

THE ANALYSIS OF THE THREE DIMENSIONAL MATERIAL OBSERVED FROM THE MATHEMATICAL CRITICAL THINKING ABILITY OF HIGH SCHOOL STUDENTS BY APPLYING BRAIN BASED LEARNING (BBL)

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Abstract

The background of this research was that the mathematical critical thinking ability of the students is still low. Therefore, the purpose of this study was to find out the misconceptions or difficulties of students in each indicator of mathematical critical thinking ability of high school students that learned Brain Based Learning (BBL) with material in the Three Dimensions. This research used a qualitative approach with the descriptive method. The subjects in this study were the students of XII MIPA 5 class or first grade of senior high school in Subang Regency which was on a total of 32 students. The instrument of this study consisted of a test instrument of mathematical critical thinking ability and a non-test instrument in the form of an observation sheet. The results of this study shows that students almost have difficulty in carrying out tests of mathematical critical thinking skills based on the indicators tested. The indicators of critical thinking ability tested include providing simple clarification (elementary clarification), making conclusion (inference), determining strategies and tactics (strategies and tactics) to solve problems, and making further clarification (advances clarification).

Keywords: Critical thinking, Brain Based Learning (BBL), Three Dimensions

Abstrak

Penelitian ini bertujuan untuk mengetahui miskonsepsi atau kesulitan siswa pada tiap indikator kemampuan berpikir kritis matematis siswa SMA yang diberikan pembelajaran *Brain Based Learning* (BBL) dengan materi Dimensi Tiga. Penelitian ini menggunakan pendekatan kualitatif dengan metodenya yaitu deskriptif. Subjek dalam penelitian ini adalah siswa kelas XII MIPA 5 yang berjumlah 32 siswa di salah satu SMA di Kabupaten Subang. Instrumen penelitian ini terdiri dari instrument tes kemampuan berpikir kritis matematis dan instrument non tes berupa lembar observasi. Hasil penelitian menunjukkan bahwa siswa hampir mengalami kesulitan dalam mengerjakan tes kemampuan berpikir kritis matematis berdasarkan indikator yang diujikan. Adapun indikator kemampuan berpikir kritis yang diujikan diantaranya adalah memberikan penjelasan sederhana (*elementary clarification*), membuat simpulan (*inference*), menentukan strategi dan taktik (*strategi dan taktic*) untuk menyelesaikan masalah, dan membuat penjelasan lebih lanjut (*advances clarification*).

Kata Kunci: berpikir kritis, Brain Based Learning (BBL), Tiga dimensi

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INTRODUCTION

Mathematics as a scientific discipline that clearly relies on thought processes, which are considered very good to be taught to students. Especially critical thinking, is very necessary for the life of students, so students are able to filter information, choose whether or not a need is needed, question the truth that is sometimes bogged down by lies, and everything that could endanger their lives. Moreover, in mathematics learning which is dominantly relying on thinking ability, it is necessary to foster students' thinking skills, especially critical thinking in order to be able to overcome the problems of mathematics learning which the material tends to be abstract.

According to Anderson in Lestari argued that: 'if critical thinking is developed, a person will tend to seek truth, divergent thinking (open and tolerant of new ideas), can analyze problems well, think systematically, curiously, mature in thinking, and can think independently' (Lestari, 2014).

Based on this opinion, it can be said that critical thinking skills must be possessed by every student, this is in line with the government's expectations contained in the Minister of National Education Regulation No. 23 of 2006 concerning Graduates' Competency Standards which states that: "competency standards for graduates of science and technology subject groups include seeking and applying information logically, critically, and creatively and showing the ability to think logically, critically, and creatively". Furthermore, the graduation competency standard related to mathematics learning is contained in the appendix of the ministerial regulation, which says having the attitude of respecting mathematics and its usefulness in life, having the ability to think logically, analytically, systematically, critically and have the ability to cooperate.

Recognizing the importance of mathematical critical thinking skills, the learning process should focus on developing critical thinking, but the effort escapes the attention of the teacher, based on a preliminary study conducted in one of the schools in Kabupaten Karawang. discussion, question and answer, practice and division of tasks.

In learning that is usually done in school, the role of students is still lacking, it is because a few students show active opinion and ask questions. Questions asked by students have also not shown questions that measure mathematical critical thinking skills related to the material being studied, when the teacher asks questions only a few students are able to answer the question. The answer to the question is still limited to memory, there is no student attitude that shows the answer to the analysis of the teacher's question. This can affect the students' mathematical critical thinking ability because thinking skills cannot develop on their own, it is in accordance with Zohar's opinion in Suwarma which states that: kritis critical thinking skills do not develop without effort explicitly and deliberately invested in their development' (Suwarma, 2009).

In addition to learning that affects students' critical thinking skills mathematically, other factors that influence it are students who are less familiar with the questions in the form of non-routine questions, so that when students are given the problem some students do not understand the purpose of the questions given, so that thinking ability critical students are still lacking, this is in accordance with the results of testing questions in measuring students' critical thinking skills carried out to students of class X. The form of a given question is:

Is the beam a prism? Explain your opinion!

Indicators of critical thinking skills that were tested on the question were giving a simple explanation according to Ennis in Lestari & Yudhanegara (Lestari & Yudhanegara, 2015). From the test results obtained 7 students or 8.4% of 83 students who were able to provide answers in accordance with the expected indicators. From the results of testing the questions performed, it can be seen that students' critical thinking skills are still low.

Therefore, by teaching critical thinking skills not only rely on left brain function, but also need support from right brain movement. Meanwhile, learning that is usually done by teachers generally places more emphasis on the use of left brain functions. According to Lestari stated that: "effective learning is learning that is able to balance all potential thinking of students". In other words effective learning is learning that is able to balance the potential of the right brain and the left brain(Lestari, 2014).

According to Ramlah & Marlina, he stated that: "some theories say that the right brain has the ability to be able to make people become geniuses, even in exact fields like mathematics. Dianne Craft, a homeschooling expert in America, is one of the experts who believes in the theory. Craft revealed that many homeschoolers know the fact of multiplication in a week after using learning by optimizing their right brain function" (Ramlah & Marlina, 2018).

In addition to this, Shichida in Japan also uses the students' right brain function in learning. The results obtained did not disappoint. Many Shichida students have the ability to exceed other students (Shichida in Ramlah& Marlina) (Ramlah & Marlina, 2018).

Based on the description above, learning is needed that can multiply the work of the brain and is expected to improve students' critical thinking skills mathematically. One learning that matches these characteristics is brain-based learning (BBL). BBL offers a concept to create learning oriented towards empowering students' brain potential (Jensen, 2008). Learning using the BBL method is able to improve individual abilities and skills as learning effects. This means that in Brain Based Learning the emphasis is on the student center.

Three main strategies that can be developed in the implementation of Brain Based Learning; first, creating a learning environment that challenges students' thinking skills by providing questions that facilitate students' thinking abilities based on Taxonomy Bloom. Second, creating a fun learning environment, such as doing learning outside the classroom, accompanying learning activities with music, conducting learning activities with group discussions interspersed with interesting games, and so on. Third, creating an active and meaningful learning situation for students (active learning), namely by building a learning situation that allows all members of the body to move optimally. Learning is a simple process that must be carried out and experienced by students to build knowledge and meaningful learning.

This is in accordance with the results of research conducted by Lestari in the results of his research which concluded that: "increasing the ability of mathematical critical thinking students who get Brain Based Learning learning is better than students who get direct learning" (Lestari, 2014).

METHOD

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In this study the approach used is a qualitative approach. This study aims to look at and analyze the difficulties of students in material Three Dimensions in terms of critical thinking skills of students who get Brain Based Learning (BBL) learning models and see the implementation of Brain Based Learning (BBL) learning models in one high school in Pamanukan District, Subang Regency class XII with research subjects taken one class, XII MIPA 5 with 32 students who are considered to represent the characteristics of the population under study. The test instruments in this study were instruments of mathematical critical thinking ability with subjective forms and non-test instruments, namely the observation sheet to see the effectiveness of the application of the Brain Based Learning (BBL) learning model. The procedure of this study is to provide test instruments to students, then the test results will be analyzed based on the level of difficulty of the students.

RESULTS AND DISCUSSION

Students' difficulties in solving the problem of mathematical critical thinking are seen from the average and the percentage of students answering each item. From the results of students, we can find out the difficulties of students in dealing with the problem of mathematical critical thinking ability in what indicators exist. The percentage of the answers to all students in each item is summarized in the following table:

Table 1. Average Percentage of Mathematical Critical Thinking Ability for Each Item

Question Number	Average Percentage of Classroom Student Answers with a Brain Based Learning (BBL) model
1	73,53
2	47,65
3	57,84
4	64,71
5	64,71

The average percentage of student answers in Table 1. shows that at numbers 1 and 2 are elementary clarification indicators, the percentage obtained ranges from 76-85% with good categories and $\leq 54\%$ with very few categories, meaning that the indicators are relatively easy and partly classified as very difficult for students. In question number 3, the indicator makes an inference, the percentage obtained ranges from 55-59% with a less category, meaning that the indicator is considered difficult for students. In question number 4, namely the strategy and tactic indicators to solve the problem, the percentage obtained ranges from 60-75% with sufficient categories, meaning that the indicator is (not too easy and not too difficult) for students. Meanwhile, in question number 5, namely the clarification advances indicator, the percentage obtained ranges from 60-75% with sufficient categories, meaning that the indicator is (not too easy and not too difficult) for students.

The students' difficulties in solving the problem of students' mathematical critical thinking skills are obtained from the results of the analysis of students' answers in answering the questions about the students' mathematical critical thinking skills which are described per indicator as follows:

Based on the average percentage of posttest data the students' mathematical critical thinking ability for indicators provides elementary clarification, namely 73.53% and 47.65%. The

percentage value is in the category less once, which means that the indicator is very difficult for students, especially in question number 2, the percentage is 47.65%. Difficulties of students in indicators giving elementary clarification can be seen in one of the student answers below.

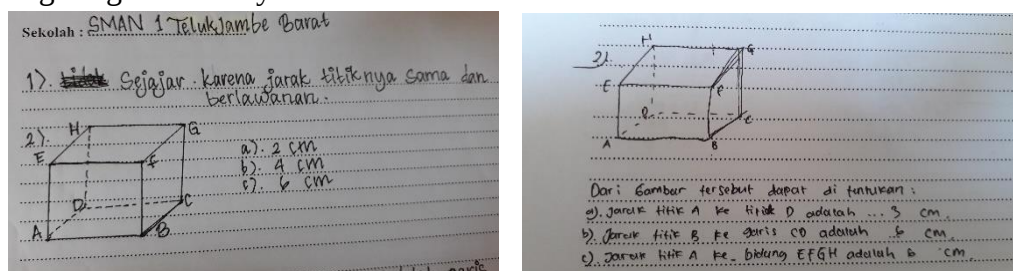


Figure 1. Answers to questions number 1 and 2 indicators provide simple clarification.

Based on Figure 1. above, the difficulties that occur in this indicator students can only answer questions without giving an explanation that supports the student's answer, there are some students who answer the question for the reason, but not accompanied by an explanation that supports the student's answer. Supposedly, on this indicator students are required to provide a simple explanation of the answers given by the students themselves in solving a problem in order to strengthen the answer to the right.

Based on the average percentage of mathematical critical thinking abilities students for indicators make conclusions (inference) in the experimental class that is 57.84%. The percentage value is in the category of less and less once, which means that the indicator is difficult for students in the experimental class and is very difficult for students in the control class. Students' difficulties in the indicator make an inference (inference) seen in one of the student answers below.

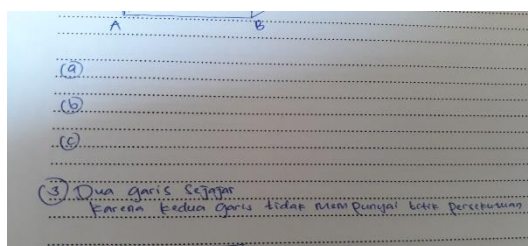


Figure 2. Answers to number 3 indicators make inferences.

Based on Figure 2. above, the difficulties faced by students are that students do not understand the intent of the problem so that students give unexpected answers, or students answer questions without giving a conclusion and an explanation of the students' answers given. Supposedly, on this indicator students are required to make a conclusion of the problem given in the problem, then explain the conclusion well.

Based on the average percentage of students' critical thinking skills mathematically for the indicator determines strategy and tactics (strategy and tactic) to solve the problem of 64.71%. The percentage value is in the sufficient and less category, which means the indicator is (not too easy and not too difficult) for students. Students' difficulties in the indicators determine strategy and tactics (strategy and tactic) to solve problems seen in one of the results of student answers below.

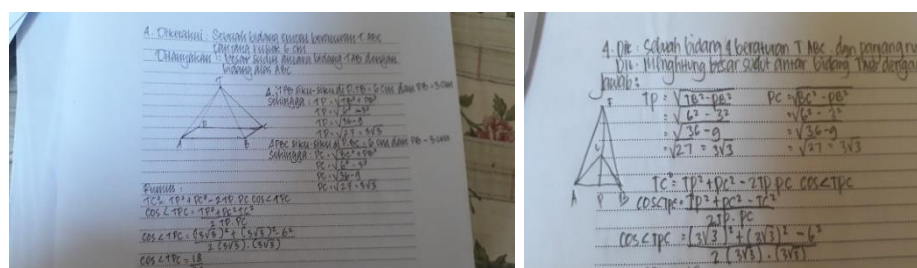
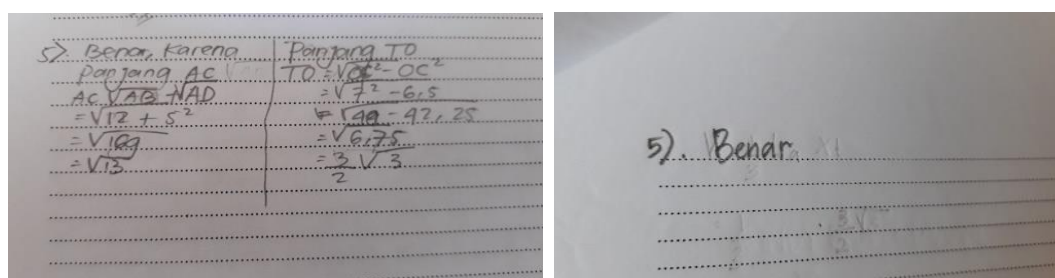


Figure 3. Answers to question number 4 indicators determine strategy and tactic to solve problems.

Based on Figure 3. above, the difficulties faced by students on this indicator are that students cannot determine what strategies should be used, so most students do not fill this question when the instrument test and pretest are carried out, but when posttest some students can understand the strategy and the right tactics in solving problems. As for other students who answer questions without the existence of strategies and tactics on the results of student answers. Supposedly, on this indicator students are required to be able to determine the right strategies and tactics in solving problems.

Based on the average percentage of posttest data mathematical critical thinking skills of students for indicators make further clarification (advances clarification) that is 64.71%. The percentage value is in the sufficient and less category, which means the indicator is (not too easy and not too difficult) for students. Students' difficulties in the indicators make further explanations (advances clarification) seen in one of the student answers below.



5). Benar karena

Panjang AC	Panjang AD
$AC = \sqrt{AB^2 + BD^2}$	$AD = \sqrt{AB^2 + OD^2}$
$= \sqrt{12^2 + 5^2}$	$= \sqrt{12^2 + 6.5^2}$
$= \sqrt{169}$	$= \sqrt{177.25}$
$= 13$	$= \frac{2}{2} \sqrt{3}$

5). Benar

Figure 4. Answers to number 5 indicators make further clarification.

Based on Figure 4. above, students' difficulties in this indicator are that students still do not understand the purpose and purpose of the problem or problem given, so always ask the teacher first about the purpose of the problem. After that students only answer the truth of the statement given without an explanation of the statement. Whereas, on this indicator students are required to be able to give a true or false statement in a statement accompanied by further explanation about the statement known on a problem.

The explanation of student attitudes in the learning process is described in each step of the Brain Based Learning learning model, as follows:

In the first stage, namely the pre-exposure stage, this stage provides a brain review of new learning before it is really explored further. Pre-exposure helps the brain develop better conceptual maps and prepare concentration to be ready for learning. In its implementation students learn the teacher's explanation of the learning objectives to be achieved so that later students can express their desires in learning. However, at this stage students look passive because they are accustomed to ordinary learning where students only follow teacher instructions. At this stage students are also invited to do a brain gym, which aims to make

students more concentrated so they are ready to carry out classroom learning. With the brain gym, students look active and enthusiastic, so they feel happy in taking part in mathematics learning.

The second stage is the preparation stage. At this stage, the teacher creates curiosity and pleasure in students. In the implementation the teacher performs apperception to students so that there is a question and answer about the previous material that has relevance to the material to be discussed. That way, raises students' curiosity about the material to be discussed. So, students ask questions that need to be solved regarding the material to be discussed. But in its implementation only a few students dared to ask questions and were actively involved at this stage.

The third stage is the stage of initiation and acquisition, this stage is the stage of creating a connection or when the neurons "communicate" with each other. In its implementation students divide the group in an orderly manner, then students receive student activity sheets (LKS) and observe LKS to prepare problem solving. In this step the students initially seemed enthusiastic because students rarely did mathematics learning in groups, but at the next meeting students began to complain about the LKS.

Then at this stage students pay attention to the teacher's explanation well about the material discussed at the meeting. Then, students read and observe in groups about the questions on the LKS. At this stage students carry out it in an orderly manner, there is a question and answer when the teacher explains the material, so that it can hone students' mathematical critical thinking skills. Furthermore, students prepare themselves to discuss and exchange ideas about the worksheets given by the teacher accompanied by classical music. Students look enthusiastic when the teacher plays classical music during the learning process, but at the next meeting students feel bored and want to change the type of music played, according to students classical music makes students sleepy during the discussion process.

In the fourth stage, namely the elaboration stage. The elaboration stage provides an opportunity for the brain to sort, investigate, analyze, test, and deepen the lesson. At this stage students conduct discussions with group friends to analyze the information available to complete the LKS. Students are faced with interacting with their own groups so as to arouse their curiosity to conduct investigations, and encourage students to build basic skills, explain simple explanations, to provide further explanation, determine the right strategies and tactics in solving a problem and make a conclusion in the presence guide from the teacher. This is in accordance with the indicators of mathematical critical thinking skills, so that with this activity mathematical critical thinking skills can be well trained. However, not all students are actively involved in the discussion on the implementation, there are some students who just keep quiet.

At this stage also one group presents the results of the answers in front of the class. Meanwhile, other groups respond and perfect what is presented, because each group has different solutions. Furthermore, students briefly watch motivational videos that are aired by the teacher, so students can be motivated to learn more actively in school.

The fifth stage is the incubation stage and inserting memory. This stage emphasizes the importance of rest and time to repeat. The brain learns most effectively from time to time, not at a time. So, at this stage students do relaxation accompanied by music.

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The sixth stage is the stage of verification and checking of student understanding. In this stage, the teacher checks whether the students understand the material that has been learned or not. This is done not only for the benefit of the teacher, but for the interests of students. Students also need to know whether they have understood the material or not.

The last stage is celebration and integration. This stage instills the importance of love for learning. This stage is made fun, cheerful, and fun. In the implementation of his teacher the students applauded happily to end the learning process that day.

The learning process will not always run smoothly. No matter how good the model, approach, strategy, method and technique are used, there must be flaws in it. Brain Based Learning learning model is an alternative solution in solving mathematical learning problems. The hope is that learning objectives, especially indicators of mathematical critical thinking skills can be achieved well. In general, the implementation of the Brain Based Learning learning process works effectively.

At the beginning of learning, students are still rigid in learning by using the Brain Based Learning model that uses the student center approach, which in the process students are required to be actively involved in the learning process, in addition there are stages of learning according to foreign students such as the presence of a brain gym at the beginning of learning, there is classical music playback during group discussions and relaxation, and video playback of student motivation at the elaboration stage. This is due to the habits of students in learning who only listen, and write on what is delivered by the teacher so it is difficult to express answers and argue.

Another problem faced by teachers is that the Brain Based Learning model requires more time than ordinary learning because the steps in this learning model are more than the usual learning and require a lot of time such as during brain gym, discussion, video playback motivation, and during relaxation.

However, learning mathematics using the Brain Based Learning learning model shows effective results. Besides being seen from the statistical results as mentioned in the previous section, the attitude of students in answering questions and opinions is better when viewed from the comparison of learning done with the model with ordinary learning. This is in accordance with the results of research conducted by Sari which explains that: "during the learning process with Brain Based Learning learning strategies students look enthusiastic and actively participate in solving problems given by the teacher in each group"(Sari, 2018).

This is because at the stage of initiation and acquisition until the elaboration stage, students are faced with interacting with their own groups to arouse their curiosity to conduct investigations, and encourage students to be able to build basic skills, explain simple explanations, to provide further explanations, determine strategies and tactics the right to solve a problem, and can make a conclusion with the guidance of the teacher. Thus students will feel happy and challenged, towards learning mathematics so that motivation in learning mathematics is greater and will ultimately affect students' mathematical critical thinking skills.

CONCLUSION

Based on the previous discussion, it was concluded that students almost had difficulty in doing tests of mathematical critical thinking skills based on the indicators tested. The indicators of critical thinking skills tested include elementary clarification, inference, strategy and tactics to solve problems, and clarification advances. Meanwhile, the implementation of the Brain Based Learning learning model for class XII high school students has gone quite well. However, not all students are actively involved in the learning process.

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