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Learning Mathematics With Polya Heuristic Strategies To Increase Students' Critical Thinking Ability

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Abstract. The purpose of this study is to find out the differences in students' critical thinking ability after getting learning with Heuristic Strategies compared to the critical thinking ability of students who get mathematics learning with conventional learning, and how students behave towards mathematics learning with Polya heuristic strategies. This research used experimental methods. The population in this study was all grade VII students of SMPN 1 Muara Bungo, while the sample in this study was randomly selected by two classes. The instruments used in this study are tests of students' mathematical critical thinking ability and attitude scale. The test used is a description type test. The results of this study can be concluded that: (1) the mathematical critical thinking ability of students who get mathematics learning with polya Heuristic Strategies is better than students who get conventional learning models; and (2) siswa be positive towards mathematics learning by using Polya Heuristic Strategies.

Key words: Learning Polya Heuristic Strategies; students' mathematical critical thinking ability.

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INTRODUCTION

The ability to think critically is essential for the life of society especially democratic societies, because according to Jackson and Newberry (2007) we are responsible for making decisions that affect our own lives and the lives of our fellow citizens and we must be able to think carefully about arguments so as to make better choices. In line with this, the ability to think critically is an indispensable ability for a person to be able to face various problems faced in social and personal life ((Nuryanti et al., 2018) addition, Qomariyah (2016) argues that because of critical thinking students become more agile in identifying, analyzing, and solving problems.

The urgency to master or have the ability to think critically is not in accordance with existing expectations. Based on the *Trends in International Mathematics and Science Study* (TIMSS) in 2015, the critical thinking ability of Indonesian students shows that Indonesian students still need to strengthen the ability to integrate information, draw conclusions, and generalize their knowledge to other things. According to Reeder, (1984) the ability to integrate information, draw conclusions, and generalize is included in the aspect of critical thinking. In addition, opinions that say students' low critical thinking skills are also known from several studies that students' critical thinking levels are still low due to lack of activity in learning activities (Wati & Koeshandayanto, 2021). This situation is enough for us to reflect back on our students that the demand to have the ability to think critically of students opens up a new paradigm shift for teachers regarding learning strategies in exploring student competence. Azizah & Fajaroh (2020) said that if students' critical thinking skills are not fulfilled in understanding science and experience difficulties for that, a way is needed to improve critical thinking skills.

Robert Ennis identified critical thinking skills into 12 indicators that he grouped in the top five activities (Ennis, 1995), namely as follows:

Table 1. Critical Thinking Ability Indicators

Step	Critical Thinking Ability	Indicators
1	Provides a Simple Explanation (Elementary Clarification)	1. Focusing the question; 2. Analyze arguments; 3. Ask and answer clarifying questions;
2	Building Basic Skills (Basic Support)	4. Consider whether sources are reliable or not; 5. Observing and considering the results of observations;
3	Conclude (Inference)	6. Require deduction and consider the result of deduction; 7. Make induction and consider the results of induction; 8. Make and consider the value of decisions;
4	Advanced Clarification	9. Defining terms and considering definitions; 10. Identifying assumptions
5	Strategies and Tactics	11. Determining the action; 12. Interact with others

Heuristics are a general step that guides problem solving in finding a solution to a problem (Pangestika et al., 2014). The steps to solve the problem according to polya (in Umar, 2016) are: (1) understanding the problem; (2) plan a solution; (3) solve the problem according to the plan; and (4) re-examine the results obtained. However, these steps are the way and do not guarantee solving the problem.

The purpose of this study was to determine the difference in students' critical thinking ability after getting learning with Polya Heuristic Strategies compared to the critical thinking ability of students who got mathematics learning with conventional learning.

METHODS

The method to be used in this study is an experimental research method. In this study, the treatment given was the use of Polya's Heuristic strategy, while the aspect it measured was the student's mathematical critical thinking ability. The design of his research is described as follows:

A_1 : O_1 X O_2
A_2 : O_1 O_2

Keterangan:
A_1 : Kelas Experiments
A_2 : Control Class
O_1 : *Pre-Test*
O_2 : *Post-Test*
X : Treatment using mathematics learning with polya Heuristic Strategies.

The population in this study was all grade VIII students of SMPN 1 Muara Bungo consisting of three classes. While the sample is obtained using random sampling method.

RESULTS AND DISCUSSION

In Table 2, it can be seen that the average pretest scores in the experimental class and control class are 31.81 and 27.32. From these two grades, it can be interpreted that the average pretest scores of the two classes are not much different. This means that the average pretest of the two classes is not much different. The standard deviations of the two classes are also not much different, meaning that the average distance of each data to the average score is almost the same. However, to see whether the difference is significant enough (signify) or not, a statistical test is carried out.

Based on the variance normality test with the *Shapiro-Wilk* test in Table 3, if the significance value or probability value > 0.05, then the distribution of the two classes is normal (Sukestiyarno, 2014). The visible probability value in the significance column for the experimental class is 0.318 and the control class is 0.560. Because the probability value of the two classes is more than 0.05, it can be said that the experimental class and the control class are samples derived from normally distributed populations.

Furthermore, the homogeneity of variance test using the *Levene* test in Table 4, if the significance value or probability value > 0.05, the data comes from populations that have the same variance (Sukestiyarno, 2014). It is seen that the probability value in the significance column is 0.105 > 0.05. So it can be concluded that the students of the experimental class and the control class come from populations that have the same variance, or that the two classes are homogeneous.

Table 2. Maximum Grade, Minimum Value, Mean and Standard Deviation of Initial Test (Pretest) Experimental Class and Control Class

Class	Initial Tests (Pretests)				
	N	Maximum Value	Minimum Value	Average	Standard deviation
Experiment	37	58	0	31.81	15.162
Control	37	55	0	27.32	12.134

Table 3. Experimental Class and Control Class (Pretest) Distribution Normality Data Output

	Class	Shapiro-Wilk		
		Statistic	df	Itself.
Ready	experiment	.966	37	.318
	control	.975	37	.560

Table 4. Maximum Grade, Minimum Value, Mean and Standard Deviation of Initial Test (Pretest) Experimental Class and Control Class

		Levene Statistic	df1	df2	Sig.
Pretes	Based on Mean	2.703	1	72	.105

After the two classes are normally distributed and have homogeneous variance, then a two-mean similarity test with the t-test is carried out through the *SPSS 25 for windows* program application using *the Independent Sample t-test* assuming both homogeneous variances *(equal variance assumed)* with a significance level of 0.05. Thestatistical hypothesis (Two-party test) according to is:

Ho : $\mu_1 = \mu_2$
H_1 : $\mu_1 \neq \mu_2$

Information:
Ho : The mathematical critical thinking ability of the experimental class and the control class in the initial test did not differ significantly.
H_1 : The mathematical critical thinking ability of the experimental class and the control class in the initial test differed significantly

In Table 5, if the probability > 0.05, then H 0 is accepted, conversely if Sig (2-tailed) < 0.05, then H 0 is rejected (Sukestiyarno, 2014). The visible *significance value (2-tailed)* is 0.164. Because the probability value > 0.05, then H 0 is accepted or the mathematical comprehension ability of the experimental class and the control class in the initial test do not differ significantly.

Tabel 5. T Test Output Initial Test (Pretes) Experimental Group and Control Group

		Pretest	
		Equal variances assumed	Equal variances not assumed
Levene's Test for Equality of Variances	F	2.703	
	Sig.	.105	
t-test for Equality of Means	t	1.405	1.405
	df	72	68.700
	Sig. (2-tailed)	.164	.164

Afterprocessing postest data for each class, the maximum value, minimum value, average value and standard deviation as shown in Table 6, it can be seen that the average postest scores in the experimental class and control class are 70.14 and 54.22. From these two grades, it can be interpreted that the average postest score of the two classes increases from the average pretest score. This means that the average pretest of the two classes is smaller than the average postest. However, to see whether the difference is significant enough (signify) or not, a statistical test is carried out.

Based on the variance normality test using the *Shapiro-Wilk* test in Table 7 above, if the significance value or probability value > 0.05, then the distribution of the two classes is normal. The visible probability value in the significance

column for the experimental class is 0.087 and the control class is 0.172. Because the probability value of the two classes is more than 0.05, it can be said that the experimental class and the control class are samples derived from normally distributed populations.

Based on the variance homogeneity test with the *Levene test* in Table 8 above, if the significance value or probability value > 0.05, the data comes from populations that have the same variance (Sukestiyarno, 2014). It is noticed that the probability value on the significance column of 0.265 is greater than 0.05. Thus, it can be concluded that the students of the experimental class and the control class come from populations that have the same variance, or the two groups are homogeneous.

Table 6. Maximum Value, Minimum Value, Mean and Standard Deviation of Initial Test (Postest) Experimental Class and Control Class

Class	Final Test (Postes)				
	N	Maximum Value	Minimum Value	Average	Standard deviation
Experiment	37	85	48	70.14	8.430
Control	37	75	40	54.22	6.738

Table 7. Experimental Class and Control Class Distribution Normality Data Output

	Class	Shapiro-Wilk		
		Statistic	df	Itself.
Posts	Experiment	.949	37	.087
	Control	.958	37	.172

Table 8. Homogeneity Test Output Two Final Test Variances (Postes) Experimental Group and Control Group

		Levene Statistic	df1	df2	Sig.
Postes	Based on Mean	1.260	1	72	.265

After the two classes are normally distributed and have homogeneous variance, then a two-mean similarity test with the t-test is carried out through the *SPSS 25 for windows* program application using *the Independent Sample t-test* assuming both homogeneous variances *(equal variance assumed)* with a significance level of 0.05 . The hypothesis formulated in the form of a statistical hypothesis (one-party test) is:

Ho : $\mu_1 = \mu_2$
H_1 : $\mu_1 > \mu_2$

Information:
H_0 : The mathematical critical thinking ability of students who get mathematics learning with Polya Heuristic strategies is not significantly different from students who get conventional learning.
H_1 : Mathematical critical thinking ability of students who get mathematics learning with Polya Heuristic strategies is better than students who get conventional learning models

In Table 9, if sig. (2-tailed) > 0.05, then H_0 is accepted, conversely if sig.(2-tailed) < 0.05, then H 0 rejected (Sukestiyarno, 2014). It is seen that *the significance value (2-tailed)* is 0.00 < 0.05 then H 0 is rejected and H_0 is accepted or The mathematical critical thinking ability of students who get mathematics learning with Polya Heuristic strategies is better than students who get conventional learning models.

Table 9. t-Test Output Final Test (Postes) Experimental Class and Control Class

		Posts	
		Equal variances assumed	Equal variances not assumed
Levene's Test for Equality of Variances	F	1.260	
	Itself.	.265	
t-test for Equality of Means	t	8.973	8.973
	df	72	68.664
	Sig. (2-tailed)	.000	.000

Based on the results of the study, it shows that the use of Polya Heuristic Strategies in mathematics learning is better than conventional learning of students' mathematical critical thinking skills. Thus it can be seen that by using the Polya Heuristic Strategy students can achieve indicators of critical thinking skills. Based on the formulation of the problem in this study, researchers want to find out whether the mathematical critical thinking ability of students who obtain mathematics learning with Polya Heuristic Strategies is better than students who obtain conventional learning. So the answer is, the mathematical critical thinking ability of students who obtain mathematics learning with Polya Heuristic Strategies is better than students who obtain conventional learning.

In learning mathematics with the Polya Heuristic Strategy model, students are conditioned to actively integrate new knowledge using knowledge that students already have before. Through the stages in the Polya Heuristic Strategy, students are required to be active in building their knowledge, reading each problem given, then estimating answers and solution processes by selecting and connecting them with previously possessed knowledge so that students' mathematical critical thinking skills will increase through learning with Polya Heuristic Strategies.

This is the basis for the author as an explanation of the hypothesis that has been accepted in this study, the mathematical critical thinking ability of students who obtain mathematics learning with Polya Heuristic Strategies is better than students who obtain conventional learning. This reflects that conventional learning does not encourage students to be actively involved in learning. Students are less able to explore their potential in constructing concepts on their own so they have little difficulty in drawing conclusions from what they have learned compared to students who acquire mathematics learning with Polya Heuristic Strategies.

CONCLUSION

Based on the results of data analysis and discussion of research results in class VIII of SMPN 1 Muara Bungo, which has been described in the previous section, it was concluded that the mathematical critical thinking ability of students who obtained mathematics learning with Polya Heuristic Strategies was better than the mathematical critical thinking ability of students who obtained conventional learning. This can be seen from the results of research data analysis.

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