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The Effectiveness of Applying a Problem-Based Learning Model in Mathematical Learning in Improving Students Critical Thinking

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Abstract: This research was inspired by the low critical thinking skill and learning outcomr of PGSD students on Mathematics Course at the Bung Hatta University. This study was aimed at describing the effect of applying a Problem-Based Learning model on critical thinking skill and Mathematic learning outcomr of PGSD students at the Bung Hatta University. This was categorized as a Class Action Research. This research was conducted in two cycles. This research had 26 students as a data source. The instrument used was Questionnaire for students' critical thinking skill, lecturing activity sheets and learning outcomes tests. Based on the data analysis on students 'critical thinking skill, the percentage of students' critical thinking in each cycle increased. Students achievement in the first cycle (72.55%) increased in the second cycle(76.77%). Students learning outcomes (57.69%) in the first cycle also increased in the second cycle (84.6%). From the data obtained, it can be concluded that the Problem Based Learning model can increase students' critical thinking skills and Mathematic learning outcomes. In other words, the Problem Based Learning Model is effective in improving students' critical thinking skill.

Keywords: problem-based learning model, thinking critical ability, mathematics learning results

INTRODUCTION

The main purpose of mathematics learning is to solve a problem. This is in line with one of the objectives of studying mathematics based on the regulation of National Education Ministry, Number 22 in 2006, namely students should have the ability to solve problems (Ministry of National Education, 2006). To learn mathematics, the students are required to have higher-order thinking skill in solving various problems given. Thinking ability is seen as a person's ability to solve a problem using reason. The ability to think in mathematics is more emphasized in the process, namely the process of basic thinking, critical thinking and creative thinking. Therefore, thinking skill in mathematics is more appropriately labelled as the basic, critical, and creative thinking skills (Ghufron, 2014).

Syahbana (2012) states that the critical thinking skill in learning mathematics is a person's cognitive process to obtain mathematical knowledge based on mathematical reasoning. According to Noer (2009), thinking critically is a process that leads to drawing conclusions about what we must believe and what actions will be taken. According to Amrina (2015), critical thinking is thinking about ideas related to the concepts given or problems presented. In the learning process, students can improve many things to achieve satisfying learning outcomes through lecturer guidance. One of things that can be improved by students is the ability to think critically in order to be able to solve problems, form conclusions, gather various possibilities, and make decisions to get a solution in the learning process.

Amasari (2011) mentions several components of critical thinking. They are: (a) *Basic operations of reasoning;* to think critically, a person has the ability to explain, analyze, draw

deductive conclusions, and formulate more mentally logical steps, (b) *Domain-specific knowledge;* in facing a problem, a person must have knowledge of the topic or content (c) *Metacognitive knowledge;* effective-critical thinking requires someone to monitor when he tries to really understand an idea, realize when he needs new information, and invent how he can easily collect and study that information, (d) *Values, beliefs, and dispositions;* thinking critically means judging fairly and objectively. According to Susanto (2014), critical thinking is thinking about ideas related to the concepts given or problems presented". Furthermore, Ennis in Susanto (2014) states that critical thinking is a form of thinking whose aim is making reasonable decisions about what is believed or done. From some understanding on critical thinking, it can be concluded that critical thinking is a form of thinking that needs to be developed in order to solve problems, form conclusions, gather various possibilities, and make decisions to get a solution.

To solve each problem or to learn a number of new knowledge, students must take an active role in learning. In other words, the students must do their best to develop a number of active thinking processes, including: (a) Listening carefully, (b) Identifying or formulating questions, (c) Organizing their thoughts, (d) Paying attention to similarities and differences, (e) Performing deductions (reasoning from general to specific), (f) Distinguishing between valid and invalid conclusions logically, (g) Learning how to ask clarification questions "(like" what's the point?" , "what do you mean by this question? ", and why?") (Amasari, 2012) .

Furthermore, Dressel & Mayhew in Jufri (2013) states that critical thinking indicators developed by Intercollege Committee on Critical Thinking include abilities: (1) to formulate problems and hypotheses, (2) to complete information and data to solve problems, (3) to recognize assumptions, and (4) to draw conclusions and take an action.

To assess the level of someone's critical thinking skill, an indicator of critical thinking is needed. According to Watson (Amasari, 2011), critical thinking skill can be assessed by using a questionnaire that includes five indicators: (a) recognizing assumptions, (b) doing inference, (c) deduction, (d) interpretation, (f) evaluating arguments " In addition, Ennis in Amasari (2011) states that critical thinking has six basic elements: (a) Focus, (b) Reason (c) Inference), (d) Situation, (e) Clarity, and (f) Overview.

The description of the basic elements of critical thinking is as follows: (a) Focus; The first step in critical thinking is to identify the problem well. The problem as a focus can be found in the conclusion of an argument. The focus indicator intended is that the students are be able to focus on questions or problems and determine concepts that can be used to solve problems, (b) Reason; The reasons given must be logical to be concluded as stated in the focus. The reasons come from information, theorems, or characteristics known. The intended reason indicator is that students are able to provide reasons for the answers raised, (c) Inference; drawing the right conclusions must be based on the steps of the reason to a reasonable or logical conclusion. The intended inference indicator is that students are able to draw conclusions from the reasons expressed by making steps in the settlement, (d) Situation; the situation meant is matching problems with the actual situation. Indicator situation meant is that students are able to answer questions according to the context of the problem, use mathematical language and answer application questions, (e) Clarity; there must be clarity about the terms used in the argument so that no any mistake is available in decision making. The clarity indicator meant is that students are able to provide further clarity on either the definition or the relevance of the concept, (f) Overview; Indicator overview meant is that students are able to check what has been found, decided, considered, studied and concluded. From the previous description of theory, the 6

critical thinking elements above will be used as an indicator to make an instrument of critical thinking ability.

In learning process, the learning outcome is an indicator used to determine the level of students success in understanding the concept. Sudjana (2013) states that learning outcomes are the abilities possessed by students after receiving learning experiences. Meanwhile, Kingsley in Sudjana (2013) divides three kinds of learning outcomes: (1) skills and success, (2) knowledge and direction, (3) attitudes and dreams. Furthermore, Gagne in Jufri (2013) states that learning outcomes are skilled abilities or performance owned by a person and are called capabilities. There are five categories of human capabilities, name: (1) intellectual skills, (2) cognitive strategy, (3) verbal information, (4) motor skills, dan (5) attitude.

Based on the experience of researcher teaching Mathematics in PGSD majors (approximately 12 years), it can be concluded that 90% of students experienced difficulties in learning mathematics. Of the total PGSD students, only 10% of students liked mathematics (source: archive PGSD study program). 60% of students forgot concepts that should have been mastered in elementary or high school. 65% of students were in panick when given a rather complex problem or mathematical problem. Likewise, if given a question that is different from the sample questions given, 65% of students also could not complete it. Based on the results of interviews with students, it was found that students had math difficulties because students could not understand the problem and forgot the ways and the formulas used to resolve the matter. Students only focused on the difficulty of the questions given not on their ability to solve the problems presented. This is an evidence that students' critical thinking skills are low (Amrina, 2013). In addition, the learning model used, so far, tends to be lecture methods-oriented. Indeed, students were able to learn on their own way. Although the lecturer only provides a little explanation on the teaching material, they should be able to expose material by themselves. But this was not found on students of the PGSD Study Program, FKIP of Bung Hatta University. The lack of critical thinking skill of students adversely affects the student's learning outcomes. In the last three years, the average of student learning outcomes in mathematics learning courses was that only 60% of students' grade was fair, not more.

For this reason, the learning should be improved in order that the learning problems can be overcome. In this study, an innovations (the application of the Problem Based Learning model) will be applied. The problem-based learning model begins a learning activity with a problem. Arends (2012) states that the problem-based learning model is applied to expose students to authentic and meaningful problems and encourage students to carry out investigative and discovery activities. The learning model consists of 5 steps: (1) Orienting students to a problem, (2) Organizing students for study, (3) Assisting Independent and group investigation, (4) Developing and presenting artifacts and exhibits, (5) Analyzing and evaluating the problem-solving process. Amrina (2018) developed a model on problem-based learning with the steps as follows: (1) Orienting students to a problem, (2) organizing students to understand the issue, (3) Guiding students do an investigation to solve the problem individually and in group, (4) Communicating and presenting the work, (5) Analizing and evaluating the process of problem solving. Through Problem-Based Learning, it is expected to be able to optimize students' critical thinking skill.

Lidinillah (2009) states that The Problem Based Learning model has several advantages. They are: (a) Learners are encouraged to have a problem solving skill in a real situation, (b) Students have the ability to build their own knowledge through learning activities, (c) Learning focuses on problems, (d) Scientific activity occurs on students through group work, (e) Students are used to using sources of knowledge from the library, the internet, interviews and

observations, (f) Students have the ability to assess their own learning progress, (g) Students have the ability to discuss or present their work scientifically, (h) Individual learning difficulties can be overcome through group work in the form of peer teaching. The study on problem-based learning and critical thinking has been carried out by many researchers. In general, their research finding is the same. The finding was that PBL effectively improves students' critical thinking (Li & Chen, 2019; Kong, Qin, Zhou, Mou, & Gao, 2004; Gholami, Moghadam, Mohammadipoor, Tarahi, Pour, 2016; Ismail, Harun, Zakaria, & Salleh, 2018; Şendağ, & Odabaşı, 2009; Hong, & Yu, 2017; Choi, Lindquist, & Song, 2014; Mulyanto, Gunarhadi, & Indriayu, 2018; Masek, & Yamin, 201; and EL-Shaer & Gaber, 2014)

This study was intended to describe the effectiveness of applying the Problem Based Learning Model in improving critical thinking skill and student learning outcome at Primary Education-Teacher Department (PGSD) of Bung Hatta University.

RESEARCH METHOD

This study was conducted to describe the effectiveness of Problem Based learning models viewed from critical thinking skill and student mathematic II learning outcome. The type of research used was a classroom action research (CAR). Classroom action research is a research conducted by a lecturer in their own class through self-reflection whose objective is to improve his/her performance as a lecturer, so that student learning outcomes increase (Wardhani, 2013). Meanwhile, Arikunto, et al (2012) defines Classroom Action Research (CAR) as a study in which the source of problem arises in the class, and is felt directly by the lecturer.

The subjects of this study were 26 students who took Mathematics course in class IV A in Even semester 2018/2019. The study was conducted in two cycles in which each cycle consisted of 4 meetings and ended with a test. The research data was collected using observation sheet on lecturer activity, the questionnaire sheet on students' critical thinking skills and the sheet on student achievement test. Each of them will be described as follows:

1) Observation data on lecturer activity was the data of observation used to see if what a lecturer is doing meets the planned learning steps. The results of observation were analyzed by summing all aspects signed, then assessed using criteria if teacher does 4 descriptors, then the criterion is BS with score of 4; if doing 3 descriptors, the criterion is B with score of 3, if doing two descriptors, criterion is C with score of 2, and if the teacher does 1 descriptor, then the criteria was K with score of1. Then the data was analyzed by percentage techniques. The percentage values obtained are categorized as follows:

Table 1. Critical Thinking Ability Criteria Based on Test Score Percentage

No.	Percentage of Scores	Criteria
1	76 % <x ≤ 100%	Well
2	51 % <x ≤ 75 %	Pretty good
3	26 % <x ≤ 50 %	fair
4	0 % <x ≤ 25 %	Not good

2) Data analysis used to determine the students' critical thinking skills score is the score of questionnaire filled out by the students. The results of the questionnaire data were derived from score given to each item according to the scoring guidelines of critical thinking skill questionnaire. Then, each indicator of the critical thinking skill from

questionnaire was summed and the percentage of score was decided. The results of the percentage of the score are categorized as follows:

Table 2. Criteria for Critical Thinking Ability Based on Questionnaire Score Percentages

No.	Percentage of Scores	Criteria
1	$89\% < x \leq 100\%$	Very high
2	$79\% < x \leq 89\%$	High
3	$64\% < x \leq 79\%$	fair
4	$54\% < x \leq 64\%$	Low
5	$x \leq 54\%$	Very low

3) Learning outcomes data were ones obtained through learning outcomes tests. This data were processed using the average of learning outcomes and mastery of learning outcomes. These learning outcomes are seen classically.

RESEARCH RESULTS AND DISCUSSION

Cycle 1 Research Results

Planning was carried out in accordance with the steps that have been set begining from compiling the material to preparing the final test questions. Furthermore, this implementation was carried out based on the planning in which one cycle consisted of 4 meetings. The activity began by arising students' motivation and attention, providing references and conducting apperception. The core activities were conducted based on the steps on the Problem Based Learning Model. The lecturer ended the activity by reviewing students' understanding and carrying out the assessment. Observations were intended to discover the process of the learning conducted by the lecturers based on the planning that had been prepared for each meeting. At the end of the cycle, a questionnaire on critical thinking skills and learning outcomes tests was given. Furthermore, data from observation sheets, result of questionnaire, and learning test were analyzed. The results of the analysis are described as follows.

1) Observation results on lecturer activities at cycle I
Based on the observation sheet, the lecturers' activities were filled in by the observer during the learning process. In this first cycle, researchers got an average of 57.59% with a fairly good category. This means that the instruction carried out by lecturer need to be improved. The learning steps that have been planned must be analyzed again,

2) Result of students' critical thinking skills assessment at cycle I
Data from students 'critical thinking skill assessment were obtained from a questionnaire sheet on students' critical thinking skills. In the first cycle, the percentage of students critical thinking ability obtained was 72, 55%. This percentage already was classified into the criteria of fair. This has not yet reached the expected criteria, namely the good category.

3) Students' learning outcomes at cycle 1.
Based on the results of data analysis on students' learning outcome, it was found that from 26 students who took the tests, 15 students (57,69 %) who reached or exceeded the set value, namely B (75), and 11 students (42,31 %) of all students taking the test had values below B. The data showed that students' learning outcomes had not reached the

desired target of success indicators, that was, at least 75 % of students who took the learning outcomes test got a minimum score of B (≥ 75) .

4) Reflection at cycle 1

Then, the reflection was done to see if the implementation of learning met the planning and to see whether the success indicator had been achieved or not, and to see the actions that needed to be made in the next cycle. Based on the results of the data analysis of observation, the results of questionnaires, and students' achievement, it was found that the indicators of success had not been achieved. Therefore, it was decided to continue research into cycle 2. There were some improvements to be made in cycle 2; (1) For apperception activities, there should be the problems or events that were more challenging for students to think critically, (2) Lecturer must monitor students' participation in discussions in order to make sure that all students were involved in discussion activities, (3) Lecturers should expose students to respect their friends who were presenting their group report in front of the class. (4) The time used should be in line with the planned time allocation.

Cycle 2 Research Results

Planning cycle II was designed based on the reflections carried out in the first cycle, starting from guiding and paying attention to students when learning was taking place until organizing time well. Actions carried out were in accordance with the steps in lesson plan. Observations were made to determine students' critical thinking skill and students' learning outcomr and lecturer activities in class. Furthermore, from the results of reflection done, the cycle 2 was carried out. In cycle 2, the students were still given the opportunity and facilitated to demonstrate their critical thinking skill in completing and discussing problems given on the work sheet during the learning process, either individually or in groups. Meanwhile, lecturers still played a role as motivators and facilitators. Each meeting was observed by the observer. After the learning session for 4 meetings was completed, a questionnaire of critical thinking skill and a test of learning outcomes were given to students. Furthermore, the data of observation, data of questionnaires and test result were analyzed. The results of the analysis are described as follows.

1) Observation results of lecturer activities at Cycle II

The success of students in learning is generally seen also from classroom management conducted by lecturer through the Problem Based Learning model. Lecturer activities in cycle II were classified to be good because 78.40% of lecturers managing learning had increased from the previous cycle

2) Data on the results of students critical thinking ability at Cycle II

In the second cycle, the percentage of students' critical thinking skill increased. The indicators of drawing conclusions and taking action increased higher than the other indicators. In this second cycle, the percentage of students' critical thinking abilities increased (76,77%). The increase of percentage in the 4th indicator was higher than the first cycle because students began to be used to working with the questions given.

3) Data on Students' Learning Outcomes in Cycle 2

Student learning outcomes in this second cycle had achieved the indicators of success. Based on the percentage of completeness of students learning outcome above, it can be seen that 22 of 26 students taking the test (84,6%) reached or exceeded the grade 75 (above B). Four students (15, 4%) got grade below B. The data showed that students

learning outcomes had reached the indicators of success intended, namely 75% of students who took the test got grade at least B.

4) Reflection in Cycle 2

The results of the analysis of the whole aspects in cycle 2 showed that the indicators of the effectiveness of the implementation of problem-based learning had been reached. It was found that overall learning activities on the implementation of the actions could be implemented effectively. During the discussion (both group discussion and class discussion), it was found that the students were involved actively and totally in terms of identifying and understanding the problems, questioning and answering the problems, solving the problems and making decisions, and interpreting and summarizing the problems in the group worksheet. When learning was taking place, the class atmosphere was conducive because each student focused and was enthusiastic about doing their respective assignments. All students were involved in finding concepts and solving problems given correctly. The questions asked were already higher-level questions. This illustrates that students were critical in solving problems. Because the indicator of the success of the research had been reached, the cycle ended.

Discussion

Based on the data analysis in cycle 1 and cycle 2, it was found that implementing the Problem Based Learning model in improving students' critical thinking skill and Mathematics learning outcome at PGSD of FKIP of Bung Hatta University was effective. From the analysis results of questionnaire data, students' critical thinking skill and mathematic learning outcome increased. Likewise, the implementation of learning carried out by lecturer also showed improvement. Thus it can be described as follows.

1) The description on the ability of lecturers in developing problem-based learning patterns as an effort to develop critical thinking skill and student learning outcome showed a significant increase. Previously, the learning model implemented by lecturers was limited to the lecture method in which the lecturer was a learning center and turned into student-centered. Hopefully this can be sustainable.

2) The description on students' critical thinking skill through the implementation of problem-based learning showed a significant increase. By implementing the Problem Based Learning model, the students were more critical in giving opinions, asking questions, identifying problems and finding solutions to problems. This had an impact on students' interest in mathematics course. Previously they always avoided this course. The Problem Based Learning model made students competent in resolving the problem. It is expected that in the future students will also be accustomed to solving problems in daily life and caring about their environment.

3) Learning outcome is the indicator of student success in learning. Based on data analysis in cycle 1, the percentage of students who received grade at least B was 57.69%. Meanwhile in cycle 2, it reached 84.6% . This showed a very significant increase. Based on the analysis of the observations conducted, the researchers found that in cycle 1 a number of students did not understand the good learning strategy, so that they still did many mistakes in answering their questions. To overcome the difficulties experienced by students, the lecturers tried to do their best in order that in cycle 2 all students could provide critical answers to the tests given in line with the questions that have been determined. The number of highest completeness was gained by students in cycle 2

because students were getting used to doing tests based on questions given. The improvement of students' learning outcomes was reflected in achievement analysis of cycle 2. This was caused by the increase of students' critical thinking skills. In other words, the student learning outcomes increase because the students' critical thinking skills also increased.

What was found in this study meets the previous studies conducted by Zabit (2010), Masek (2011), and EL-Shaer and Gaber (2014). They also found that Problem Based Learning could improve students' critical thinking. Although Problem Based Learning was carried out to students with different majors, the result is the same (it can improve students' critical thinking).

CONCLUSION

Based on the results of the research obtained, it can be concluded that the implementation of Problem Based Learning model was effective in improving students' critical thinking skills and Mathematics learning outcomes at PGSD of FKIP of Bung Hatta University. This can be seen as follows: (1) Students' critical thinking ability has increased by 4.22%. In the first cycle, the students' critical thinking ability was 72.55% classified as medium criteria and 76.77% in the second cycle classified as good criteria, (2) Student learning outcomes also increased (57,6 9 % in the cycle 1 and 84,6% in cycle 2). Related to the results of the research obtained, the researcher provides two suggestions on the implementation of learning as follows: (1) For lecturers , the Problem Based Learning model is suggested to be used as an alternative way to improve students' critical thinking skills and learning outcomes and make students able to think critically in participating in learning activities, (2).Students are expected to practice Problem Based Learning to develop their critical thinking in the learning process because these activities greatly support mastery of learning material .

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