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The Influence of Inquiry Learning Model towards Students' Mathematical Critical Thinking Ability

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Abstract

This study was conducted due to the low mathematical critical thinking ability of students. Inquiry learning model is assumed as one of learning model which can improve this issue. Therefore this study was aimed to find out the influence of inquiry learning model toward students' mathematical critical thinking ability. This study was conducted in SMP Negeri 1 Ciruas in the academic year of 2018/2019. The research method used was quasi-experimental with the non-equivalent pre-test post-test control group design. This study involved two groups consisting of the experimental and control group. The population of this study were all seventh grade students in SMPN 1 Ciruas while the sample was the VII A class as the experimental group and VII E as the control group. For more, the instrument used was mathematical critical thinking ability test. Afterwards, the result of this study proved that inquiry learning model positively influenced students' mathematical critical thinking ability.

1. Introduction

Critical thinking is a cognitive ability in deciding a decision or conclusion based on logical reason and empirical evidence (Yaumi, 2012). This ability is one of high level thinking ability which leads students to be more active as they are asked to analyze, evaluate, and create (Conklin, 2012). Additionally, Kalelioglu and Gulbahar (2014) confirm that critical thinking is needed to examine the truth of an information so students can decide which truth information is.

In the current global competition era, it is necessary to develop critical thinking ability. As As'aril (2017) says that critical thinking is very important in this modern era including modern education. In line with government programs which also expect that every learning should equips students' critical thinking ability as a competency that supports daily activities and success in the future (Kemendikbud, 2013). Besides, critical thinking is also one of mathematics learning objectives (King and Goodson, 2010).

Regarding to preliminary explanation, critical thinking is important to be early applied. Kuniarti, et al. (2015) suggest that mathematics education in elementary school should provide basic ability to think of mathematics due to its important role in elementary school to develop mathematical critical thinking ability. Again, Sari, et al. (2016) add that one of Curriculum 2013 objectives is to provide generation who has critical thinking ability. This generation will not only believe their surrounding facts without proofing so the facts are trusted. In addition, Chukwuyenum (2013) argues that critical thinking becomes one of tools to solve daily problem since it involves ability to think, interpret, and evaluate information to decide valid and reliable decision.

In fact especially in Indonesia, mathematics learning is still dominated with exercise activities to achieve basic mathematics skill, consequently students' mathematical critical thinking ability is still low (Agusman, 2016). As Glaser (2001) says a person will experience some obstacles in critical thinking if the basic knowledge to make and arrange arguments is not well controlled as well as Octaria (2018) reveals in her study in one of senior

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high school in Jakarta. From the result of students' score in completing critical thinking ability questions, the average percentage of their ability is 22.36%. In other words, their critical thinking abilities are still low.

The low level of students' mathematical critical thinking ability is caused by several factors. One of them is the condition of mathematics learning in the class which is still dominated with conventional learning system such as lecturing without emphasizing students' learning creativities as a result they are not optimal in critical thinking (Jusniani, 2016). Furthermore, Nuriali, et al. (2016) state that the cause of students low critical thinking ability is the learning model used by most of teachers in Indonesia which mostly makes students' daily activities only watch the teacher solves the problems on the board and then asks them to work on the text book (LKS) by their own. Hence, the process of building knowledge becomes less successful and there is tendency for students to be guided or given instruction to solve the questions. Therefore, students are not actively involved in finding the solution. Sumarmo (2013) suggests that to develop students' mathematical critical thinking ability in learning, teacher also needs to encourage students to be more active in discussion, asking and answering questions, critically thinking, explaining answers, and addressing reason for an answer.

According to Widyatiningtyas, R., et al. (2015), learning mathematics which is to build and develop students' mathematical critical thinking ability is designed to make students be able to solve non-routine problems both individually and in group. Therefore, it is necessary to find an appropriate alternative learning model that actively involves students in learning activities so their mathematical critical thinking ability will improve.

Besides, teachers also should arrange and apply various methods that make students will be interested and excited to attend mathematics class. One of the methods is inquiry learning model. Sidiq and Prayitno (2012) suggest that the development of critical thinking through inquiry model that is based on the activities of formulating problems solving is a process of inquiry learning in order to result students who have problem solving ability. In line with Rasiman (2017), everyone who consistently does exercises through focused discussion or with guidance from teachers possibly have high critical thinking.

2. Methods

This study was conducted in SMP 1 Ciruas with population of all students in VII class in the even semester in the academic year of 2018/2019. This study used Cluster technique random sampling that is random data collection in a population. According to Sugiyono (2016), cluster random sampling is used to determine a sample if the objects are too wide.

In this study, 2 classes from population were selected as the sample. In detail, VII A was the experimental class which was consisted of 32 students and VII E as the control class which was consisted of 37 students. A guided inquiry learning model was treated for experimental class and expository learning model for the control class.

For more, this study used quasi experimental method that is non-equivalent pretest and posttest control groups to observe students' basic ability. Then, a guided inquiry learning model was given during the learning process. Eventually, posttest was given to see the change or improvement of students' mathematical critical thinking ability. Likewise in the control class, before the material was given, pretest was given to students. After the learning finished, posttest was given to see the progress.

Moreover, there were 3 steps research procedures conducted namely preparation, implementation, and final stage. The study had been begun from March 11th till April 20th 2019 consisting of 8 meetings in which 2 meetings were for pretest and posttest and the rest was for learning process.

The data of this study were quantitative data that came from pretest, posttest, and N-gain mathematical critical thinking ability of the students. The analysis techniques covered descriptive and inferential statistic. Meanwhile the test instrument used was mathematical critical thinking ability test that was developed in the descriptive questions form.

The chosen indicators to make the instruments of mathematical critical thinking ability test were as follows 1) understanding and identifying problems, 2) connecting gained information, 3) analyzing problems, 4) solving the problems with the right strategy, and 5) evaluating and drawing conclusion.

3. Results & Discussions

The result of this study covered pretest and posttest result of mathematical problem solving ability. The analysis of pretest and posttest was based on the score of the tests. The descriptive statistics of students' initial ability of mathematical critical thinking of experimental and control class is presented on the following table.

Table 1. The Descriptive Statistics of Mathematical Critical Thinking Ability Pretest

Class	Amount of Data	Lowest Score	Highest Score	Average Score	Standard Deviation	Variance	SM 1
Experiment	32	0	4	1.09	1.12	1.25	20
Control	37	0	3	1.11	0.84	0.71	

In this study, the analysis of mathematical critical thinking ability data consisted of assumption or prerequisite test which included normality and homogeneity test which was then followed by a two-mean difference test to conclude whether there was difference between mathematical critical thinking ability of experimental and control students. The data used were the pretest score of experimental and control class students as presented on the following figure.

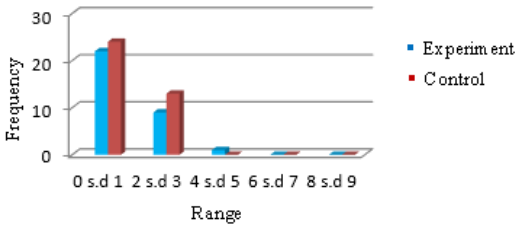

Figure 1. The Frequency Distribution of Mathematical Critical Thinking Ability Pretest Data

3.1. Normality Test (Pretest)

To examine the normality of students' critical thinking ability, this study used Kolomogrov Smirnov test. The result normality test of pretest data from two classes is presented on the following table.

Table 2. The Result of Normality Test of Students' Mathematical Critical Thinking Ability (Pretest)

Statistics	Class	
	Experiment	Control
D_{count}	0.22	0.21
D_{table}	0.24	0.22

Based on table 2, D_{count} for experimental and control class was 0.22 and 0.21 which was less than D_{table} with $\alpha = 0.05$ that was 0.24 and 0.22, so H_0 was accepted. In brief, the initial data of students' mathematical critical thinking ability of experimental and control class on lines and angle subject were normally distributed.

3.2. Homogeneity Test (Pretest)

Based on the result of normality test, the homogeneity test was carried out by using F test. The result of this test can be seen on the following table.

Table 3. The Homogeneity Test of Students' Mathematical Critical Thinking Ability (Pretest)

Statistics	Class	
	Experiment	Control
Variance	1.25	0.71
F_{count}	1.76	
F_{table}	1.78	

Based on table 3, F_{count} was 1.76 with significant level of 0.05 in which the numerator df = 32-1 = 31 and denominator df =37-1 = 36, then F_{table} was 1.78, it means that H_0 was accepted as $F_{count} < F_{table.}$ Shortly, the initial data of mathematical critical thinking ability of experimental and control class students on lines and angles subject had homogeneous variance.

3.3. Two-mean Difference Test

Two-mean difference test was conducted to prove that the pretest results of experimental and control class were not significantly different. This test was carried out by using t test. The test result is presented on the following table.

Table 4. The Two-mean Difference Test of Students' Mathematical Critical Thinking Ability.

Statistics	Class	
	Experiment	Control
Variance	1.25	0.71
t_{count}	-0.00019	
t_{table}	2.000	

Based on table 4, it can be seen that t_{count} was -0.00019, t_{table} was 2.000 with significant level of 0.05 in which $d = n_1 + n_2 - 2 = 67$, and another t_{table} was -2.000. Because t_{count} was between two t_{table} values, H_0 was accepted. Hence, it can be concluded that the initial knowledge of mathematical critical thinking ability of experimental and control class on lines and angles subject was same.

Then, the posttest of students' mathematical critical thinking ability was performed. The descriptive statistics of mathematical critical thinking ability of experimental and control class can be seen in the following table.

Table 5. The Descriptive Statistics of Students' Mathematical Critical Thinking Ability (Posttest)

Class	Amount of data	Lowest Score	Highest Score	Average Score	Standard Deviation	Variance	SM1
Experiment	32	0	16	7.72	5.35	28.66	20
Control	37	0	8	3.95	2.03	4.11	

The analysis of posttest data consisted of assumption or prerequisite test namely normality and homogeneity test which then followed by t test. To draw the conclusion whether the mathematical critical thinking ability of experimental students is better than control students, hypothesis test was performed. This test used posttest scores of both classes as presented on the following figure.

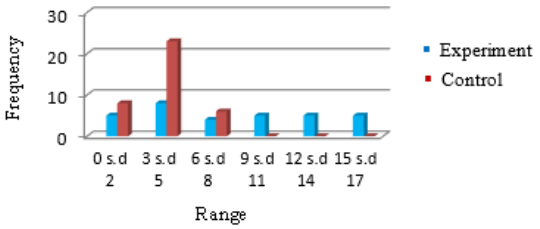

Figure 2. The Frequency Distribution of Students' Mathematical Critical Thinking Ability (Pretest)

3.4. Normality Test (posttest)

To gain the result of this test, researchers used Kolomogrov Smirnov test. The results are presented on the following table.

Table 6. The Result of Normality Test of Mathematical Critical Thinking Ability (Posttest)

Statistics	Class	
	Experiment	Control
D_{count}	0.15	0.19
D_{table}	0.24	0.22

As seen on table above, D_{count} of experimental class was 0.15 and 0.19 for control class. Since these values were smaller than D_{table} (0.24 and 0.22) with $\alpha = 0.05$, H_0 was accepted. Shortly, the final knowledge of mathematical critical thinking ability of both classes on lines and angles subjects were normally distributed.

3.5. Homogeneity Test (posttest)

In this test, researcher used F test to gain the results. The results are presented on the following table.

Table 7. The Result of Homogeneity Test of Mathematical Critical Thinking Ability

Statistics	Class	
	Experiment	Control
Variance	28.66	4.11
F_{count}	6.98	
F_{table}	1.78	

Based on table 7 with a significant level of 0.05 in which the numerator 32-1 = 31 and the denominator 37-1 = 36, F_{count} was 6.98 and F_{count} was 1.78, so H_0 was rejected as $F_{count} > F_{count}$. Hence, the final knowledge of students' mathematical critical thinking ability on lines and angles subjects of both classes had non homogeneous variance.

3.6. T test (posttest)

A parametric test was carried out to find out whether the posttest data of experimental and control class were different or not. Then, it was conducted by using two-party t test. The results are presented on the following table.

Table 8. The Parametric Test of Students' Mathematical Critical Thinking Ability (Posttest)

Statistics	Class	
	Experiment	Control
Variance	28.66	4.11
t_{count}	3.760	
t_{table}	2.042	

With a significant level of 0.05 in which dk1 = 32 – 1 = 31 and dk2 = 37 – 1 = 36, it was obtained t_{count} = 3.760 and $t_{(\alpha)}$ = 2.042. H_0 was rejected as the value of $t_{count} > t_{(\alpha)}$. Regarding to this finding, it can be concluded that there was difference between final achievements of experimental and control class on lines and angles subject.

3.7. Hypothesis Test

The aim of this test was to find out whether the final achievements of mathematical critical thinking ability of experimental class was better than control class. Further, based on the result of t test, the one party (right side) hypothesis t test was performed. It shows that H_0 was rejected, so $\mu_1 > \mu_2$. Thus, it can be concluded that the achievement of students' mathematical critical thinking ability with inquiry model was better than students with expository model.

Furthermore, data analysis was carried out to obtain N-gain. The descriptive statistics about N-gain data can be seen on the following table.

Table 9. The Descriptive Statistics of N-gain data of Students' Mathematical Critical Thinking Ability

Class	Amount of data	Lowest Score	Highest Score	Average Score	Standard Deviation	Variance	SM1
Experiment	32	-0.05	0.76	0.36	0.27	0.07	20
Control	37	-0.05	0.37	0.15	0.10	0.01	

After the N-gain data were obtained, these data were used to find out whether the ability of experimental students was better than control students. Apparently, the result shows that the ability of experimental students was better than control students as presented on the following figure.

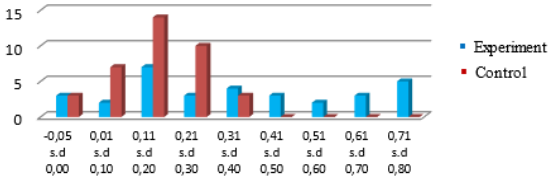

Figure 3. Frequency Distribution of N-gain Data of Students' Mathematical Critical Thinking Ability

3.8. Normality Test (N-gain)

As previous normality test, researcher used Kolomogrov Smirnov test. The result can be seen on the following table.

Table 10. The Normality Test Result of Students' Mathematical Critical Thinking Ability (N-gain)

Statistics	Class	
	Experiment	Control
D_{count}	0.14	0.16
D_{table}	0.24	0.22

As showed on table 10, D_{count} for experimental class was 0.14, and control class was 0.16. These values were less than D_{table} of both classes that was 0.24 and 0.22 with $\alpha = 0.05$. It means H_0 was accepted. In other words, N-gain data of students' mathematical critical thinking ability on lines and angles subject of both classes were normally distributed.

3.9. Homogeneity Test (N-gain)

The N-gain data for homogeneity test was carried out by using F test. The test results of two classes are presented on table 11.

Table 11. The Homogeneity Test Result of Students' Mathematical Critical Thinking Ability (N-gain)

Statistics	Class	
	Experiment	Control
Variance	0.07	0.01
F_{count}	6.73	
F_{table}	1.78	

Based on table 11, F_{count} was 6.73. Meanwhile F_{table} was 1.78 with significant level of 0.05 in which the numerator = 32 – 1 = 31 and the denominator = 37 – 1 = 36. Because of $F_{count} > F_{table}$, H_0 was rejected. In brief, the N-gain of students' mathematical critical thinking ability of both classes on lines and angles subject had non homogeneous variance.

3.10. T test (N-gain)

The parametric test was conducted whether N-gain of mathematical critical thinking ability of both classes was difference or not. This test was carried out by using two-party test. The results are presented on the following table.

Table 12. The Result of Parametric Test of Students' Mathematical Critical Thinking Ability (N-gain)

Statistics	Class	
	Experiment	Control
Variance	0.07	0.01
t_{count}	4.123	
$t_{(\alpha)}$	2.042	

Based on the result, the value of t_{count} was 4.123. Meanwhile t_{table} or $t_{(\alpha)}$ was 2.042 with a significant level of 0.05 and $dk_1 = 32 – 1 = 31$ and $dk_2 = 37 – 1 = 36$. Because the value of $t_{count} > t_{(\alpha)}$, H_0 was rejected. Thus, there was differences between the improvement of mathematical critical ability of classes on lines and angles subject.

3.11. Hypothesis Test

The aim of this test was to find out whether the improvement of mathematical critical thinking ability of experimental class was better than control class. In this test, researcher used one party t test (right side) since H_0 was rejected (t test result) then $\mu_1 > \mu_2$. Hence, it can be concluded that mathematical critical ability of students with inquiry model (experimental class) was better than those with expository model (control class).

For more, the posttest results of mathematical critical thinking ability of both classes were categorized into three levels, namely high, middle, and low classes. The following figure shows the level of students' ability.

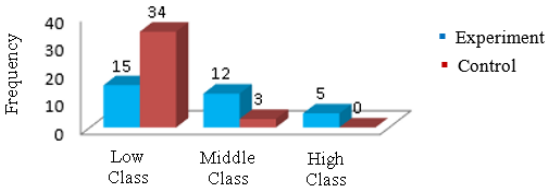

Figure 4. The level of Students' Mathematical Critical Thinking Ability

Meanwhile, the percentage of mathematical problem solving indicators can be seen on the following table 13 and figure 5.

Table 13. The Percentage of Mathematical Problem Solving Indicators

No	Indicator	Class	Presen-tation	Cate-gory
1	Identify	Experiment	51%	Less
		Control	41%	Less
2	Connect	Experiment	49%	Less
		Control	19%	Bad
3	Analyzing	Experiment	49%	Less
		Control	18%	Bad
4	Solve	Experiment	14%	Bad
		Control	10%	Bad
5	Evaluate	Experiment	30%	Bad
		Control	11%	Bad

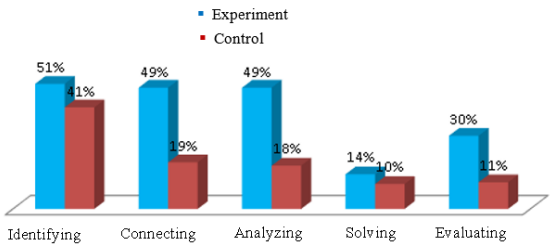

Figure 5. The Percentage of Mathematical Problem Solving Indicators

Based on table 13 and figure 5, the achievements of experimental class were better than control class in each indicator, even though the achievements were still relatively low.

Based on the test results, it can be concluded that the inquiry learning model positively influenced the improvement of students' mathematical critical thinking ability rather than expository learning model. Apparently, this happened because of several factors which one of them was by motivating and recalling students' memory to the problems faced. They were encouraged to be more active in learning activities and be able to find information to solve the problems. This is proved through the percentage of mathematical critical thinking ability indicators namely connecting indicator. This indicator led the students to express their ideas to solve the

problems with appropriate information and strategies.

Another factor that support positive influence of inquiry learning model was directly involved the students in every learning activity so they would be motivated to hardly learn and solve all the problems. Additionally, the role of teacher as learning partner in checking or reviewing students' ideas was also one of supporting factor of inquiry learning model (Suryosubroto, 2009: 185). This is good for the improvement of students' mathematical critical thinking ability as Sumarmo (201 3:4) says to develop students' mathematical critical thinking ability in learning activities, teachers also need to encourage students to be actively involved in every discussion, actively asking and answering questions, critically thinking, explaining each answer, and delivering the reason for each answer given. Hence, inquiry learning model positively influenced students' mathematical critical thinking ability.

4. Conclusion

Based on analysis and discussion of the result of this study in SMPN 1 Ciruas, the inquiry learning model positively influenced students' mathematical critical thinking ability. It was proved through the final achievement of inquiry learning model students (experimental class) which was better than expository learning model students (control class).

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