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Collaborative Learning on Mathematical Critical Thinking Skills

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Abstract

This research is quasi experiment with research design "Posttest Only Control Group Design" which aims to determine the application influence of collaborative learning models on the critical thinking ability students i.e. case study on grade VIII even semester SMP 1 Kelumbayan Barat Tanggamus. Sampling techniques using Cluster Random sampling. The research sample consists of two classes, namely one class experiment class i.e. grade VIII B as many as 39 students and one class control class VIII A as many as 40 students. Data collection techniques are obtained through mathematical critical thinking tests, observations, and interviews. Based on the results of the analysis obtained that tcount = 3.39. Distribution table, at the level of 5% obtained tdaf = 1,667 and at the level of 1% tdaf = 2,382. Proven tcount > ttable. It can be concluded that the collaborative learning model affects the ability of mathematical critical thinking students. The average mathematical critical thinking ability of students who use the collaborative learning model is higher than the average mathematical critical thinking ability of students who use the conventional learning model.

Keywords: *Collaborative Learning Model, Critical thinking skills*

Abstrak

Penelitian ini merupakan penelitian eksperimen semu dengan desain penelitian “Posttest Only Control Group Design” yang bertujuan untuk mengetahui pengaruh penerapan model pembelajaran kolaboratif terhadap kemampuan berpikir kritis siswa yaitu studi kasus pada siswa kelas VIII semester genap SMP 1 Kelumbayan Barat Tanggamus. Teknik pengambilan sampel menggunakan Cluster Random sampling. Sampel penelitian terdiri dari dua kelas yaitu satu kelas eksperimen yaitu kelas VIII B sebanyak 39 siswa dan satu kelas kontrol kelas VIII A sebanyak 40 siswa. Teknik pengumpulan data diperoleh melalui tes berpikir kritis matematis, observasi, dan wawancara. Berdasarkan hasil analisis diperoleh thitung = 3,39. Tabel distribusi, pada taraf 5% diperoleh tdaf = 1,667 dan pada taraf 1% tdaf = 2,382. Terbukti thitung > ttabel. Dapat disimpulkan bahwa model pembelajaran kolaboratif berpengaruh terhadap kemampuan berpikir kritis matematis siswa. Rata-rata kemampuan berpikir kritis matematis siswa yang menggunakan model pembelajaran kolaboratif lebih tinggi daripada rata-rata

kemampuan berpikir kritis matematis siswa yang menggunakan model pembelajaran konvensional.

Kata kunci : *Model Pembelajaran Kolaboratif, Kemampuan Berpikir Kritis*

1. INTRODUCTION

The challenge of education in Indonesia in this period of transformation towards the Industrial revolution 4.0 in this modern era is how to create highly competitive graduates. In the current era of the industrial revolution 4.0, educators who act as facilitators are expected to be able to carry out education and teaching patterns by prioritizing High Order Thinking Skills (HOTS). HOTS tends to use logic rather than remembering, memorizing so that students' mastery of concepts is more complex. This ability can be obtained if students are accustomed to critical thinking in the learning process. Critical thinking in mathematics is the ability to think which includes elements of testing, questioning, connecting, and evaluating Use the "Insert Citation" button to add citations to this document.

[1] All aspects that exist in a situation or a math problem so that students can compete actively[2]. Critical thinking skills performed by students require the presentation of problems that contain elements of problem solving and high-level mathematical thinking processes, logical, analytical, systematic and creative thinking skills[2], [3]. However, the fact that occurs in the learning process is that the presentation of mathematical problems is still limited to presenting routine questions. This is supported by the results of research conducted by the Program for International Student Assessment (PISA) in 2018, regarding students' mathematical abilities, showing that Indonesia is ranked 7th from the bottom (73) with an average score of 379[4]. This survey shows that the ability of Indonesian students is still limited to being able to work on routine questions that do not require high-level thinking skills. Indonesian students are not familiar

with problem solving problems which result in weak development of mathematical thinking processes. As a result, students' ability to think critically, namely the ability to evaluate their own beliefs and opinions is also not well developed. Students consider mathematics difficult so that students experience errors in presenting mathematical sentences [5]–[7].

This can also be seen in the preliminary study of class VIII students in even semesters of SMP Negeri 1 Kelumbayan Barat Tanggamus which also shows low learning outcomes, based on the KKM, namely 61, it is known that students who have reached the KKM are 18.75% and the rest have not reached the KKM as much as 81.25%. The causes of the low are also based on preliminary research, namely (1) teacher-dominated learning which causes student involvement to be active in learning is still lacking, (2) students have difficulty in providing arguments in the basis of their thinking, (3) students' lack of ability to represent sentences into models mathematics. This indicates that students' critical thinking skills are not optimal. Therefore, a learning model that can be developed to improve critical thinking skills, analyze and understand is one of them can use a collaborative learning model. Collaborative learning is learning by forming groups, students learn and work together, improve verbal skills, and student interaction. During the discussion students can exchange ideas, and know their own abilities in the group [7]. Active student involvement in learning can affect learning outcomes [8]. The teacher as a facilitator where learning is student-centered. This learning model can produce more understanding than individual learning and increase mastery of mathematical competencies [8]. The fact is supported by many studies showing that collaborative learning can improve student learning outcomes[9], [10][11]. The advantages of collaborative learning besides being able to improve learning outcomes are (1) Encouraging students to learn from each other in groups, (2) students are more active in conveying ideas, (3) being responsible for themselves so that they become critical thinkers, (4) At

the time of discussion, students can carry out activities to take inventory of the necessary information, accept other people's ideas and draw conclusions [12].

2. RESEARCH METHODS

This research is a quasi-experiment with a research design of "Posttest Only Control Group Design". The population were students of class VIII even semester of SMP Negeri 1 Kelumbayan Barat Tanggamus which consisted of 118 students. The sampling technique used was cluster random sampling technique. Every member in the population has the same opportunity to be sampled in the study. There are 2 research sample classes, namely one experimental class class (using collaborative learning) class VIIIB as many as 39 students and one control class (using conventional learning) namely class VIIIA as many as 40 students. The authors used data collection techniques to test the truth of the hypothesis, i.e observation and interview techniques. The test was given with the same type for the control class and the experimental class. It is an essay test, a set of tests consisting of 10 essay items. The score assessment is as follows:

TABLE 1. Guidelines for Assessment of Mathematical Critical Thinking Ability

Indicator	The Test Kits Score	Score
Explore	Wrong answers	0
	Construct meaning by examining the problem situation from a point of view but the answer is wrong	1
	Construct meaning by examining the problem situation from a point of view and the correct answer	2
	Construct meaning by examining the problem situation from various points of view but the answer is wrong	3
	Construct meaning by examining problem situations from various points of view and correct answers	4

Indicator	The Test Kits Score	Score
Identify and establish the truth of the concept	Wrong answers	0
	Explain the concepts used and correct	1
	Explain the concepts used and give reasons but still wrong	2
	Explains the concepts used and gives reasons but is incomplete	3
	Explain the concepts used and give reasons correctly	4
Generalize	Wrong answers	0
	Only complete supporting data completely and correctly	1
	Complete supporting data completely and correctly but incorrectly in determining general rules	2
	Complete the supporting data completely and correctly but incorrectly in determining the general rules	3
	Complete the supporting data completely and correctly and determine the general rules and how to obtain it	4
Classification and Resolution	Wrong answers	0
	Only problem solving ability algorithms	1
	Checking problem solving algorithms, giving incomprehensible explanations	2
	Checks problem solving algorithms, explains, but doesn't fix errors	3
	Checking problem solving algorithms, explaining and correcting errors	4

Thus, the maximum score entirely is 40, while the minimum score is 0. The student's score moves in the interval $0 \leq x \leq 100$. The scoring system to be used:

$$N = \frac{\text{score obtained}}{\max score} \times 100$$

3. RESULTS AND DISCUSSION

The table 2 explain about result for the experiment class and the control class :

TABLE 2. Test results for the experiment class and the control class

Group	The number of students	Highest score	Lowest score	Average score	Graduation Percentage
Experimental group	39	93	47	67,23	74,35
Control group	40	87	40	58,93	42,5

Results of the mathematics test between experiment class and control class, it can be seen that the average value of the experimental class is 67.23 and the control class is 58.93. In addition, if we look at the highest score from the experimental class, which is 93 and the lowest score is 47 and the graduation percentage is 79.48%. The KKM used in class VII is 61. The control has the highest score of 87 and the lowest score of 40 and the pass percentage is 42.5%. These results indicate that the experimental class with learning using collaborative learning has a fairly good test result when compared to conventional. The ideal learning completeness occurs if at least 70% of the total students get a score above the KKM [11]. Furthermore, to find out the indicators of students' critical thinking skills after learning, an analysis of students' critical thinking skills scores was carried out for each indicator in the posttest score data. Table 4 presents data on critical thinking power managers as follows:

TABLE 3. Indicators for assessing students' critical thinking skills in the experimental and control class

Indicator	Maximum	Experiment Class		Control Class	
		Achievement	Perscentage	Achievement	Percentage
Explore	96	66	68,75	59	61,45
Identify and establish the truth of the concept	192	126	65,62	105	54,68
generalize	96	68	70,83	62	64,58
classification and resolution	192	121	63,02	104	54,16

3.1 NORMALITY TEST OF EXPERIMENT CLASS

The achievement of students' mathematical critical thinking ability indicators, namely exploring, identifying and establishing the truth of concepts, generalizing and clarifying and resolution that the experimental class is higher than the control class. The percentage of each critical thinking indicator has a balanced proportion in the experimental class with an average achievement of 68.75% on exploring indicators, indicators identifying and establishing the truth of concepts 65.62%, generalizing indicators 70.83% and indicators clarifying and resolution of 63.02%. This shows that collaborative learning provides opportunities for students to discuss, take responsibility for themselves so that they become critical thinkers [14]. The normality test of the experimental class data is analyzed in testing hypotheses. Data normality test carried out using the chi square technique χ^2

TABLE 4. List of Frequency Distribution of Test Results in the Experimental Class (Lestari et al., 2019)

Value	f_1	x_1	x_1^2	$f_1 . x_1$	$f_1 . x_1^2$
47 – 53	4	50	2500	200	10000
54 – 60	7	57	3249	399	22743
61 – 67	12	64	4096	768	49152
68 – 74	6	71	5041	426	30246
75 – 81	5	78	6084	390	30420
82 – 88	3	85	7225	255	21675
89 – 95	2	92	8464	184	16928
$\sum$	39	497	36659	2622	181164

Calculate the theoretical function will be determined first [3][4][6].

1. specifies the class boundary (X_i) ;
2. calculate Z for class boundaries with the formula $Z = \frac{x-\bar{x}}{s}$;
3. calculate the area of the interval class by looking at table f ;
4. calculating the expected area of the class (Ei) by involving the area of each class with the amount of data, namely Ei = Li. n.

Based on the calculations obtained data in table 6 as follows:

TABLE 5 List of Expected Distributions and Frequency of Observations in the Experimental Class [3][4][6].

X_1	Z	Z_1	L	E_1	O_1
46,5	-1,83	0,4664			
53,5	-1,21	0,3869	0,0795	3,10	4
60,5	-0,59	0,2224	0,1645	6,42	7
67,5	0,02	0,008	0,2144	8,36	12
74,5	0,64	0,2389	0,2309	9,01	6
81,5	1,26	0,3962	0,1573	6,13	5
88,5	1,88	0,4699	0,0737	2,87	3
95,5	2,49	0,4936	0,0237	0,92	2

Determine χ^2_{hit} by using the following formula:

$$\chi^2_{hit} = \sum_{i=1}^{k} \frac{(O_i - E_i)^2}{E_i}$$

$$= \frac{(4-3{,}10)^2}{3{,}10} + \frac{(7-6{,}42)^2}{6{,}42} + \frac{(12-8{,}36)^2}{8{,}36} + \frac{(6-9{,}01)^2}{9{,}01} + \frac{(5-6{,}13)^2}{6{,}13}$$

$$\frac{(3-2{,}87)^2}{2{,}87} + \frac{(2-0{,}92)^2}{0{,}92}$$

$= 0,26 + 0,05 + 1,58 + 1,00 + 0,21 + 0,01 + 1,25$
$= 4,36$

Test Criteria: Reject Ho if $\chi^2_{hit} \geq \chi^2_{daf}$ to a significant degree 5% (α = 0,05) obtained:

$\chi^2_{daf} = \chi^2_{(1-0,05)(7-3)}$
$= \chi^2_{(0,95)(4)}$
$= 9,49$

Significant degree 1% (α = 0,01) obtained:

$\chi^2_{daf} = \chi^2_{(1-0,01)(7-3)}$
$= \chi^2_{(0,99)(4)}$
$= 13,3$

For α = 0,01 and for α = 0,05 obtained $\chi^2_{hit} < \chi^2_{daf}$ so that Ho accepted and Ha reject, which means the data comes from a normal population.

3.2 NORMALITY TEST OF CONTROL CLASS

The result of the data analysis and calculation performed, the normality test of control Class obtained showed that the sample came from populations that were normally distributed $\chi^2_{hit} < \chi^2_{daf}$, because at a significant level of 5% obtained $4,05 < 9,49$ and for level 1% obtained $4,05 < 13,3$ so that Ho accepted and Ha riject, which means the data comes from a normal population.

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3.3 HOMOGENEITY TEST

Based on testing on two populations that have been proven to be normally distributed, the next step is to test the homogeneity of the variance of the two samples [3]. It is obtained that $F_{hit} < F_{daf}$ for α = 0.10 and α = 0.02 obtained at the level of = 0.10 obtained 1.19 < 1.71 while for the level of = 0.02 obtained 1.19 < 2.142 so that both samples have the same variance.

Hypothesis Formulation

Ho 1: $\mu_1 = \mu_2$ There is no effect of the application of the collaborative learning model on the critical thinking skills.

Ha 1: $\mu_1 \neq \mu_2$ There is an effect of the application of the collaborative learning model on the critical thinking skills.

Test Criteria

Accept Ho if $-t_{\left(1-\frac{1}{2}\alpha\right)} < t_{hit} < t_{\left(1-\frac{1}{2}\alpha\right)}$otherwise Ho is rejected Based on the calculation, we get $t_{hit} = 3{,}39$. For = 5%, we get $t_{daf} = t_{(0{,}975)(77)} = 1{,}994$ and for = 1% we get $t_{daf} = t_{(0{,}995)(77)} = 2{,}649$.. It turns out that for = 5% and = 1% the test criteria $-t_{\left(1-\frac{1}{2}\alpha\right)} < t_{hit} < t_{\left(1-\frac{1}{2}\alpha\right)}$ not met, in this case the hypothesis Ho is rejected so Ha accepted, namely there is an effect of the application of the collaborative learning model on the critical thinking skills.

3.4 TEST THE DIFFERENCE OF TWO MEANS

Testing the hypothesis that is used to test the difference between two averages whose hypothetical formula pairs are:

Ho 2: $\mu_1 \leq \mu_2$

The average mathematical critical thinking ability of students using the collaborative learning model is lower than or equal to the average mathematical critical thinking ability of students using conventional learning models.

Ha 2: $\mu_1 > \mu_2$

The average mathematical critical thinking ability of students who use the collaborative learning model is higher than the average mathematical critical thinking ability of students who use conventional learning models.

$t_{hit} = 3{,}39$
$t_{daf} = 1{,}667$ ($\alpha = 0{,}05$)
$t_{daf} = 2{,}382$ ($\alpha = 0{,}01$)

In accordance with the test criteria for both a significant level of 5% and 1%, $t_{hit} > t_{daf}$, is obtained, so Ho is rejected and Ha is accepted, which means that the average critical thinking ability using

collaborative learning models is higher than the average thinking ability of students using conventional learning models. From the results of the analysis and calculation of the data carried out, it was found that for testing the similarity of two the average was obtained t_{hit} = 3.39. The test criteria used are accept Ho if $-t_{(1-\frac{1}{2}\alpha)} < t_{hit} < t_{(1-\frac{1}{2}\alpha)}$otherwise Ho is rejected with dk = n1 + n2 – 2. By taking the level significant α = 0.05 obtained t_{daf} = 1.994 while at the significant level α = 0.01 obtained t_{daf} = 2.649. It can be seen that thit does not meet the criteria for acceptance of Ho both for the significant level α = 0.05 and α = 0.01. There is an effect of the application of the collaborative learning model on the critical thinking skills.

Meanwhile, for testing the difference between the two averages with t_{hit} = 3.39 and the test criteria used are Accept Ho if $t \leq t_{(1-\alpha)}$, in addition Ho is rejected with dk = n1 + n2 - 2. By taking the level significant = 0.05 obtained tdaf = 1.667 while at the significant level α = 0.01 obtained t_{daf} = 2.382. It can be seen that $t \geq t_{(1-\alpha)}$ at the significant level α = 0.01 and α = 0.05. So, Ho is rejected and Ha is accepted, which means that the average mathematical critical thinking ability of students using the collaborative learning model is higher than the average mathematical critical thinking ability of students using conventional learning models.

The critical thinking indicator tested in the experimental class has an average of 67.05%. Each of these indicators develops in a balanced way after learning using a collaborative learning model. The highest percentage of indicators is on generalizing and indicators with the lowest percentage on classification and resolution indicators. This is because when lowering one formula to another, students can easily find out through examples of numbers and problems that they create themselves. stating that something can help to think about these things based on statements such as graphs, photos , table, or figure This makes it difficult to translate the problem into a simpler form of picture. resulted in many students not succeeding in doing this

problem. While the indicator of critical thinking of students in the control class which has an average with a comparison of the assessment of each indicator is 58.71%. students who take control class learning only receive the material presented by the teacher. After the teacher explains, students are given examples of questions and their solutions. Then, students are given the opportunity to ask if there is something that has not been reached. Finally, students will be given practice questions. Based on these conventional learning processes, there is no exploration in students, which causes students' knowledge to be limited to what the teacher explains. The ability of students to solve problems is also limited to the examples of questions given, the process that is written in general is the same as what is explained by the teacher so that the critical thinking skills of students in classes that take classroom learning do not develop optimally. It also shows that Collaborative Learning is better in improving students' critical thinking skills.

CONCLUSION

The data analysis and hypothesis testing that the author has described, it can be concluded that there is an effect of applying the collaborative learning model on the mathematical critical thinking skills of class VIII students in the even semester of SMP Negeri 1 Kelumbayan Barat Tanggamus, in addition to statistical tests it is obtained that t_{hit} = 3.39 from the table the distribution at the 5% level was found to be t_{daf} = 1.667 so that 3.39 > 1,667 and at the 1% level it was known to be t_{daf} = 2.382 so that 3,39> 1,667. So, H_0 rejected, means H_a accepted which mean the collaborative learning model has an effect on students' mathematical critical thinking skills and the average mathematical critical thinking ability of students who use the collaborative learning model is higher than the average mathematical critical thinking ability of students who use conventional learning

models. Based on the conclusions, it is also in order to improve learning and the quality of education, especially for students learning mathematics, the authors provide the following suggestions:

a. a teacher does not hesitate to try new learning methods, because by trying the teacher will know whether the new learning method is better than the usual learning approach. It can also increase knowledge and insight for teachers and the learning methods used can help students master the subject matter well;
b. education practitioners are expected to be able to apply collaborative learning as one of the learning models in the classroom considering the positive influence given in improving students' critical thinking skills.

REFERENCES

[1] NCTM, *Principles and Standards For School Mathematics*. Reston:VA, 2000.

[2] R. Sagala, R. Umam, A. Thahir, A. Saregar, and I. Wardani, "The Effectiveness of STEM-Based on GenderDifferences: The Impact of PhysicsConcept Understanding," *Eur. J. Educ. Res.*, 2019.

[3] F. Lestari *et al.*, "The effectiveness of math learning based on multiple intelligence: Implications at MTs Darul Ma'wa," *AIP Conf. Proc.*, vol. 1, p. 2438, 2021, doi: https://doi.org/10.1063/5.0071296.

[4] OECD, *Results in Focus: What 15-year-olds know and what they can do with what they know.* 2018.

[5] S. Huda *et al.*, "Effect of Application Smart Circuit Learning Media to Mathematics Learning Outcomes: A Case Study of Islamic School Students," *Educ. J. Gift. Young Sci.*, vol. 7(4), pp. 699–715, 2019, doi: https://doi.org/10.17478/jegys.597053.

[6] F. Lestari *et al.*, "Cooperative Learning Application with the

Method of Network Tree Concept Map: Based on Japanese Learning System Approach," *Educ. J. Gift. Young Sci.*, vol. 7(1), pp. 15–32, 2019, doi: https://doi.org/10.17478/jegys.471466.

[7] Munifah *et al.*, "Management Development of Student Worksheets to Improve Teacher Communication Skills: A Case Study Self-Efficacy and Student Achievement," *Educ. J. Gift. Young Sci.*, vol. 7(4), pp. 777–798, 2019, doi: https://doi.org/10.17478/jegys.625618.

[8] D. Dewi, "The Influence of Lesson Study-based Collaborative Learning Model on Students' Critical Thinking Ability. Department of Mathematics and Natural Sciences," *Univ. Jember*, pp. 29–33, 2019.

[9] A. Azis, M. Muis, and Faisal, "Application of Collaborative Learning to Improve Learning Activities of Class XI Science 3 Students through School-Based Lesson Study at SMA Negeri 8 Makassar," *Bionature J.*, 2013.

[10] D. Marhamah, "The Effect of Collaborative Learning Model Based on Lesson Study Learning Community (LSLC)," *Student Sci. J. Phys. Educ.*, vol. 2, no. 3, 2017.

[11] S. Santoso, "Influence of Collaborative Learning Model and Learning Motivatation on Improving Physics Learning Outcomes of Students Class X of Purwantoro Wonogiri State High School, Central Java. Indonesian Physics Periodicals," *Indones. Phys. Period.*, 2013.

[12] M. Soto, *Challenges Schools Must Face, a paper in Reference Readings for Lesson Study – Based on Japanese Experience and IMSTEP*, Sistems. Jakarta, 2007.