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Improving The Mathematic Critical And Creative Thinking Skills In Grade 10th SMA Negeri 1 Kasihan Bantul On Mathematics Learning Through Problem-Based Learning

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Abstract

This research aims to describe: (1) implementation of the PBL that improve the mathematic critical and creative thinking skills and (2) improvement the mathematic critical and creative thinking skills of students with PBL. The research is Classroom Action-Research, which is consisted of two cycles. The research was conducted in SMA Negeri 1 Kasihan Bantul in August until December 2010. The subjects were all of the students in class X D which consist of 33 students. The data was obtained from observation sheet, field notes, documentation, interviews, and tests of critical and creative thinking skills in mathematics learning. The data validation has done by triangulation. The results shows that the implementation of the PBL which can improve the students' mathematics critical and creative thinking skills consist of four steps: (1) *engagement*, (2) *inquiry and investigation*, (3) *performance*, and (4) *debriefing*.

Keyword: critical thinking, creative thinking, problem based learning

I. INTRODUCTION

In this globalization, all parties enabling to get information quickly and easily from various sources. For that reason, humans are required to have the ability to acquire, select, manage, and follow up information to resolve problems that occur in the life. It demands that we have the critical and creative thinking skills to confront the problems and solve them.

Critical thinking according to Johnson (2007: 183) is a process directed and clearly used in mental activities such as problem solving, decision making, persuading, analyzing assumptions, and conduct scientific research. Aspects of critical thinking according to Ennis (Lipman , 2003: 57) are focus, reasons, inference, situation, clarity, and overview. The characteristics of people capable of critical thinking are open-minded, humble, independent-minded, and highly motivated.

Creative thinking by Utami Munandar (1999: 48) is the ability to find many possible answers to a problem, where the emphasis is on quantity, efficiency and diversity of answers based on data or available information. Aspects of creative thinking by Evans (1991: 51) and Guilford (1967: 138) are fluency, flexibility, originality, and elaboration. The characteristics of people who have creative thinking are open to new

experiences, flexible in thought, and independent.

Critical and creative thinking skills are very important for students. This is because critical and creative thinking skills allow students to understand the problem systematically, the challenge in an organized manner, formulate innovative questions, and designing original solutions (Johnson, 2007: 183). Moreover, according to Zaleha I. Hassoubah (2008: 13) by critical and creative thinking skills the students can develop them in making decisions, judgments, and solve problems. Ability to make decisions and solve the problems often encountered when these will reach adulthood. Given the importance of critical and creative thinking skills, there needs to be an activity that can accommodate both the development of such capabilities.

Unfortunately, most people think that critical and creative thinking skills rather than a habit of thinking that should be instilled at an early age. They assume that the critical and creative thinking skills are something that is difficult and can only be done by genius people (Johnson, 2007: 188). In fact, the critical and creative thinking skills are something that can be done by everyone. Mathematics learning activities is one of the ways to develop critical and creative thinking skills. That is because the purpose of learning math in school according to the Depdiknas (2003) are (1) train the way of thinking and reasoning in drawing conclusions, (2) develop a creative activity involving imagination, intuition, and discovery to develop divergent thinking, original, curiosity, making predictions and expectations, trial and error, (3) develop problem-solving skills, and (4) develop the ability to convey information and communicate ideas.

Mathematics is one of the subjects taught from basic education. That is because mathematics has a very important role in human life. Students need math to meet the practical needs and solve problems in everyday life, for example count, collect, process, present, and interpret the data. Moreover, mathematics is also required students to be able to follow the math further, to help understand other areas of study, and enable the students to think logically, critically, practical, and positive attitude and also creative spirit (Erman Suherman et.al, 2003: 60).

Based on the observations before the study was conducted in class XD SMA Negeri 1 Kasihan Bantul in August 2010, the critical and creative thinking skills cannot be developed well in mathematics learning activities. This is because teacher is generally too concentrated on completing the exercise the routine problems by applying

the formula. Learning activities are centered on the math's teacher, using the lecture method, students are passive, oriented at a correct answer, and do not explore the many ways of solution. Such learning activities according to Tatang Herman (2006: 3) does not accommodate the development of mathematic critical and creative thinking skills but only accommodate low-level thinking skills, such as remembering and applying the formula. In addition, based on results of tests before the study was conducted to note that the mathematic critical thinking skill still in low category at 60.94%, while the mathematic creative thinking skill is 46.01% and very low category.

Based on the problems that arise, particularly related to the practice of mathematics learning in the classroom and the importance of improving the students' mathematic critical and creative thinking skills, then the innovative efforts to solve them should be done immediately. One alternative that can overcome these problems is to improve the quality of learning through Problem-Based Learning (PBL). The main focus in efforts to improve the quality of teacher learning is positioned as a planner and an organizer of learning so that students have opportunities to understand and make sense of mathematics through the learning activities.

Problem-based learning is a learning model that is designed and developed to develop problem-solving ability learners. Problem solving is done by the pattern of collaboration and the use of higher-order thinking skills: the ability of analysis-synthesis, and evaluation or use abilities in order to solve a problem (Bloom & Merrill (Yatim Riyanto, 2009: 285)). Characteristics of the PBL are include (1) position the students as self-directed problem solver through collaborative activities, (2) encourage students to be able to find problems and elaborate by filing allegations and the solution plan, (3) facilitating the students to various alternative solution and implications, as well as collecting and distributing information, (4) train students to skillfully present the findings, and (5) familiarize students to reflect on the effectiveness of their thinking in solving problems. By applying PBL activities the learning activity to be that can accommodate the development of mathematics critical and creative thinking skills.

Based on the background have been described there are problems in class XD SMA Negeri 1 Kasihan Bantul that can be identified, i.e.: (a) public awareness of the importance of students' mathematic critical and creative thinking skills is still low, (b) the category mathematic critical thinking in is low, while the mathematic creative

thinking category is very low, (c) mathematics learning activities not accommodate the development of mathematic critical and creative thinking skills; (d) The PBL model that can develop the mathematic critical and creative thinking skills undeveloped. Based on these problems and the solutions proposed, the proposed formulation of the problem are (1) how the implementation of the PBL to improve the mathematic critical and creative thinking skills?, and (2) how to increase the mathematic critical and creative thinking skills by the PBL?.

The purpose of this study is generally to improve the quality of learning mathematics through PBL in terms of mathematic critical and creative thinking skills. Specifically, the study aims (1) describe the implementation of the PBL that enhance the students' mathematic critical and creative thinking skills, and (2) describes the increased students' mathematic critical and creative thinking skills with PBL.

II. RESEARCH METHOD

The research was conducted in SMA Negeri 1 Kasihan Bantul in August until December 2010. The subject of this study was class X D SMA Negeri 1 Kasihan Bantul in the first semester of the school year 2010/2011. The objects of this study were (1) model of PBL, (2) the mathematic critical thinking skill, and (3) the mathematic creative thinking skill.

This research is Classroom-Action Research which is consisted of two cycles. The first cycle includes material Simultaneous Linear Equation in Two Variables and the second cycle includes material Simultaneous Linear Equation in Three Variables.

The learning activity of each cycle is carried out through four stages. Implementation of the action research class at each cycle is as follows.

a. Plan

Planning is conducted jointly by the lecturer and teacher of Mathematics. Activities undertaken in this section are (1) planning the implementation of PBL model to overcome the problems that have been identified as outlined in the Lesson Plan, (2) develop worksheets that correspond with the implementation of PBL model, (3) prepare the final written test cycle and rubrics are used, (4) planning data collection techniques, and (5) to train teacher in implementing the PBL learning model.

b. Action

Implementation of the action is learning process in classroom that is implemented in problem-based learning through the following stages based on Sears (2002: 12-13) and Pierce & Jones (1998: 71):

1) **Engagement**. The teacher gives understanding to the students that they will learn independently as individuals or in groups. After worksheet distributed, students identify the knowledge they already have related material. Furthermore, students are given time to understand the main problem and examine the nature of the problem. Students gather information that can help find solutions to individual problems. Furthermore, students are independently working on pieces of self-learning.
2) **Inquiry and investigation**. At this stage the teacher encourages students to explore the many ways to get solutions to problems on sheets of the main problems and self-learning. After students are given sufficient time to discussions with the group that has been formed by the teacher. In groups students discuss the solution to the problems posed by each member of the group and prioritize the solutions to problems that will be presented to the class.
3) **Performances**. Students prepare a media presentation of the results of group discussion and present in front of class. At the presentation the students who are not currently a presenter can give questions, comments, and suggestions for the group's presentation.
4) **Debriefing**. Teacher and students reflect on the results of group discussions that have been presented. Teacher and students assess what methods are more precise and easier to resolve problems that exist in worksheet.

c. Observe and Evaluation

At this stage carried out observations of teaching and learning process that is underway to determine the learning activities of students and to learn about the constraints faced in implementing the learning. At the end of each cycle is measured against the mathematic critical and creative thinking skills and the opinions of teacher and students about learning applied.

Data obtained from this action research consists of two types, i.e. quantitative and qualitative data. Quantitative data in the form of mathematic critical and creative thinking skills derived from student test scores, while the qualitative data in the form of student learning activities and opinions of teacher and students of the interview.

d. Reflect

Reflections on the action are performed by collecting the results of evaluation of students' activities and test results. Next, review the results obtained and the barriers or weaknesses encountered during the learning for the alternative solution found in order to improve the next cycle.

III. RESULT AND DISCUSSION

The observations of the learning process in cycle I show that the teacher is still too much to give an explanation for the material to students. Independent learning activities that should be done individually cannot be done because there is no instruction from the teacher to work worksheet individually. At group time, students form groups independently so that students tend to cluster with friends who liked it. Discussions in the group work well. However, some students still seemed shy to ask questions and express opinions. Students also have not many questions when the class presentation. Students not explore the many ways to do the problems in worksheet. Students work on worksheets in a hurry so the workmanship tends to not move coherently.

A mathematic critical thinking skill of students in cycle I see from the average percentage is 82.50% of test results or high category. Reviewing from every aspect that are: 88.64% of focus aspect, 74.24% of clarity aspect, and 84.60% of inference aspect. A mathematic creative thinking skill of students seen from the average percentage is 73.82% of test results or medium category. Reviewing from every aspect that are: 94.44% of fluency aspect, 51.01% of originality aspect, and 76.01% of elaboration aspect.

Repair actions performed on the second cycle refers to the shortcomings that are still found in cycle I. Actions that have been well be maintained. The corrective action is teacher give understanding to the student that they must understand the material independently, worksheet done individually first, and then work in teams. Students are encouraged to explore the many ways in the solution map of the main problems in worksheet. It is easier for students to discuss the results of they work with their group.

Learning activities of students in a discussion group on the second cycle has been going well and there is an increase from cycle I. Number of students who ask or answer questions is increase than the previous cycle. Smart students were guiding his

friends who have less academic ability. Students are able to explore many different ways as well. Students are completing the main problem carefully so that they can present the solving steps are become more coherent.

The mathematic critical thinking skill of students in second cycle is seen from the average percentage is 89, 23% of test results or very high category. Reviewing from every aspect that are: 93.43% of focus aspect, 83.84% of clarity aspect, and 90.40% of inference aspect. The mathematic creative thinking skill of students seen from the average percentage is 80.05% of test results or high category. Reviewing from every aspect that are: 82.83% of fluency aspect, 66.92% of originality aspect, and 90.40% of elaboration aspect.

Teacher and students responded very positively to the applied of problem-based learning. Teacher and students found this learning can encourage cooperation, improve motivation to learn, encourage and help students express opinion, solve problems in a structured and phased, and easy to understand math concepts. However, teacher and students demonstrated the shortcomings of this study, i.e. require a lot of time.

Problem-based learning has been implemented based on the stages of implementation of learning i.e.: engagement, inquiry and investigation, performance, and debriefing.

At this *engagement* stage the teacher delivering the learning topics that will be studied and explain briefly what will be done by student on learning. Students identify the knowledge they have associated with the material. Furthermore, students are given the main problems that encourage them to be able to find the problem. The main problem is designed to attract motivated students to be able to resolve the problem. The plan of the main problem tailored to the plan of good problem design by Duch et.al. (2001: 48-50) i.e. be able to motivate students to engage in the process of thinking critically and analytically.

Students use critical and creative thinking skills to solve mathematical questions such main problem. This is analogous with Tatang Mulyana (2008: 7-8) that the mathematic critical and creative thinking skills very involved when students are on an episode of solving the problem. Students use critical thinking skill to formulate

mathematically in main problem i.e. write what you know and asked in main problems. Furthermore, students change the statement in main problem into mathematical symbols and develop appropriate mathematical models. The mathematical model can be structured in various ways. It requires students to use mathematic creative thinking skills.

At this *inquiry and investigation* stage the teacher encourage students to explore the many ways to get a solution to the problem. In these activities students use creative thinking skill to present a lot of mathematical problem-solving ideas. Based on the observations of researcher, students sometimes find difficulties when they must seek an alternative problem-solving as occurs in cycles II. However, teacher can encourage students by giving a clue so that the students re-motivated. The teacher action is very appropriate because the teacher is obliged to provide indirect intervention when students have difficulty solving so that students can solve problems in accordance with that suggested by Tatang Mulyana (2008: 8).

At this *inquiry and investigation* stage the students are also working in groups. Students work together in groups to discuss the ideas generated by each member of the group and prioritize the most appropriate one idea as the solution of main problem mapping. In these activities students develop the ability to become a self-directed learner, which means individuals who are self-directed learning, able to think creatively full of initiative, have confidence, be able to resolve the problem, and can make their own decisions (Sugiman, 2006: 7). In addition, students also develop critical thinking skill to make mathematical inferences appropriate to the context main problems encountered.

On *performance* stage the students prepare and present the results of group discussions in class. The media used a PowerPoint presentation to be more efficient. Each group gets an equal opportunity to present the results of their discussion in front of class. There are four groups that presented the results of discussions on each cycle. Students use mathematic creative thinking skill to express the unique and interesting findings. Students also use critical thinking skill to express mathematical ideas or

questions to another student who was a presenter. Based on the observations of researcher, students came to have the confidence to perform in front of class to explain the results of the discussion, ask each other, and give each other feedback.

In the *debriefing* stage the teacher and students reflected on the results of student presentations. Based on the observations of researcher, on reflection cycle I performed by the teacher. Teacher reflects on the presentation by student but they are not included to conclude together. In cycle II, the teacher invites the students' joint to think of what can be inferred from the results of group discussions. The participation of students in the reflection is very important because by participate in that process so the learning will be more meaningful for students. As expressed by Jonassen & Land (2000: 221) reflection is a very important activity in order to get a meaningful learning.

The application of problem-based learning model implemented in this research received positive response from students. It can be seen from the learning activities of students who tend to have increased from cycle I to cycle II. In cycle I the activities of students' individual self-learning cannot be done, but on the cycle II can already be done very well. Students are able to position their self as a self-directed problem solver through collaborative activities, students are able to find the problem and elaborate them by filing presumptions and plan the completion, students are able to gather and distribute information, students are skilled in presenting the findings, and students learn to reflect on the effectiveness of the way their thinking in solving problems. It is in accordance with the characteristics of PBL expressed by Yatim Riyanto (2009: 285). In a learning which has been done the teacher role as facilitator rather than knowledge transferor. The role of teacher described by Sugiman (2006: 8) i.e. monitor the course of learning, challenging students to think, keeping the students to participate actively involved in learning, and adjust the dynamics within the group.

The data of each student test results can be seen that the mathematic critical and creative thinking skills of increased. Increased of the mathematic critical thinking skill always accompanied by increased the mathematic creative thinking skill. Students' mathematic critical thinking skill is much higher than the mathematic creative thinking

skill. This was due before students use the mathematic creative thinking skill necessary to use mathematic critical thinking skill in advance. This is accordance with the opinion Jozua Sabandar (2007: 7) that before the students use the mathematic creative thinking skill to generate ideas in an effort to resolve the matter of solving the problem, they uses the mathematic critical thinking skill in choosing its strategy completion and controls his thoughts.

From interviews with students the PBL model favored by students because they are given the opportunity to learn in groups and "forcing" students to study at home in order to follow the lessons in the classroom. According to teacher, a main problem presented at the PBL model can improve students' motivation so that students can position themselves to be self-directed problem solver. This is accordance with the advantages of the PBL by Pamen et al (2001: 99-102) that students learn actively and independently with a dish of integrated materials, improving students' ability to initiate (as there are opportunities for independent study and group work and discussion), paradigm changes teacher as facilitator, etc.

IV. CONCLUSION AND SUGGESTION

Learning mathematics through problem-based learning that can enhance the mathematic critical and creative thinking skills are the stage of *engagement, inquiry and investigation*, *performance*, and *debriefing*.

The mathematic critical thinking skill of students in cycle I seen from the average percentage of test results is 82.50% and 89.23% in cycle II. Focus aspect is 88.64% in cycle I and 93.43% in cycle II. Clarity aspect is 74.24% in cycles I and 83.84% in cycle II. Inference aspect is 84.60% in cycles I and 90.40% in cycle II. The mathematic creative thinking skill of students in cycle I seen from the average percentage of test results is 73.82% and 80.05% in cycle II. Fluency aspect is 94.44% in cycles I and 82.83% in cycle II. Originality aspect is 51.01% in cycles I and 66.92% in cycle II. Elaboration aspect is 76.01% in cycles I and 90.40% in cycle II.

The suggestions of researcher are the need to develop the problems interesting and challenging for students. In addition, in problem-based learning students are given

the freedom to seek information that could help solve the problem. Researcher is recommending that the necessary resources are limited in beginning so that the search conducted by the student resources can be effective.

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