The effect of problem based learning on critical thinking ability in mathematics education

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Abstract. Critical thinking is considered necessary to everyone because the ability to think critically is one of the requirements of education process. Therefore, it is very important for students in various levels of education to learn to think critically. One of learning models that increases the critical thinking ability and involves students’ role actively is Problem Based Learning. The purposes of this experimental quantitative research were to examine the ability of students’ critical thinking, the students’ activity and the teachers’ ability in managing the learning process by using Problem Based Learning. The method of this study was Pre Experimental Design with one-group post-test design with no control class. The data were collected through the test items and the observation sheet. The results showed that the students’ critical thinking ability increase by using Problem Based Learning model on enumeration rule, both the students’ activity during the learning process and the teachers’ ability in managing the learning were in active category. Based on the results of the research and data analysis, the authors concluded that Problem Based Learning can increase the students’ critical thinking ability.

1. Introduction

Critical thinking ability is very crucial for students from various level of education. A person who has the ability to think critically will always analyze, examine whether the experience he meets has something to do with something he already know [1]. Therefore, the management of critical thinking ability is very important to be implemented in every subject, especially the Mathematics. Mathematics is one of the areas studied at every level of education, which is expected to train the students to learn to think in a practical, critical, realistic, creative and systematic way in taking a step [2].

Critical thinking in mathematics learning is crucial because of the fact that critical thinking is a form of thinking developed in order to solve problems, formulate conclusions, collect possibilities and make decisions appropriately. The critical thinker has the following characteristics: the problem is solved with a specific purpose; analyzing, announcing, grouping ideas based on facts / information; and conclusions to solve problems using correct means and arguments [3]. A person who thinks critically not only transfers the information that he gets from the teacher, but also can make the right questions and solve the problems given.
The reason for the students’ low critical thinking ability is due to the method of learning by memorizing. It causes the students to easily forget the information gained and they will not be able to apply it in everyday life. A proper teaching learning process is needed to be able overcome this problem. Education experts perform various steps in developing strategies and learning models to increase the students’ interest in the learning process, so that the quality of education can be improved.

One of learning models to improve students' critical thinking ability is the Problem Based Learning (PBL) model. Problem Based Learning (PBL) is a learning model that presents contextual, realistic, ill-structured, and precedes lesson material. Problem Based Learning (PBL) requires students to work in groups to solve real-world problems. By using problems to start a lesson, students will learn a concept and principle and solve the problem at the same time [4]. Problem Based Learning (PBL) is a model of student-centered learning by presenting students various real-life problems [5]. Students are able to use critical thinking skills to solve the problem in various ways with different outcomes. Previous study demonstrated that problem-based learning can improve the high school students’ critical thinking ability [6].

Critical thinking ability mainly have 5 indicators, but this study only uses 3 of them. The first indicator is Elementary Clarification, which focuses on what is known and what is the main point of the problem before deciding to choose the right strategy or procedure. The second is The Basic for Decision that determines a decision by including the right reasons. The last is Inference which means drawing conclusions [7].

2. Method
In this study, the author used Quasi Experiment design type with one-group post-test design. The design was used by the author because this study did not use the control class. One class was given learning activity of enumeration rules by applying Problem Based Learning model (PBL) and then measuring its dependent variable (Post-Test), without any group or class of comparison. As for the population in this study was students of class XI, one of high schools in Banda Aceh.

This study used a critical thinking ability test sheet and observation sheet. The data collection conducted by the author in this study were: test, observation on students’ activity and teacher’s ability. The data collected in this study was the data of students' critical thinking ability, data of students’ activities during the learning process and data of teacher’s ability in organizing the learning.

Scores of all students on each aspect were summed and converted into percentages. After that, the scores were categorized into very high, high, medium, low and very low [8]. The test questions given to students were some of the enumeration rules in the form of a description or essay. The scoring of this description form was based on the scoring guideline according to the student's answer key [9].

3. Result and discussion
The study applied the Problem Based Learning model in learning Mathematics about concept of enumeration rules. The study was conducted for four meetings. In this study, the data analyzed was the students’ mathematical critical thinking ability from the posttest score. The data was calculated by N-Gain value from the students’ critical mathematical thinking. Table 1 demonstrate the descriptive statistic of the posttest score and N-gain in experimental class.

|        | N  | Xmin | Xmax | \(\bar{x}\) | SD  |
|--------|----|------|------|-------------|-----|
| Posttest| 21 | 63.33| 100  | 78.71       | 12.65|

Table 1 demonstrated the distribution of class sample based on indicators of critical thinking ability. Hypothesis testing was done by right side test at level \(\alpha = 0.05\) using t test [10]. After doing the test, it was found that t value equal to 4.96 bigger than t table. It means the research hypothesis is accepted. Therefore, students' critical thinking skills after being given learning using Problem Based Learning model had increased.
The average score of students’ critical thinking skill was 78.71. Considering the critical thinking level, they were medium. It demonstrated that the average score of students’ critical thinking skills exceeded the value of mathematics KKM that is 65. Based on observations during the learning process, students’ participation in learning process was fairly significant. The students were more active in learning and expressing opinions. By using Problem Based Learning model, it was also giving great enthusiasm to students in delivering material on learning mathematics.

Cooperative learning was not only improve students’ learning achievement, but also increased the enthusiasm and awareness among fellow students. In this learning they were guided to be able to communicate well so that the ability to argue will increase. It was in line with a theory by Duch that Problem Based Learning is a model that exposes learners to the challenge of "learning to learn". Students actively work together in groups to find real-world solutions. The problem was designed as a reference for learners to formulate, analyze, and solve it [11].

Based on the results of data calculations of students’ activity during the learning, the percentage obtained on the learning process by using Problem Based Learning model on the enumeration rules showed that the learning model caused the students to be active. Based on the result of study, it was found that students’ were active during learning process. This is in accordance with the percentage of ideal time agreement that had been established in every aspect of observation of student activity was within the tolerance limit of 5%. The time were mostly used to solve problems or to find ways to solve problems / think together, and listen to or pay attention to teacher / friends’ explanations. It proved that learning by using Problem Based Learning model enabled students to be active, so that students have many opportunities to understand problems and find ways to solve problems.

The data from observation on the ability of teacher on managing the learning showed that the teacher’s score in every aspect during the two meetings is ranged from 3 to 5, then this score reached the category of teachers’ ability to manage learning into adequate, good and excellent based on the criteria given, so the ability of teacher to manage learning as a whole were good.

4. Conclusion
Based on the study results and data analysis, the author concluded that: The students' critical thinking skills increased after Problem Based Learning model was applied. Students’ activity during the implementation of Problem Based Learning model on the material of enumeration rules were in the active category. The ability of teacher during the implementation of Problem Based Learning model on the material of enumeration rules were in good category. The application of a model or method of teaching was supported by other factors such as adequate facilities, the level of student ability and the level of teacher’s ability in applying the model, without the support of these factors then the results obtained would not be maximized.

Based on the study results on the conclusion above, there are some suggestions to improve the education quality, such as: Problem Based Learning (PBL) needs relatively longer time, so the author must organize the learning time well to avoid a boredom class. Not all of Mathematics materials can be taught using Problem Based Learning model, so it is necessary to determine an appropriate materials when the author want to use Problem Based Learning model. It is expected that the Mathematics researchers can choose an effective and efficient learning media so there will be not much time wasted. To other authors who are interested to study about the critical thinking ability, it is suggested to do the interview to get an optimum research result.

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