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Application of Problem Based Learning Model to Mathematical Thinking Ability

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abstract

This research is a pre-experimental research that aims to determine differences in the mathematical critical thinking skills of class VIII students of MTs Hj. Haniah before and after the application of the problem based learning model. The design of this research is quantitative research with one group pretest-posttest design, the population in this study were students of class VIII MTs Hj. Haniah with samples taken randomly or simple random sampling, namely class VIII A with a total of 21 students. The data were collected using a test of students' mathematical critical thinking skills and an observation sheet on the implementation of the learning model that has been validated by the expert. The research data were analyzed descriptively and inferential with the normality test as the prerequisite test for analysis and paired sample t-test as the hypothesis test. The results of data analysis showed that the mean pre-test was 51.9 while the post-test mean was 74.14. Based on the paired sample t-test, the significant value was $0.000<\alpha= 0.025$. The results of this study indicate that there are differences in the mathematical critical thinking skills of class VIII students of MTs Hj. Haniah between before and after the problem-based learning model is applied to the material pattern and object navigation.

Keywords:
Problem based learning model; mathematical critical thinking skills

INTRODUCTION

Education has an important role in realizing the nation's generation of potential and quality. Education is a conscious effort that is carried out systematically, which creates an atmosphere of learning and teaching so that students will be able to develop their potential. With this education, a person can have intelligence, noble character and others. To improve the competitiveness of Indonesian human resources, national development is more directed to improve the quality of education. Mathematics as one of the fields of study taught from primary to secondary level education is an important part of the attempt to improve the quality of education (Novitasari, 2016)

The purpose of Mathematics at school is not only understanding the concepts by students but also applying the concepts learned to solve problems in their lives. Duncker (in (Silwana et al., 2021) explained that problems arise when a person has a goal but does not know how to achieve his goal. When someone cannot switch from a given situation to the desired situation only by action, then the other way is through the process of thinking.

Mathematics is identical to solving problems and the main purpose of learning Mathematics is to develop students' abilities in solving various mathematical problems because someone who can solve problems in daily life and at work will make a big profit. So by studying mathematics, students are trained in solving various problems in daily life especially mathematical problems in society, so that they can prepare their lives in the future as the next generation of the nation.

One of the efforts that can be done to help students in solving these problems is to improve students' thinking skills. Thinking skills help students solve problems of everyday life. Especially by thinking critically, students can decide what steps are appropriate to solve the problem by thinking about the impact that will result from that step. If the resulting impact is not good, then students critically look for causes and other alternative solutions. In addition, critical thinking can help a person understand how he sees himself, how he sees the world, and how he relates to others, helps understand one's own behavior, and evaluates oneself according to Lambertus.

According to (Tinio, 2003), one of the skills needed to face challenges in the future is critical thinking skills or higher order thinking skills. The importance of developing critical thinking skills should be carried out from early stages of education to higher level education even though it is still needed. This reason makes the need for learning that involves more thinking learning processes.

However, the reality in the field is not yet in accordance with what is expected, mathematics learning still tends to orient to textbooks. It is not uncommon to find mathematics teachers who are still attached to their teaching habits by using learning steps such as: presenting learning material, giving examples of questions and asking students work on the practice questions contained in the textbooks they use in teaching and then discuss them with students. Learning like this will not maximize the development of students' mathematical problem-solving skills. Students will only work on math problems based on what the teacher exemplifies. If they are given different problems they will experience difficulties in solving them (Darmawan & Suparman, 2019) .

Based on information from class VIII students at MTs Hj. Haniah, most of the students indicated that students' critical thinking skills were still low. This can be seen during the process of learning activities, namely students are less able to study and solve problems given that are not in accordance with the examples, because students only rely on the examples given (teacher center). All of this happened because, teacher more convey a lot of material with the method lecture, then students are given questions practice. This causes the process learning has not been maximized in provide opportunities for students to think critically and act creatively. Learning like this causes

students to work procedurally without understanding actual concept. Other than that, learning that is still glued to books lessons and less related to life everyday so that learning cannot interpreted by students to solve math problem (Ernawati & Lestari, 2020) .

Therefore, it is necessary to have models and learning strategies that are appropriate and in accordance with the conditions of students in order to create a conducive learning atmosphere. Educators are required to be able to manage the learning process so that students have the desire to learn.

One of the learning models that can place students at the center of learning and be actively involved is the Problem Based Learning model. The Problem Based Learning model is a learning based on problems that require students to gain important knowledge, which makes them proficient in solving problems, as well as having their own learning strategies and the ability to participate in teams.

Problem-based learning model is a learning model that uses real-world problems as a context for students to learn about problem solving and critical thinking skills, as well as to acquire essential knowledge and concepts from course material or subject matter (Lidinillah, 2013). Lecturers are required to choose a learning model that can stimulate the enthusiasm of each student to be actively involved in their learning experience. One alternative learning model that allows learning to solve real-world problems in an interesting way is problem-based learning

Meanwhile, according to Herman ((Rosmala, 2021)) problem based learning is a learning that refers to the four pillars of universal education, namely learning to understand (learning to know), learning to implement or doing (learning to do), learning to be yourself (learning to do), learning to work together or living together (learning to live together).). (Rosmala, 2021) also expressed an opinion about Problem Based Learning, namely problem based learning is another term for Problem Based Learning (PBM) which focuses on the existence of a problem that students face in learning. Learning is presented as a starting point in building concepts. In learning mathematics, students are given a life problem around mathematical concepts. Through these problems students can learn from what is in their daily environment so that it can make it easier for them to understand and apply mathematics in life. Therefore, it is necessary to apply the Problem Based Learning model in learning.

This problem-based learning model allows students to be involved in studying: real-world problems; higher order thinking skills; problem solving skills; interdisciplinary learning; learn to be independent; learn to dig up information; learn to work together; learn communication skills (Sani, 2014).

Based on this description, the researchers were motivated to conduct research on "The Application of Problem Based Learning Models on Mathematical Critical Thinking Skills for Class VIII MTs Hj. Haniah".

1. Formulation of The Problem

Based on the above background, the problem is formulated as follows: 1) How is the mathematical critical thinking ability of class VIII MTs Hj. Haniah before the problem based learning model was applied? 2) How is the mathematical critical thinking ability of class VIII MTs Hj. Haniah after applying the problem based learning model? 3) Is there a difference in the mathematical critical thinking ability of class VIII MTs Hj. Haniah between before and after the problem based learning model was applied.

2. Research Purposes

Based on the formulation of the problem, the objectives of this study are: (1). To determine students' mathematical critical thinking skills before applying the problem based learning model, (2) To determine students' mathematical critical thinking skills after applying the problem based learning model model, (3) To find out the difference in

mathematical critical thinking abilities of class VIII MTs Hj. Haniah between before and after the problem based learning model was applied

LITERATURE REVIEW/ THEORETICAL FRAMEWORKS (IF APPLICABLE)

Problem Based Learning is learning which trains and develops the ability to solve problems oriented to authentic problems from students' actual lives, to stimulate high-level abilities (Slameto Slameto, 2015). Problem Based Learning Model Learning learning model that trains students' skills to solve problems and gain new knowledge, in addition to Problem Based Learning learning model trains students to think high level. Problem Based Learning is considered as one of the effective strategies and contributes to developing students' cognitive and metacognitive thinking skills.

Critical thinking has the same meaning as convergent thinking which means thinking in one right direction or one most correct answer or a solution to a problem. Critical thinking can help students more active in the learning process (Slameto, 2017). Critical thinking is a clearly directed process using mental activities such as solve problems, make decisions, analyze assumptions, and conduct scientific research (Magno, 2010)

Critical thinking is a mental process to analyze information. Information is obtained through observation, experience, communication, and reading (Suryosubroto, 2009). Critical thinking is the process of analyzing or developing problem information based on logical thinking to determine decisions. This understanding is in line with the opinion of (Kuswana, 2011), which explains that "critical thinking is an analysis of problem situations through potential evaluation, problem solving, and synthesis of information to determine decisions". According to (Fisher, 2011) who argues that "Critical thinking is a skilled and active interpretation and evaluation of observation and communication, information, and argumentation". Lipman stated that critical thinking is a consideration based on criteria, self-correcting and context sensitive (Aizikovitsh & Amit, 2010)

METHODS

This type of research is pre-experimental with quantitative methods. This study uses treatment on the object of research by involving one class group as an experimental class without control variables. The treatment in question is the application of a problem based learning model. This research design is in the form of One Group Pretest-Posttest Design as presented in the following table:

Table 1 Research Design One Group Pretest-Posttest Design

Pre-test	***Treatment***	***Post-test***
T_1	X	T_2

Information:
T1 : Pre-test, test before treatment
T2 : Final test, test after treatment
X : Learning with Problem Based Learning model

1. Research Procedure

The research procedure is broadly used in four stages, namely (1) the preparation stage, (2) the implementation stage, (3) the analysis stage and (4) the conclusion-making stage. The preparation stage includes research planning, and preparing instruments and validating them to experts. The implementation phase begins by giving a pre-test to the experimental class to determine the students' initial critical thinking abilities. After the class was treated with learning using a problem based learning model, then a post-test

was given. After data collection is done, the data that has been obtained is analyzed, the next step is drawing conclusions on the hypothesis made.

2. Research instrument

The research instruments used in this study are: 1) Critical Thinking Ability Test and 2) Observation Sheet.

3. Data Analysis Technique

Data were collected through the provision of critical thinking skills tests and observation sheets. The test is given twice, namely before the learning process takes place (pre-test) and after the learning process (post-test). The critical thinking ability test given is a test that has been validated by experts. Data on students' critical thinking skills were analyzed descriptively and inferentially.

Descriptive statistics are used to determine and measure the differences that occur before and after the students are given treatment. In addition to showing the differences, the normalized gain score is used as variable data to test the hypothesis. The reference criteria for normalized gain according to Hake (in (Nasir & Hadijah, 2019) are presented in table 2.

Table 2. The Normalized Gain Categories

No	Interval	Categories
1	$\langle g \rangle \geq 0,70$	High
2	$0,30 < \langle g \rangle < 0,70$	Medium
3	$\langle g \rangle \leq 0,30$	Low

Inferential statistical analysis was used to test the research hypothesis by using the t-test. However, before testing the hypothesis, a prerequisite test or assumption test is carried out which includes a normality test. The research data were analyzed using the SPSS software program. Inferential statistical analysis was used to test the research hypotheses using the t-test. However, before testing the hypothesis, a prerequisite test or assumption test is carried out which includes a normality test. The research data were analyzed using the SPSS software program.

RESULT AND DISCUSSION

Data Description

Students' Mathematical Critical Thinking Ability Before and After Application of Problem Based Learning Model

The description of the results of this study describes the students' mathematical critical thinking skills before and after applying the problem based learning model in the experimental class. For more details are presented in the following Figure:

Table 3. Recapitulation of Mathematical Critical Thinking Ability of Class VIII MTs Hj. Haniah

	Pre-test	Post-test
Number of Samples	21	21
Lowest Value	15	47
The Hiehest Score	80	90
Mean	51,9	74,14
Median	50	76
Range	65	48

Variance	268,69	164,029
Standar Deviation	16,392	12,807

In Table 3. it can be seen that the scores of students' mathematical critical thinking skills after applying the learning model are different. This can be seen from the changes in the scores that occurred at the lowest score from 15 to 47, the highest score from 80 to 95, the average pre-test score was 51.9 which based on the category of students' mathematical critical thinking ability tests were in the less category to 74, 14 with good category. The median value from 50 to 76.

The categories of the mathematical critical thinking ability test can be seen as follows:

Tabel 4. Categories of Students' Mathematical Critical Thinking Ability Test Results Based on Pre- test and Post-Test Results

Score	Category	Frequency		Percentage (%)	
		Pre	Post	Pre	Post
80 – 100	Excellent	2	8	9,52	38,1
66 – 79,9	Good	1	9	4,76	42,86
56 – 65,9	Enough	5	2	23,81	9,52
40 – 55,9	Not enough	10	2	47,62	9,52
0 – 39,9	Very less	3	0	14,29	0
Total		21	21	100	100

Based on Table 4. the category of students' mathematical critical thinking ability test results before and after being given treatment has increased, it can be seen that the percentage of students' mathematical critical thinking abilities before treatment is in the good category with a percentage value of 4.76% increasing to 42.86%.

In the following, a description of the students' mathematical critical thinking ability data is also presented based on the measured indicators.

Table 5. Data Description of Students' Mathematical Critical Thinking Ability Based on Pre-test Results

No	Indicator	N	Average	Percentage (%)	Average	Percentage
			Pre	Post	Pre	Post
1	Provide a simple explanation (elementary clarification)	21	3	75	3,48	87
2	Develop basic skills (basic support)	21	2,14	52	3,19	78
3	Making inferences	21	1,86	47	2,71	68
4	Make further explanations (advance clarification)	21	1,91	48	3,05	76
5	Determine strategy and tactics (strategy and tactics)	21	1,62	41	3,14	79

Based on the five indicators of mathematical critical thinking skills that have been measured before and after treatment, it appears that there is an increase for all indicators.

Furthermore, to describe the differences in students' mathematical critical thinking abilities after the problem based learning model was applied, the researchers analyzed the normalized gain scores as shown in the following Table 6.

Table 6. Normalized Gain of Students' Mathematical Critical Thinking Ability

	Min	Max	Mean	Varian	Std. Deviasi
Score gain	-0,20	0,78	0,451	0,063	0,25

Table 6. shows that the average normalized gain of students' mathematical critical thinking skills is 0.45 which is based on the normalized gain classification in table 2 is in the medium criteria. That is, classically, students' mathematical critical thinking skills in the pattern and configuration of objects after being taught using a problem based learning model experienced moderate differences.

Hypothesis testing

Research Hypothesis:

a) If the value (*sig.*(2-*tailed)>1/2a)*, then Ho is accepted Ha is rejected

This means that there is no difference in the mathematical critical thinking ability of class VIII MTs Hj. Haniah between before and after the problem based learning model was applied.

b) If (*sig.*(2-*tailed)<1/2a*), then Ho is rejected Ha accepted Ha

This means that there is no difference in the mathematical critical thinking ability of class VIII MTs Hj. Haniah between before and after the problem based learning model was applied.

The results of hypothesis testing using the paired sample t-test on the pretest and posttest data can be seen in the following table.

Table 7. Paired Sample T-Test Results on Pre-Test and Post-Test Data

Test t	*Sig. (2-tailed)*
Paired sample t-test	0,000

Based on the results of the paired sample t-test in the table above, it is known that the value of Sig. (2-tailed = 0.000) < (0.025). So in accordance with the rules of decision making if the value of sig. (2-tailed) < then HO is rejected and Ha is accepted. Thus it can be seen that there are differences in the mathematical critical thinking ability of class VIII MTs Hj. Haniah between before and after the problem based learning model was applied

Discussion

In this research process, before students are given treatment or apply a problem based learning model, students are first given a 5-item test to measure the extent of students' mathematical critical thinking skills or in this case a pre-test. After that, students were taught by applying a problem based learning model to the pattern and object configuration material for 2 meetings. Furthermore, to measure the difference in students' mathematical critical thinking skills after the problem based learning model was applied, students were given a post-test.

From the results of the descriptive analysis of this study, it shows that the students' average scores are different. It can be seen from the average value of the pre-test results, which is 51.9, increasing to 74.14 from the post-test results. This is relevant to the category of students' mathematical critical thinking ability test results which also experience differences in each indicator. The following is a description of students' mathematical critical thinking ability test results based on the indicators:

a. Give a simple explanation

In this indicator, the representative Pre-test and Post-test questions are in question number 1. From the results of the Pre-test obtained an average of 3 with a value of 75, while from the results of the Post-test the average is 3.48 with a score of 87. This shows that the indicator provides a simple explanation, the students' post-test results are higher than the students' pre-test results, so that the students' ability to recognize problems is different after being given treatment.

b. Develop basic skills

In this indicator, the representative pre-test and post-test questions are in question number 2. From the pre-test results obtained an average of 2.14 with a value of 52, while from the Post-test results the average is 3.19 with a score of 78. This indicates that the indicator of developing basic skills, the results of the post-test of students are higher than the results of the pre-test of students, so that the ability of students in terms of developing basic skills is different after being given treatment.

c. Make a conclusion

In this indicator, the representative pre-test and post-test questions are in question number 3. From the pre-test results obtained an average of 1.86 with a value of 47, while from the Post-test results the average is 2.71 with a value of 68. This shows that the indicators of making inferences, the results of the post-test students are higher than the results of the pre-test students, so that the ability of students in terms of making inferences experienced differences after being given treatment.

d. Make further explanation

In this indicator, the representative pre-test and post-test questions are in question number 4. From the pre-test results obtained an average of 1.91 with a value of 48, while from the Post-test results the average is 3.05 with a value of 76. This shows that the indicator of making further explanations, the results of the post-test students are higher than the results of the pre-test students, so that the ability of students in terms of making further explanations is different after being given treatment.

e. Determine strategy and tactics

In this indicator, the representative pre-test and post-test questions are in question number 5. From the pre-test results obtained an average of 1.62 with a value of 41, while from the Post-test results the average is 3.14 with a value of 79. This shows that in the indicators of determining strategies and tactics, students' Post-test results are higher than students' Pre-test results, so that students' abilities in determining strategies and tactics experience differences after being given treatment.

The highest score on the post-test of students' mathematical critical thinking skills was achieved on the indicator of providing a simple explanation with a score of 87. The highest score on the pre-test was also found on the same indicator with a value of 75, while for the value of students' mathematical critical thinking ability in the post-test the test is on the indicator of making conclusions with a value of 68. The lowest score on the pre-test is on the indicator of determining strategies and tactics with a value of 41.

In addition, the categorization of the students' mathematical critical thinking ability test obtained from the two tests, in the pre-test 10 out of 21 students were in the less category with a percentage of 47.62 while after the application of the problem based learning model only 2 students were in the poor category. , the rest are in the very good, good, and sufficient categories. This means that there are differences in students' mathematical critical thinking abilities after the problem based learning model is applied.

The average value of the normalized gain of students' mathematical critical thinking skills is 0.45 with moderate criteria. This shows that there are differences in the mathematical critical thinking abilities of class VIII MTs Hj. Haniah between before and after the problem based learning model was applied with moderate criteria.

As explained, in addition to descriptive analysis, inferential analysis was also carried out using the paired sample t-test. From the results of the paired sample t-test with the help of SPSS version 16, the value (2-tailed) is 0.000 with the significant level used is = 0.025. Then based on the rules of decision making if the value of sig (2-tailed) < then Ho is rejected and Ha is accepted. Thus, because the value (2-tailed = 0.000) < (0.025) it can be concluded that there is a difference in the mathematical critical thinking ability of students of class VIII MTs Hj. Haniah between before and after the problem based learning model was applied.

Based on the research that has been done, this research is in line with research conducted by (Asrar, 2018) stating that the Problem Based Learning model has several advantages, namely it can make education in schools more relevant to life, can familiarize students with dealing with and solving problems skillfully and can stimulate the development of critical, creative and thorough. Problem Based Learning model can affect ability students' critical thinking which was initially being improved became higher. Model This is very suitable for use in learning activities because students will interested in practical learning as opposed to writing. Model Learning by way of practice can also stimulate thoughts, feelings, attention and ability of children to participate in learning activities. This matter It can also be seen from a pleasant condition and learning space conducive environment. students look happy and enthusiastic in participating in learning which results in learning response can serve as a driving force for the achievement of abilities students' critical thinking. Based on the explanation above, every teacher should be able to choose and adjust the learning model and the method you want to apply in the classroom to attract students' motivation and desire to learn.

CONCLUSION AND IMPLICATION

a. Conclusion

Based on the results of research and discussion in the previous chapter, several conclusions were obtained, namely: 1) The results of the student's mathematical critical thinking ability before the learning model was applied had an average of 51.9 of the 5 indicators that had been measured, it was seen that the highest score was on the indicator providing a simple explanation of 75, while the lowest score was on the indicator of determining strategies and tactics with value of 41. 2) The results of students' mathematical critical thinking skills after applying the learning model have an average of 74.14 of the 5 indicators that have been measured. The highest value on the indicators measured is on the indicator providing a simple explanation with a value of 87, while the lowest value is on the indicator making conclusions with a value of 68. 3) The results of hypothesis testing using the paired sample t-test with a value of (*sig.*(2-*tailed)<1/2a*) , namely 0.000 < 0.025; This shows that the students' mathematical critical thinking skills after being taught using the problem based learning model are better than before the learning model was applied. Thus, it is known that there are differences in the mathematical critical thinking abilities of class VIII MTs Hj. Haniah between before and after the problem based learning model was applied.

b. Implication

The application of the problem based learning model for class VIII MTs Hj. Haniah has an influence on mathematical critical thinking skills and has also been proven by many researchers. Therefore, the authors suggest to apply the problem-based learning model in learning, especially in learning mathematics which requires students' ability to analyze, think critically, and metacognitively.

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