptive statistical analysis only provides a general understanding of the data obtained. Meanwhile, in making decisions, whether there is a statistically significant effect, you cannot use descriptive statistics but use inferential statistics, namely the t-test.

The test used is Test *independen sample t-test* because the data obtained is normally distributed and homogeneous. In table 4.9, the sig.(2-tailed) value is 0.000 which is < 0.05. This, it is rejected and accepted or it can be indicated that the students' mathematical problem solving abilities are based on HOTS questions participating in the lesson *Problem Based Learning* better than students who follow conventional learning can be accepted. This is in line with the demands of the 21st century era, it is important for students to develop HOTS skills in problem solving in the context of learning mathematics. The PBL (Problem-Based Learning) model serves as an effective approach to enhance students' abilities in solving mathematical problems. Supported by the research of (Muachor & Agoestanto, 2023), the PBL model is considered an appropriate approach to improve students' problem-solving skills. Similarly, in a study conducted by (Arni & Sari, 2022), there was an improvement from an initial average of 73.33 to 83.83. However, the findings of this research also show a more significant improvement, from 66.99 to 86.76.

Furthermore, in student learning, the focus is on solving real and complex problems and addressing challenges that require analytical thinking, information gathering, identifying possible solutions, and implementing effective problem-solving strategies. Thus, students have the opportunity to develop their overall HOTS-based problem-solving skills. This enables them to sharpen their problem-solving, creative thinking, collaboration, communication, and knowledge transfer skills. However, PBL requires a longer time to engage students in solving complex problems. This poses a challenge in conducting research on learning activities with limited time.

Conclusion

Based on the research results, it can be concluded that the model *Problem Based Learning* (PBL) has an influence on students' mathematical problem solving abilities based on HOTS questions. The results of the data analysis showed that classes taught using the PBL model had better HOTS problem-based mathematical problem solving abilities compared to the conventional model. With an average score of 86.76 for the experimental class and 66.99 for the control class. The suggestion for further research is as follows: (1) Learning through PBL requires a significant amount of time; therefore, several factors that may hinder the learning process need to be anticipated. (2) Additionally, there is a need to redevelop research based on HOTS questions.

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