CRITICAL THINKING SKILL THROUGH PROBLEM POSING POST-SOLUTION LEARNING: CUBE AND BAR TOPIC

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Abstract

According to data obtained from one of the mathematics teachers in one of the junior high schools in West Nusa Tenggara, Indonesia, the learning outcomes of students in grade VIII B were still below the minimum completion criteria set by the school. The observation which conducted in class VIII B indicated that students' critical thinking ability was still low. The purpose of this research was to analyze the effect of Problem Posing Post Solution on students' critical thinking ability on cube and bar's theme through: analysis of student response in cycle I on each indicator of critical thinking ability used and analysis of student response on cycle II after the reflection from cycle I was implemented. The indicators of student's critical thinking ability which were used in this research were asking correctly, checking the validity of arguments or statements and identifying relevant and irrelevant data. This research was classroom action research within two cycles. The subjects of the research were students of class VIII B in school concerned consisting of 19 women and 7 men. Student response data for each indicator of critical thinking ability was obtained from student worksheet, observation, and interview. In this research, there was eight student group created from 26 students. The result of this research was 1) According to indicator asking correctly: there was an increasing number of groups that could make the problem which involving the overall situation given, from two groups in cycle I to seven groups in cycle II; 2) according to indicator checking the validity of arguments or statements: there was an increase in the number of groups that could identify errors in the process of solving problem from 0 groups in cycle I to 1 group on cycle II, 3) according to identifing relevant and irrelevant data in problem: in cycle I, student could just identify the problem has enough or fewer data to be able to solve, but in cycle II, student could identify the problem has enough, less, or exceed data to be able to solve. From students 'responses in each cycle showed that the implementation of Problem Posing Post-Solution was able to improve students' critical thinking ability.

Keywords: critical thinking, problem posing post-solution, reasoning, cube and bar, classroom action research

1 INTRODUCTION

According to data which was obtained from one of mathematics school teacher in one of the junior high school in West Nusa Tenggara, student average score in odd semester final exam still below the minimum completion criteria set by the school. The observation which was conducted in class VIII B showed that student critical thinking ability still low because students were not able to ask correctly, determine the correctness of problem solution given by the teacher at the whiteboard, and determine whether the problem has less, enough or exceed data to solve that problem. That three indicators of critical thinking ability are the factor which a correlation with student ability to solve the problem including the problem in the odd semester final exam (Arikan & Unal, 2014,p.23 ; Cai& Hwang, 2002, p. 401; Abu Elwan, 2000, p.67; English, 1997, p.83).

The learning model which is able to create a condition to make student asking correctly, checking the validity of arguments or statements and identifying relevant and irrelevant data in a problem allegedly help students to improve their critical thinking skills. Such learning is a characteristic of learning Problem Posing.

1.1 Critical Thinking Ability

Critical thinking is a mental process to make a responsible decision from reliable information (Ennis, 1985, p.46). Zoller (1999, p.583) explain critical thinking as reflective, rational, and logical thinking in order to make a decision. Baron and Stenberg (in Hendrian and Sumarmo, 2014, p.41) state the indicator of mathematic critical thinking ability are focus on problem, analyze and classify problem, answer, and argument, consider reliable source, observe and analyze deductions, induce and analyze inductions, make an explanations, conclusions, and hypotheses, make a judgments and establish actions. Those indicators are in line with Ennis (1985, p.45) who include (a) elementary clarification which is focused on problem, analyze the argument, clarify question, answer, and argument with relevant argument, (b) basis support related to considering reliable source, do observation then make a judgement, (c) inference which related to deduction, induction in order to make a judgement, (d) advanced clarification related to defining term, and identified an assumption, (e) strategy and tactics which is determining action. In this research, mathematical thinking ability is student ability to make a responsible decision which has three indicators, that is checking the validity of arguments or statements, the validity of arguments or statements, and asking correctly.

1.2 Problem Posing

Problem Posing is a model which emphasizes the student activities to form a question (Budiasih and Kartini, 2002, p. 203; Suryosubroto, 2009, p. 239). Silver and Cai (1996, p. 523) classify Problem Posing into three acts, that is pre-solution posing, within solution posing and post solution posing. In this study, it focused on the task of post-solution posing. Problem Posing post-solution is an activity to form a question by modifying the data or the goal of the previous question.

Previous research about problem posing related to forming a question was done among others by Rahman and Ahmar (2017, p. 7) who investigated the type of problem that student make according to their cognitive level, Koichu and Kontrotovich (2013, p.71) who investigated the type of problem that students make in Biliar Task case, and Silver and Cai (1996, p.521) who investigated about arithmetic problem which high school student able to make. Arican and Unal (2015, p.23) focused their study on problem posing ability of student in grade eight in Turkey, while da Ponte and Henriques (2013, p.145) focused their study on the undergraduate student. Problem posing in relation to student critical thinking ability was done by Rustina (2016, p.41) who found that problem posing could improve student critical thinking ability on Calculus III course. Research by Rustina did not focus on the type of problem posing used in the research. Furthermore, the research which focused on one type of problem posing was done by Sengul dan Katarinci (2015, p.1983) who evaluated free problem posing learning on the prospective teacher.

1.3 Aim of Research

The aims of this research were to analyze the effect of problem posing post solution to student's critical thinking ability through analysis of student's response in the cycle I in every critical thinking ability's indicator and analysis of student's response in the cycle II after the reflection from the cycle I was implemented.

2 RESEARCH METHOD

2.1 Subject

The subject in this research was 26 student in class VIII B (19 females, 7 males) in one of junior high school in West Nusa Tenggara, Indonesia. The student in class VIII B became the research subject because of their score in odd semester final exam still below the minimum completion criteria set by the school.

2.2 Research Design

This research was classroom action research. According to Sanjaya (2013, p.149), this kind of research is a process of assessing learning problems in a classroom through self-reflection and attempts to solve the by performing a planned action in real situations and analyzing each effect of the action. In line with this, Suyanto (1997, p.4) revealed that classroom action research is a reflective study by taking certain actions to improve the practice of learning in the classroom. Thus, classroom action research is a reflective study that examines classroom learning issues and takes planned action as an effort to improve classroom learning practice.

In this research, there was two cycle to match the material needs in cube and bar topic and there were five steps, that is planning, doing, observing, evaluating and reflecting. in doing and observing step, the students learned using problem posing post solution learning. The steps of that learning were: 1) student were given Student Worksheet in order to give student ealry insight of the types of questions which can be made; 2) students were asked to make two types of problems, the first one was a problem made similar to the problem on Student Worksheet, and the second one was a problem based on the situation given by teacher that can be seen in Table 1, 3) the students made the solution according to the problems that had been made, 4) the problem and the solution were corrected by another group, 5) the correction results were presented by several groups. The data which will be evaluated are student response in accordance with indicators of critical thinking ability. The data was obtained from the observation, interviews with students and student worksheets in each cycle. The evaluation results were used as materials for reflection at cycle I.

	Table 1. Two Types of question made by students				
Cycle	The Type of Question				
I	 Post-solution posing "Make a question similar to the previous question in students worksheet by changing data (name of the subject, the number in question, or the goal of the question) in question. Write your question on the first sheet and the solution in the second sheet! 				
	 Pre-solution posing "Yulia want to make a cube frame from wood. The price of the woods is Rp. 5.000 per meter. Yulia has money Rp. 100.000. Make a question based on Yulia's situation. Then, make the solution from your question! 				
II	 Post-solution posing "Topan has a cube shaped-gift with perimeter 28 cm. Find the surface area of two similar gifts! Make a question similar to that question above by changing data in question (name of the subject, the number in question, or the goal of the question)! Write your question on the first sheet and the solution in the second sheet!" 				
	 Pre-solution posing "Showcase (3m x 2m x 1m) will be fitted with glass. The price of glass per m2 is Rp. 10.000. Money owned Rp. 500.000. Make the problem and its solutions based on the given situation. Write down your problem on the first sheet and the alternative to completion on the second page!" 				

2.3 Data Coding

Data encoding based on the critical thinking ability indicator used is the ability to ask well, the ability to check the validity of a statement, and the ability to identify relevant and irrelevant data on the question. The coding of data by indicator can be seen in Fig. 1, 2 and 3.



Fig. 1 Data coding for asking correctly





3 RESULT AND DISCUSSION

After the research was conducted in two cycles, the results which was obtained were student responses on each indicator of critical thinking ability, the results of reflection from the cycle I I, and student response on the second after the results of reflection was implemented by teachers, as follows :

3.1 The ability to Asking correctly

In cycle I, students were asked to make two questions and the solution of those problems. The first problem was the problem-posing post-solution type that students made a problem based on the previous problem in the student worksheet by replacing the information or the purpose of the problem. The second problem is the type of problem posing pre-solution that students are asked to make a problem based on a situation.

3.1.1 The Type of Student Question in the Cycle I

Problem posing post-solution in the cycle I

The whole student's group responded to the problem-posing post-solution by making the problem with the expected and appropriate context. Each group made a problem similar to the previous problem by changing the name of figures and numbers on the matter. The students did not make any changes regarding the type of problem objectives. The interesting thing was although the students dis not changed the type of problem objectives, there was one group who split the problem into parts which were previously related to the next problem, compared to most other groups that presented one problem without split the problem.

According to the interviews, the reasons for the group to make the problem in detail was in order to map the steps of working on problems and facilitate the work of the next problem. While the reasons for the group not specifying the problem were because of the split problem had been included in the problem solved so it was not necessary to break the problem into several parts.

Problem posing pre-solution in the cycle I

According to situasion given, students response can be classified as :

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igs erve	The appropriateness of the data which is	Conformity question	The number of solution	The num

Table 2. Students Response in problem posing pre-solutin in cycle I

Things observe d	The appropriateness of the data which is provided in question and the goal of question	Conformity question with student worksheet	The number of solution step	The number of groups who responded
Student respons e	Student made a question which all the information in the question was used to solve the problem	Different from student worksheet	4 or 5 steps	2 groups
	Student made a question which not all the information in the question was used to solve the problem	Similar to student worksheet	2 until 4 steps	6 groups

In this type of problem, students generally made a problem by writing down all the information on the given situation. However, only two of the eight groups used the whole data which is provided in the question to solve the problem created. Furthermore, the problems created by those two groups are different from the problem in student worksheet and have more step of the solution than those made by the other six groups.

According to the interviews, the two groups who used the whole data which is provided in the question, made different problems from student worksheet to adjust the given situation on the problem and tried to use as much data as possible on the problem. Problems contained in the student worksheet was used as a reference to develop other problems according to the needs of the given situation. While the other six groups argue that they still stick to the type of problem on the student worksheet regardless of the situation given to

the new problem. The six groups still did not understand the function of the given situation to make the problem so they were not able to develop new problems from the given situation.

3.1.2 Reflection from Cycle I in Asking Correctly

According to student's group work on the worksheet, interview, and observation, the results of reflection are obtained as follows. In the cycle I, the student was not able to develop a new question because students were not yet accustomed to developing new problems from the given situation and students have minimal knowledge about the types of questions that can be made from a situation. The solution offered was give the students various type of question by means of questioning and answering after students do student worksheet.

3.1.3 The Type of Student Question in The Cycle II

By reflecting on the results obtained in cycle I, the teacher added a step in the learning that after the student worksheet was distributed and done by the students, the teacher asked the students about another question which can be made from the situation in the student worksheet question. Then the students are asked to make two problems.

3.1.4 Problem Posing Post-Solution in The Cycle Ii

In this cycle II, students were asked to make a problem based on similar problems on the student worksheet. Before the new question was written by student's group, there are some groups who did not use a multiple of four as the circumference of the rubric. Due to difficulties encountered during processing, the group changed the circumference of the rubric with a multiple of four. Moreover, according to the changing of the situation from the previous question, there were two groups of eight groups who change the name of the person and the goal of the question. In the example given in the student worksheet, only a problem of how much surface of the gift was presented. Meanwhile, these two groups changed the goal of their question to ask the truth of a statement as can be seen in Fig. 4.

abre Soal : (1) Noxi memiliki bubik berbentuk bubus. teliling alasnya 28 cm. Novi men punyai 10 rabik benarkan lugs permukaan Public Nori adalah + 2.340 Cm²

Novi has a rubric shaped-cube. The circumference of the base is 28 cm^2 . Novi has ten similar rubrics. Is that true that the surface area of whole rubrics are 2.940 cm²?

rubik berbentuk kubus keliling alas: 28cm n: Benaribah Waspernaulogan brubik Eikus alalah

A rubric shaped-cube has base's circumference 28 cm².. Is that true that the surface area of a rubrics is 108 cm²?

Fig. 4 Example of question which was made by student's group by changing the goal of the question

The first problem in the picture has the correct answer. Based on interviews and observat The first problem in the picture has the correct answer. Based on interviews and observations made by the researcher, before making the problem, the group of students first found the surface area of the rubric with the circumference of the base 28 cm then consider the surface area of the ten cubes that would be written on the question.

3.1.5 Problem Posing Pre-Solution in the Cycle II

According to situasion given, student's respon can be classified as below.

Table 3. Student's response in problem posing pre solutin in cycle II

Things observ ed	The appropriateness of the data which is provided in question and the goal of question	Conformity question with student worksheet	The number of solution step	The number of groups who responded
Stude nt respon se	Student made a question which all the information in the question was used to solve the problem	Similar to student worksheet	4 or 5 steps	7 groups
	Student made a question which not all the information in the question was used to solve the problem	Similar to student worksheet	3 steps	1 group

If Table 3 is compared with Table 2, there were an increase of as many as five groups have been able to make a problem by utilizing the overall situation given. Students stated that the question and answer which was did after doing the student worksheet help them to make the problem by looking at the given situation.

3.2 The Ability to Checking the Validity of Arguments or Statements

The student's ability to checking the validity of the argument was seen from the student's response when checking the solution of a problem created by another group. Students checked every step of the problem solving and comment about the correctness of the problem solving that has been made.

3.2.1 Student Response When Correcting Problem-Solving Steps In Cycle I

In the cycle I, problem and the solution of the problem were exchanged to other groups to be corrected. Corrected problems and solutions consisted of two problems: post-solution and pre-solution. From the observation, the result was obtained that the whole group did not found any errors in the problem-solving steps made by other groups. However, after the teacher checked the solution step, some errors or omissions are found in the solution step, for example, in the completion step, there is no written conclusion and miscalculation. According to observation, students were still less thorough to see the missing step in problem solution which was made by another group because the problem which each group corrected was different from the problems they made. Particularly in the problem-posing pre-solution section, there were two groups that made the problem which different from the problem in student worksheet. This cause the group who did the correcting must first learn the problem and solutions provided. With a relatively short time to correcting, students found it difficult to learn the problem and determined the wrong step in problem-solving.

3.2.2 Reflection from Cycle I in Checking The Validity of Arguments or Statements

The problem which was obtained in the cycle I was students still less thorough to see the missing step in problem solution which was made by another group. This was because there were various questions that exist and the problem which each group corrected was different from the problems they made. To solve the problem, in the cycle II, the teacher will choose a specific problem to became sample problem in Post-Solution Problem Posing. Thus, the problem created by students would not be too different so as to facilitate the time of correction.

3.2.3 Student Response When Correcting Problem Solution Steps in Cycle II

In the cycle II, the whole student made a similar problem to a problem in student worksheet choosen by the teacher. From the correction done, there was one group that found the error in the problem solution step as presented in Figure 5. According to interviews conducted with the group who found the error in the problem

solution step, the problem was similar to their problem so that made the correction process became easier.



Fig. 5. The example of student work in correcting the problem solution step in the cycle II

3.3 The Ability to Identifying Relevant and Irrelevant Data in The Problem

3.3.1 Student Response When Identifying Relevant and Irrelevant Data in the Problem in The Cycle I

In the cycle I, seven out of eight groups were not able to determine whether the data was used in the problem solution or not. According to interview, those seven groups only focused on the data in problemsolving and ensure that all the data which was used in problem solution contained in the question. In addition, there was one group who can identify the problem as the problem which has lack of data so they can determine the right solution for that problem.

3.3.2 Reflection from Cycle I in Identifying Relevant and Irrelevant Data in the Problem

According to observation, interview, and student work on student worksheet, the problem in this indicator was students were not able to identify the type of question that has exceed information. The reason was the student too focused on whether the information was enough or not to solve the problem given. To solved that problem, the teacher would give example and non-example about the problem which has exceed and not exceed data in the cycle II.

3.3.3 Student Response When Identifying Relevant and Irrelevant Data in the Problem in the Cycle II

In second cycle II, seven out of eight groups made a pre-problem posing using all the situation given so that seven group made problem which has enough data to solve that problem. Only one group who did not use all the situation given, so that they made a problem with exceed data. According to interview, the students state that when the teacher gave example and non-example problems which have exceed and not exceed data, it the student to made a problem more thoroughly.

4 CONCLUSION

Student's response to problem posing post-solution learning according to three indicators of critical thinking was:

1) According to indicator asking correctly: there was an increasing number of groups that could make the problem which involving the overall situation given, from two groups in cycle I to seven groups in cycle II;

2) according to indicator checking the validity of arguments or statements: there was an increase in the number of groups that could identify errors in the process of solving the problem from 0 groups in cycle I to 1 group on cycle II,

3) according to identifying relevant and irrelevant data in the problem: in cycle I, the student could just identify the problem has enough or fewer data to be able to solve, but in cycle II, the student could identify the problem has enough, less, or exceed data to be able to solve.

From students 'responses in each cycle showed that the implementation of Problem Posing Post-Solution was able to improve students' critical thinking ability.

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