The Effect of Brain Based Learning on Improving Students Critical Thinking Ability and Self Regulated

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Abstract

This research is motivated by the low ability of mathematical critical thinking and Self Regulated Cimahi 10 Public Middle School students, so that a learning approach is needed to overcome these problems. The alternative approach applied is the Brain Based Learning Model approach.The objectives of this researcher are: 1) to examine students' mathematical critical thinking skills; 2) reviewing the Self Regulated attitude of students who obtain Brain Based Learning learning with students who have expository learning; 3) examine there is a positive correlation between Critical Thinking with Self Regulated students who obtain Brain Based Learning and expository learning. The population in this study was grade VII students of SMP Negeri 10 Cimahi. The samples in this study were class VII-B (Brain Based Learning) and class VII-D (expository). The instruments used in this study were the Critical Thinking test and the student's Self Regulated questionnaire. The test used is a subjective type test (description). The way to analyze data is with IBM SPSS Statistics 18.0 for Windows. The results showed that: 1) the mathematical critical thinking ability of students who obtained learning based on the Brain Based Learning approach was better than students who gained expository learning; 2) Self Regulated attitude, students who get Brain Based Learning are better than students who get expository approach learning; 3) there is no correlation between critical thinking with Self Regulated students who obtain Brain Based Learning and expository learning.

Keywords: Brain Based Learning; Critical Thinking Ability; Self Regulated

How to cite this article :

Maryati, S. S., Purwanti, I., & Mubarika, M. P. (2020). The Effect of Brain Based Learning on Improving Students Critical Thinking Ability and Self Regulated. *IJIS Edu : Indonesian Journal of Integrated Science Education, 2*(2), 162-171. doi:http://dx.doi.org/10.29300/ijisedu.v2i2.3333
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INTRODUCTION

Education is an important effort to educate Human Resources (HR).One such effort is the existence of formal and informal education in which there is a curriculum which is the goal of education. Students are expected to master the subjects contained in the curriculum, especially mathematics. Currently learning mathematics is one of the subjects that is considered difficult and less attractive to many students. As according to Putra (Nugroho., Putra., Putra., & Syazali., 2017) Mathematics has an important role because it is the basis of logic or quantitative reasoning and resolution used in other lessons. However, students still view mathematics as a difficult and frightening lesson.

Based on the results of observations and interviews conducted by researchers at Dewi Sartika Junior High School Bandung the factors that influence student learning outcomes in mathematics are lacking student enthusiasm for learning mathematics because they consider mathematics learning difficult and boring. The low student learning outcomes of learning a certain material due to the delivery of material methods of learning mathematics at the time of the teaching and learning process has not been able to make students active in learning and not attract and motivate students to learn. Student test data is one proof that the lack of student interest in learning mathematics can be seen in the repetition table of 3 classes of 8th grade students and photos when using conventional learning as in table 1 and figure 1.

Tabel 1. the average results of grade 8 tests

Class	Skor
Class 8A	50,6
Class 8B	45,7
Class 8C	54,8

Figure 1. Conventional Class

To create a pleasant learning atmosphere, teachers should pay attention to one important thing in the human body so far the ability is still less optimized, namely the brain. The learning process does not only involve parts of the body, but involves all members of the body and brain. In this case, the teacher should have creativity and be able to think critically in implementing innovation properly in accordance with the structure and workings of the brain, one of which is through Brain Based Learning.

Learning using the Brain Based Learning model is learning that is aligned with the way the brain is naturally designed for learning. According to Jensen (Fitriani. 2019) Brain Based Learning (BBL) is learning taht is designed according to the way the brain naturally learns. Sierck (Fitriani. 2019) also believes that Brain Based Learning (BBL) is based on the idea that every part of the brain has a specific function when it comes to learning. The application of the Brain Based Learning approach in mathematics learning is expected to provide opportunities for students to hone their thinking skills, especially critical thinking abilities. With the ability to think critically students can think reasoned, reflect, be responsible for making decisions about what to believe or do.

According (Suhita. 2019) a person who thinks critically can ask the right questions, solve a given problem, not necessarily just transfer the information conveyed by the teacher so that it makes students passive. Critical thinking is a mentality to analyze or evaluate information. Critical thinking is also an investigation that is needed to explore situations, phenomena, questions or problem to form hypotheses or conclusions, which combine all the information that is possible and can be trusted. Students' critical thinking skills affect learning outcomes according to Sianturi., Sipayung., & Simorangkir. (2018).

In facing the globalization, it is very important for students to have critical thinking skills. But in fact some of the results of studies show students' critical thinking skills are still not satisfactory. A study conducted by TIMSS in 2015 ranked Indonesia 44 out of 49 countries Nizam (Hadi., & Novaliyosi. 2019). In the 2015 PISA program, Indonesia occupied only 64 out of 72 countries. Whereas mathematical problems in PISA can measure communication skills, reasoning, representation, problem solving, argumentation, communication and high-level thinking.

In addition to the cognitive aspects of critical thinking, affective aspects must also be developed such as Self Regulated. Self Regulated

is important for every student to have because Self Regulated can be one of the deciding factors in the success ofe one's mathematics learning. Students who obtain Self Regulated laerning in their learning process can have a strong impact on awareness in the laerning process: knowledge, beliefs, and opinions about learning and some things tha have an impact on the learning process Ferla (Pratama. 2017). So thus Self Regulated is a process when a student participates actively in learning in metacognition, motivation, and behavior

RESEARCH METHOD

The method that will be used in this research is Quasi Experimental Design. The research was carried out in two groups. The first group, the experimental class, was treated using the Brain-Based Learning model, while the control class was treated using a conventional learning model in the taeching and learning process. The subject matter chosen in this study is unteger material which is the material in class VII syllabus which is being studied in odd semester.

The population in this study were all grade VII students of SMPN 10 Cimahi. The research sample in this study was class VII-B experiments (Brain Based Learning) and class VII-D conventional (expository). This sample was taken using a purposive sampling technique, because the sampling was determined entirely by the researcher in order to achieve a certain goal. The instrument in this study was a test of students' mathematical critical thinking skills in the form of a matter of description of mathematical critical thinking skills related to integer material according to the indicators of mathematical critical thinking ability according to Ennis (Fisher. 2009) and the questionnaire used was Self Regulated, Self Regulated indicators according to ormrod (Pebrianti. 2015).

Data analysis techniques used are (1) normality test used to determine the initial test data (pretes) dan final test (postes) with normal distibution or not; (2) homogeneity test is done to find out the similarity of variance (homogeneity) between the experimental class and the control class; (3) t-test to test the difference between the two average mathematical critical thinking skills between the two classes, (4) descriptive index gain statistical tests are used to determine the increase in value from the pretest to the posttest, (5) the correlation test of

mathematical critical thinking ability and self regulated is used to find out whether there is a correlation between critical thinking skills and Self Regulated in the experimental class and the control class.

RESULTS AND DISCUSSION

1. Data Analysis Tests for Critical Thinking Ability

The descriptive statistical results of the pretest and posttest data from the research obtained from the mathematical critical thinking ability test contained the average score of the experimental class pretest results was 50,29 and for the control class was 46,91, while for the posttest results the average experimental score was 78,38 and for controls 72,79. This shows that the ability of experimental class students is higher than the control class students. To see whether the difference between the average score of the pretest-posttest control class and the experimental class is significant or not, the following statistical test is used.

Data normality test is done using Shapiro-Wilk test statistics that the pretest data results of the experimental class students had a significant values of 0,088 and the control class had a significant values of 0,179. Significant value of the two classes is greater than 0,05, then based on the decision-making criteria according to Uyanto (2006, p. 30), it can be concluded that the gain data for both classes comes from populations that are normally distributed. Posttest data of the experimental class students had a significant value of 0,021 and the control class had a significant value of 0,204. The significant value of the experimental class is less than 0,05 and the significant value of the control class is greater than 0,05, then based on the decision making criteria according to Uyanto (2006, p. 30), it can be concluded that the gain data of the two classes comes from populations that are not normally distributed. Because the normality of posttest data results are non-parametric statistical tests performed with the Mann-Whitney test results obained Sig. (2-tailed) is 0,013. The value is smaller than 0,05, with the mean rank of the eksperimental class by 40,37 and the mean rank of control class by 28,63, so based on the testing criteria H_0 is rejected, meaning that there is a difference in the mean rank of the pretest score between the experimental class and the control class. After the two pretest classes are normally distributed and homogeneous, a t-test is

conducted through a party test with a significance level of 0,05 using Independent Sample T-test, with the help of SPSS software version 18 with a significance level of 0,05. The hypothesis is formulated in the form of a statistical hypothesis (right hand side test) according to Sugiyono (2016, p. 121) as follows:

$$H_0 : \mu_1 \leq \mu_2$$
$$H_a : \mu_1 > \mu_2$$

In table 1 below , a significance value of 0,183. A value of $\frac{Sig}{2} = \frac{0,183}{2} = 0,0915$ is greater than 0,05 then H_0 is accepted. The critical thinking ability of junior high school students who obtain the Brain Based Learning model is no better than the critical thinking ability of junior high school students who obtain conventional learning model.

Calculation of Two Eqivalence Tests (t-test) is complete in the appendix and summarized in table 1.

Table 1 Equivalence Test (Pretest)

Class	t-test for Equality of Means		
	T	**Sig. (2-tailed)**	**Conclusion**
Equal variances assumed	1,345	0,183	H_0 received

2. Analysis of the increase in the ability to think critically

After analyzing the data of critical thinking skills test the next step is to analyze the improvement of critical thinking skills. The descriptive statistical results of the pretest-posttest results from the research obtained from the mathematical critical thinking ability test contained the average score of the experimental class pretest results was 0,699 while for the control class was 0,4738. This shows that the initial ability of the experimental class students is higher than the control class students. To see whether the difference between the average score of the pretest-posttest control class and the experimental class is significant or not, the following statistical test is used.

Normality test for the experimental class and the control class is performed to determine whether the data obtained is normally distributed or not. Normality test of the two classes was carried out by the Shapiro-Wilk test using SPSS software version 18 with a significance level.

After processing the data, based on the results of the normality test output using the Shapiro-Wilk in Table 3 the significance value in the significance column of the gain data for the experimental class was 0,906 and the control class 0,911. Based on the testing criteria, the experimental class and the control class come from normally distributed populations. Because the significance value of the two classes is more than 0,05 H_0 is accepted.

Based on the normality test of the gain-normal data distribution, the data gain-normal values of the two classes are normally distributed so the analysis is continued by testing the homogeneity of the two variances between the gain-normal data of the experimental class and the control class using the Levene test using SPSS software version 18 with a significance level of 0,05. After processing the data, the output display can be seen in Table 2.

Table 2. Homogeneity of Two Variants of Gain-Normal Data

Class	Homogeneity		
	Levene Statistic	**Significance**	**Conclusion**
Experimental	0,507	0,479	Homogeneous
Control	0,507	0,479	Homogeneous

Based on the results of the homogeneity variance test output using the Levene test in Table 2 the significance value is 0,479. Based on testing criteria, the experimental class and the control class are declared homogeneous. Because the significance value is greater than 0,05 than H_0 is accepted.

After the two classes are normally distributed and have a homogeneous variance, a similarity test of two means is carried out with one-party t-test using SPSS 18 software using independent Sample T-test with the assumption that both variances are homogeneous (equal variance not assumed) with a significance level of 0,05.

Table 3. Gain-Normal Value t-test

Class	t-test for Equality of Means		
	T	Sig. (2-tailed)	Conclusion
Equal variances assumed	2,065	0,043	H_0 is rejected

After processing the data, the output display can be seen in table 3 above. According to Uyanto (2006, p. 120), to conduct a one-party hypothesis test the value of sig.(2-tailed) must be divided in half, so that it becomes $\frac{0,043}{2} = 0,021$. Because the probability value is smaller than 0,05 so H_0 is rejected or the critical thinking ability of the experimental class is better than the control class on the final test (posttest).

3. Self Regulated Questionnaire Data Analysis

After analyzing the critical thinking skills test data and analyzing critical thinking abilities, then the descriptive analysis of students' self-regulated questionnaire data was performed. With descriptive statistics obtained the maximum score, minimun score, average, and standard deviation from the questionnaire data of experimental class and the control class. The average score of the experimental class pretest results was 87,5083 while for the control class was 83,7606 . This shows that the initial ability of the experimental class students is higher than the control class students. To see whether the mean difference between the control class and the experimental class pretest scores is significant or nit, the following statistical tests are used.

Normality test is carried out to find out whether the questionnaire data is independent from participants with normal distribution or not. Testing is done using the Shapiro-Wilk test. The significance level (sig.) yang digunakan yaitu 5%. Based on the results of calculations with statistical tests through SPSS version 18 software, in Table 12 can be seen the probability value in the column of significance for the experimental class is 0,337 and for the control class is 0,246. Because the significance value of the second class is more than 0,05, it can be stated that the experimental class and the control class are normally distributed. Based on Self Regulated questionnaire data normally test, the data of the two classes were normally distributed so that the analysis was

carried out using two variance homogeneity between the initial data of the regulated Self-experimental class and the control class using the Levena test using SPSS version 18 software with a significance level of 5%. Obtained a significance value of 0,651. With a significance value greater than 0,05, the variant of the data is homogeneous, so that it can distinguish data obtained from populations that have the same or both variants of the homogeneous class.

Both classes are normally distributed and have a homogeneous variance, then a similarity test of two means is conducted using the t-test through SPSS version 18 using the Independent Samples t-Test with the assumption that both variances are homogeneous (equal variance assumed) with a significance level of 5%.

Table 4 Self Regulated Data t-test

Class	Test the similarity of two averages	
	Sig. (2-tailed)	Conclusion
Experimental	0,027	H_0 rejected
Control	0,027	H_0 rejected

The hypothesis is formulated in the form of a statistical hypothesis (one-party test) according to Sugiyono (2016, p. 121) as follows:

$$H_0 : \mu_1 \leq \mu_2$$
$$H_a : \mu_1 > \mu_2.$$

In Table 4 above, a significance value of 0,027 is obtained. A value of $\frac{sig}{2} = \frac{0,027}{2} = 0,013$ is smaller than 0,05 then $H_0: \mu_1 \leq \mu_2$ is rejected and Ha: $\mu_1 > \mu_2$ is accepted, so it can be concluded that there is a difference between students' Self Regulated between the experimental class and the control class.

After analyzing the data of critical thinking skills test, analysis of increasing critical thinking skills and descriptive analysis of students' Self Regulated questionnaire data, the last analysis of correlation data between critical thinking skills and student Self Regulated. As in table 5 the correlation analysis between critical thinking skills with the Self Regulated experimentsl class was conducted and in table 5 the correlation analysis between the critical thinking skills and the Self Regulated control class was carried out.

Table 5 Eksperimental class correlation test

		SRL	Critical Thinking
SRL	Pearson Correlation	1	,104
	Sig. (2-tailed)		,558
	N	34	34
Berpikir Kritis	Pearson Correlation	,104	1
	Sig. (2-tailed)	,558	
	N	34	34

Based on the results of the correlation test output using *Pearson Correlation* in Table 5 the significance value in the significance column of the experimental class data values is 0,558. Because the significance value of the correlation is greater than 0,05, so H_0 is rejected and H_a is accepted, meaning that in the control class there is no correlation between the ability to think critically with students' Self Regulated.

Table 6 Control Class Corelation Test

		SRL	Critical Thinking
SRL	Pearson Correlation	1	-,011
	Sig. (2-tailed)		,952
	N	34	34
Critical Thinking	Pearson Correlation	-,011	1
	Sig. (2-tailed)	,952	
	N	34	34

Based on the results of the correlation test output using *Pearson Correlation* in Table 6 the significance value in the data significance column of the control class value of 0,952. Because the significance value of the correlation is greater than 0,05, so H_0 is rejected and H_a is accepted, meaning that in the experimental class there is no correlation between critical thinking and Self-Regulated students.

Discussion
1. **Students' Critical Thinking Ability**

Based on the results of the analysis of the pretest data, it was conclude that there was no difference in the initial ability of mathematical reasoning in the experimental class and control class students because the Brain Based Learning model required a long time so that more preparation and planning were needed in the preparation of learning tools and the use of contextual problems and time effectiveness so that learning can run smoothly according to the objectives achieved. Therefore, to find out the increase in students' critical thinking skills posttest data is used. Based on the results of posttest data analysis, it was concluded that the increase in students' critical thinking skills using the Brain Based Learning model was better than those using conventional learning models.

This is because when implementing the Brain Based Learning model, students feel happy because they can train and depelov their thinking power, including their memory power. Also learning becomes not boring because all students actively participate in learning in class. So that the material that was initially considered difficult and unattractive becomes easy and fun because the learning model used can make students learn easily, fun, can motivate all students to be active and give students the opportunity to teach their friends and learn something well ath the same time, and can make questions and express opinions. This is in line with the research of Fitriani. (2019) in SMP Negeri 1 Bima in odd semester 2018/2019 using the learning model used is Brain Based Learning showing that there is an effect of the Brain Based Learning (BBL) model on thinking skills critical of students. The research of Salim Nahdi. (2015) at SD Cijati in the academic year 2013/2014 by using the learning model used is Brain Based Learning, showing that increasing critical thinking skills and mathematical reasoning that obtain learning using BBL is better than students who using conventional learning. The research of Chotimah., Ramdhani., Bernard., & Akbar. (2019) at SMP Negeri 10 Cimahi by using critical thinking skills shows that the results of the study, both from the results of data analysis and hypothesis testing, can be concluded that the mathematical critical thinking ability of SMP Negeri di Kota Cimahi whose learning using the MEAs approach is better than those using conventional learning. As according to Nisa., Rhosaliana. (2020) said that the results of the analysis of three research journals concluded that the application of the problem based learning model in each journal can be seen an increase in students' critical thinking skills in mathematical subjects marked by an increase learning success of students. Furthermore, according to Khairani,

& Putra. (2020). Based on the results of data analysis, it can be concluded that: 1) Achievement of mathematical critical thinking ability of students who get (MK, MB) is better than students who get Ordinary Learning, 2) Improvement of mathematical critical thinking ability of students who get (MK, MB) is better than students who get Ordinary Learning. Therefore, (MK, MB) can be used as an alternative for teachers in carrying out mathematics learning in class. And according to Artika. (2020). Based on the results of the analysis of the discussion data it was concluded that there was an increase in students' mathematical critical thinking skills from cycle I to cycle II.

Learning activities in the experimental class and control class can be seen in Figure 2 and Figure 3

Figure 2
Learning activities in the Experimental Class

Figure 3
Learning activities in the Control Class

For students who get learning by using the Brain Based Learning model is superior in expressing opinions through answers to questions that have been made based on the source of the reading provided, through writing and expressing it in front of the class and stating wrong answers from other groups that are refuted and trained in concluding the problem and the results of studies on the problem examined. Based on findings in the field, it turns out that the Brain Based Learning model can attract and focus students' attention, even when students are noisy, even students can be more

courageous and skilled in answering and expressing their own opinios. However, not all students change the way they learn, but in general students become more active when learning mathematics.

2. *Self Regulated Students*

Based on the analysis results, the Brain Based Learning model has an effect on students' Self Regulated attitudes for the better. So the results of research based on the analysis of Self Regulated attitude scale data that Self Regulated students who use the Brain Based Learning model are better than Self Regulated students who use conventional learning models.

Based on the initial meeting the application of the Brain Based Learning model was applied, the researcher had several obstacles, such as students who did did not have motivation in understanding mathematical problems, students who choose to chat rather than work on mathematical problems, student were not eager to learn mathematics for mathematical reasons it is a very difficult lesson to understand, if students are given assignments to do at home there are still many who do not do it even though it was given one week ago with the reason of not understanding, if given questions in class there are still many who are lazy to answer if nit reminded, lack of trust themselves if told to write their answer on the balckboard on the grounds of shame, and also the time is too short which is only to foster a sense of independence of student learning. But after the second meeting the Brain Based Learning model was applied, students were more confident in doing the tasks given. Based on the analysis of Self Regulated attitude scale data, it appears taht student have a Self Regulated attitude with the use of Brain Based Learning model in mathematisc learning. The application of the Brain Based Learning model can reduce insecurity and can improve student learning independence so student can learn well and complete their assignments. This is in line with the results of research conducted by Wahyuningtyas, et al. in the 2015-2016 school year in SMAN Kabupaten Ponorogo. The results of these studies are students in the category of high learning indpendence (Self Regulated Learning) and while having low learning achievement (Self Regulated Learning). As according to Retnaningsih., & Sugandi. (2018) at Islamic Junior High School. Furthermore, there are also studies from Meiliana., & Aripin. (2019) according to the results of the analysis show that the answers of students who are self-regulated

learning are good at completing the tasks well. While the answers of students who are self-regulated learning lack in answering questions with indicators of creative thinking lacking their ideas ideas. And as for research according to Sunismi, & Fathani. (2020). The results of this research are the mix research method concluded that there are differences in students' mathematical communication skills between the experimental class and the control class in terms of self-regulated learning levels (high, medium, low) on quadrilateral. The results of this study are that this study found that in critical thinking, its benefits, and mathematical learning independence, students who received problem-based learning achieved better quality tahn students who received conventional learning. The first group of students achieved a fairly good quality while the second group students obtained a moderate quality. In addition, it also found sufficient associations between mathematical critical thinking skills and learning independence.

Therefore, in order for research to get better results on students' Self Regulated attitudes, researchers should conduct research with sufficient time so that Self Regulated or student learning independence becomes better.

3. Correlation between Mathematical Reasoning Capabilities with Self Regulated Students

Based on the analysis of correlation data in the experimental class there is no correlation between the ability to think critically with students Self Regulated, so also in the control class there is no correlation between the ability to think critically with students', so also in the control class there is no correlation between the ability to think critically with student Self Regulated.

Based on the results of the analysis of the data that the two classes there is no correlation between the ability of critical thinking with Self Regulated students, because students who have good critical thinking skills do not necessarily have a high Self Regulated attitude. In accordance with the opinion (Sugiyono, 2016, p. 225) which says "The relationship of two or more variables is said to be a negative relationship, if the value of one variable is increased it will decrease the values of other variables, and vice versa". Therefore, students critical thinking skills do not affect students Self Regulated attitudes. This is because students do not mean to answer the Self Regulated questionnaire. Students who get low posttest scores answer the questionnaire as if

students understand the material that has been taught. The similar research on correlation is according to Sabina. (2019). The results showed there was an increase in the ability to understand concepts and mathematical reasoning of students taught discovery learning models with a scientific approach, there was a relationship to increase the ability to understand concepts and mathematical reasoning of students in classes taught discovery learning models with scientific approaches, and provide an effect on increasing self-regulated student learning. Furthermore, according to Zamnah. (2017). The results showed that there was a relationship between students 'self-regulated learning and students' mathematical solving abilities. And as for according to Ruswana, & Zamnah. (2018). Based on the results of research, data processing, data analysis and hypothesis testing it can be concluded that there is a correlation between self-regulated learning with students' mathematical understanding abilities.

4. Constraints Faced by Researchers

During mathematics learning, with learning using the model of Brain Based Learning and conventional progress, the researcher encountered several abstacles even though the researcher had done many things to minimize them. These obstacles include: (1) Some students at the beginning of the meeting who had a little difficulty adapting to the Brain Based Learning model, there were still many students who made noise when learning took place; (2) Some students ability to operate integers is still low and lacking, even though the material has been taught when students are still in elementary school level so that it is quite hindering the course of the laerning process during research

CONCLUSION

Increasing students' critical thinking skills that obtain a Brain Based Learning model is better than increasing students' critical thinking skills that obtain conventional learning models. Self Regulated students who get the Brain Based Learning model are better than increasing Self Regulated students who get a conventional learning model. There is no relationship between students' critical thinking abilities and Self Regulated students who obtain the Brain Based Learning model and students who obatain the conventional learning model.

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