

Improving the Students' Critical thinking ability through Problem-Based Learning Model of Scientific Approach on "Linear Equation System of Two Variables" Learning Material

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Abstract—The quality of education today is still a relatively prominent problem in efforts to improve the quality of the national education system. One of the things needs to be improved is the ability to think critically. Critical thinking ability is an important ability to have by students in order to solve the problems faced in changing world. Learning Mathematics by using problem-based learning model of scientific approach is one alternative approach that aims to improve the ability of critical thinking to be trained properly. This study aimed to examine the improvement of students' critical thinking skills, especially on the learning material "Linear Equation System of Two Variables", both reviewed in whole and in groups of students (upper and lower groups). This research was conducted in junior high school at middle level. The data were collected through tests and questionnaires. The results of the study showed that there was an improvement of critical thinking of 35.29%. The improvement was considered as very low due to the researcher's lack of attention on the level of difficulty among the test items. The level of difficulty was very important to pay attention in order to know how the students' critical thinking skills improvement was. The Student Activities Observation Result showed that the average improvement of the students' active participation every meeting was 83.74% which meant that the students were actively joining every lesson. Furthermore, the data analysis of the students' response questionnaire revealed that students showed a positive attitude toward learning mathematics by using problem-based learning of scientific approach.

Keywords— Critical thinking, Improvement, Problem-based learning, Scientific approach.

I. INTRODUCTION

The quality of education today is still a relatively prominent problem in efforts to improve the quality of the national education system. However, many efforts have

been done to overcome the education problem. Those efforts cover all of the education components like a renewal of curriculum, improvement of teachers' quality as well as the other efforts related to the improvement of education quality.

Constitution No. 20 in 2003 about National Education System that:

Education is a conscious and well-planned effort to create an atmosphere of learning and learning process so that learners actively develop their potential to have spiritual / religious power, self-control, personality, intelligence, noble character, as well as skills owned by themselves, society, nation and state.

The statement above indicates that it is expected that through education the state is capable to prepare human resources who are ready to face any demands of the times. Qualified human resources can only be achieved by improving the quality of education in Indonesia. Improving the quality of education can be done by changing the learning system from teacher-centered learning which has been implemented for many years into student-centered learning. Student-centered learning system would be able to grow and develop creativity and train the students' critical thinking ability in both learning and solving problems faced in daily life. It is strengthened by Muhfaroyin (2009) who stated that student-centered learning paradigm is more appropriately used to develop self-regulated learners who are capable to empower critical thinking ability. To deal with the world which is rapidly changing is a mean of creating critical thinking ability in society (Sadeli dan Wati, 2013). The priority of an education system is to educate students about how to learn and to think.

In relation to the demands of the quality improvement of intellectual and critical thinking human resources, the mastery of every learning subjects needs to be improved in all education levels, one of them is Mathematics education level.

Along with the development of science and technology, the role of Mathematics as one of basic science knowledge which has many essential values in various fields in life becomes very important especially in science knowledge and technology mastery. The low quality of every level of education is still an unsolved problem. Yet, students' skills in thinking and solving problems have not been so entrenched in the society. Students used to learn by memorizing everything without any development of thinking and solving problems. Teacher as the informant is also often dominate the learning activities in classroom. There, teacher usually just writes the formulas, gives examples and asks to do the tasks. These ways of teaching make the students less active in learning activities.

By looking at above condition, a teacher indeed is required to be always creative and innovative in planning and implementing the teaching and learning process. To meet this demand, teacher needs a tool which can improve the students' critical thinking ability. The learning outcomes will be more meaningful if there is a change of students' attitude and behavior to be more critical, active, creative and innovative. Learning Mathematics should be presented in a certain context which is more actual and appropriate with the students' daily real experiences.

For those reasons, the learning approach that is appropriate to be used is scientific approach. Scientific approach is closely related to scientific method. Generally, scientific method involves observation activity which is used to formulate hypothesis or collect data. It is also based on the exposure of data obtained through observation or experiment. In this case, experiment activity is changed to the activity of obtaining information from various resources.

One of learning models that notice about the students' critical thinking ability and require students' creativity is Problem-Based Learning (PBL). PBL is based on the theory of cognitive psychology, mainly based on Piaget and Vigotsky (constructivism theory). According to constructivism theory, students learn to construct knowledge through an interaction with their environment. PBL facilitates students to learn through structured real world problems to construct their knowledge. This learning model requires students to actively conduct investigation in solving problems and teacher roles as facilitator or consultant. It can build high order thinking ability and improve students' ability to think critically.

The lack of the learning tool examples of mathematics that appropriate with problem-based learning makes teachers have not implemented this learning model. PBL is a learning approach that uses problems in real life as a context for students to learn about how to think critically, have the ability to solve problems and gain knowledge and concepts from learning materials.

Linear Equation System of Two Variables (LESTV) is one of Mathematics learning materials which is considered as difficult material by most of students especially for the test items in the form of story. The difficulties faced by the students in understanding the concept of LESTV causes the learning process hampered. The number of LESTV applications in daily life becomes one significant reason for students to master the material. Therefore, in learning LESTV, the students are required to be active and creative in solving the problems either served by the teacher or faced in daily life.

Linear Equation System of Two Variables (LESTV) is chosen as the learning material of this research because there are a number of its applications which are faced by students that make them difficult to understand LESTV contextually. When students are given exercises of LESTV in the form of story, most of them solve the exercises by memorizing the solution from the examples so that they cannot do the different exercises well. In addition, in teaching LESTV, most teachers just rewrite the existing formulas from the students' textbook, give examples and assist tasks. Students are less actively involved in solving problems related to LESTV. For these reasons, LESTV learning material is more appropriate with the implementation of Problem-Based Learning (PBL) because in this learning model the students are required to identify the problems by themselves, so that they are not only memorizing but also finding. By implementing PBL, students are expected to have no difficulties when they are given different types of exercises or even with high difficulty level.

Based on the explanation above, the researcher intends to improve the eighth grade students' critical thinking ability by using Problem-Based Learning of scientific approach on "Linear Equation System of Two Variables" learning material.

II. RESEARCH METHODS

This research used Classroom Action Research (CAR) as the design. The subjects of the research were Class VIIIA students of SMPN 2 Balung Jember in 2016/2017 academic year. The object of this research was the students' critical thinking ability and their responses.

Considering to the data needed, there were three kinds of instrument used in this research: 1) Mathematics Critical Thinking Ability Test to know the improvement of the students' critical thinking ability. This test was administered to the students before and after the teaching and learning process with some test items related to the learning material LESTV; 2) Students' Activities Observation Sheet which contained the types of students' activities observed as well as the columns that indicated the categories of their active participation. The observation sheet is filled by giving check mark in

provided columns based on what is observed; 3) Students' Responses Questionnaires which consisted of 11 written questions with some alternative options namely "Happy", "Quite Happy" and "Not Happy" that aims to collect the data from all of Class VIIIA students as the samples or responses. The responses are given and filled by the students after the teaching and learning process.

To obtain research instruments which fulfilled standard measurement, the instruments compiled had been tested first and the validity of each item had been calculated. The focus of this research was the improvement of the students' critical thinking ability.

The data analysis of the research result of Critical Thinking Ability can be described as follows:

The results of students' works are analyzed to determine the level required by each of the students with criteria:

Level 3: Critical

In this level, the students met all of the characteristics of critical thinking or met at least characteristics of it with a note that K₁ and K₂ are met.

Level 2: Quite Critical

Students said to be in this level if they met three or two characteristics of critical thinking with a note that if they met three characteristics, K₁ or K₂ will be not met, if they met two characteristics, they only met K₁ and K₂.

Level 1: Not Critical

Students said to be in this level if they met two or one or even did not met any characteristics of critical thinking provided. Note that if they met two characteristics, either K₁ or K₂ was not met.

For further details, take a look on Table 1 below.

Table.1: Critical Thinking Characteristics

Criteria	Critical Thinking Characteristics
Critical	1. K ₁ , K ₂ , K ₃ and K ₄
	2. K ₁ , K ₂ and K ₃
	3. K ₁ , K ₂ and K ₄
Quite Critical	1. K ₁ , K ₃ and K ₄
	2. K ₂ , K ₃ and K ₄
	3. K ₁ and K ₂
Not Critical	1. K ₁ and K ₃
	2. K ₂ and K ₃
	3. K ₃ and K ₄
	4. K ₁
	5. K ₂
	6. K ₃
	7. K ₄
	8. -

III. INDENTATIONS AND EQUATIONS

The action of this research was carried out in the implementation. However, the development of learning

tools and materials was done before implementation and they are validated by education experts.

In details, the activities done in implementation stage were as follows:

a. The observation of Lesson Plan Implementation

During the lesson, teacher acted as the facilitator that only accompanied students solving the problems on their worksheets. It aimed to make students accustomed solving problems by themselves in group. In this case, the researcher did not directly give the answers but gave guidance in solving the problems by doing experiment based on the students' worksheet developed by the researcher.

b. The result of Critical Thinking Ability

The result of critical thinking ability test could be showed as follows:

Table.2: The Analysis of Critical Thinking Ability Test Result

No	PRETEST		POSTTEST	
	Result	Cri	Result	Cri
1	K ₁ , K ₂ , K ₃ & K ₄	C	K ₁ , K ₃ & K ₄	QC
2	K ₁ , K ₂ & K ₄	C	K ₁ , K ₂ & K ₄	C
3	K ₁ , K ₂ , K ₃ & K ₄	C	K ₂ , K ₃ & K ₄	QC
4	-	NC	K ₂ , K ₃ & K ₄	QC
5	K ₄	NC	K ₁ , K ₃ & K ₄	QC
6	K ₁ , K ₂ & K ₃	C	K ₁ , K ₃ & K ₄	QC
7	K ₁ , K ₂ & K ₃	C	K ₁ , K ₂ & K ₃	C
8	K ₁ , K ₂ & K ₄	C	K ₁ , K ₂ & K ₄	C
9	-	NC	K ₂ , K ₃ & K ₄	QC
10	K ₁ , K ₂ , K ₃ & K ₄	C	K ₁ , K ₃ & K ₄	QC
11	K ₁ , K ₂ & K ₄	C	K ₁ , K ₂ & K ₄	C
12	-	NC	K ₂ , K ₃ & K ₄	QC
13	K ₁ & K ₄	NC	K ₂ , K ₃ & K ₄	QC
14	K ₁ , K ₂ & K ₃	C	K ₁ , K ₂ & K ₃	C
15	K ₂ & K ₃	NC	K ₂ , K ₃ & K ₄	QC
16	K ₁ , K ₂ & K ₃	C	K ₁ , K ₂ & K ₃	C
17	K ₁ , K ₂ & K ₄	C	K ₂ , K ₃ & K ₄	QC
18	K ₁	NC	K ₄	NC
19	K ₁ , K ₂ , K ₃ & K ₄	C	K ₁ , K ₂ , K ₃ & K ₄	C
20	K ₁ , K ₂ , K ₃ & K ₄	C	K ₂ , K ₃ & K ₄	QC
21	K ₂	NC	K ₁ , K ₂ & K ₃	C
22	K ₁ , K ₂ , K ₃ & K ₄	C	K ₂ , K ₃ & K ₄	QC
23	K ₂	NC	K ₂ , K ₃ & K ₄	QC
24	K ₁ & K ₄	NC	K ₁ , K ₃ & K ₄	QC
25	K ₁ , K ₃ & K ₄	QC	K ₁ , K ₂ , K ₃ & K ₄	C
26	K ₁ , K ₂ & K ₄	C	K ₁ , K ₂ & K ₄	C
27	K ₁ & K ₃	NC	K ₁ , K ₂ & K ₄	C
28	K ₁ , K ₂ & K ₄	C	K ₂ , K ₃ & K ₄	QC
29	K ₂ & K ₃	NC	K ₂ , K ₃ & K ₄	QC
30	K ₁ , K ₃ & K ₄	QC	K ₁ , K ₃ & K ₄	QC
31	K ₁ , K ₃ & K ₄	QC	K ₁ , K ₂ & K ₄	C

No	PRETEST		POSTTEST	
	Result	Cri	Result	Cri
32	K ₁ , K ₂ & K ₄	C	K ₁ , K ₂ & K ₄	C
33	K ₁ , K ₂ , K ₃ & K ₄	C	K ₂ , K ₃ & K ₄	QC
34	K ₁ & K ₂	C	K ₂ , K ₃ & K ₄	QC

Notes: C = Critical
 QC = Quite Critical
 NC = Not Critical

Based on the data as the result of critical thinking ability test in Table 2, it can be summarized into a diagram in Picture 1 below.

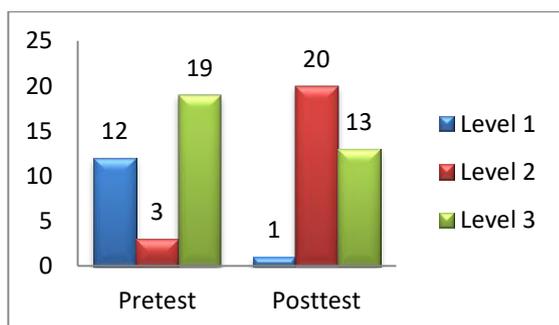


Fig.1: Diagram of Critical Thinking Ability

From the diagram above, it was known that there was a significant decline since the number of the students who still in level 1 was reduced from 12 students to 1 student. It indicated that there was an improvement of the students' critical thinking ability.

However, another concern focused on the decline of the number of the students in level 3 from 19 students to 13 students. According to the result of interview with those students, it was known that they thought that the test items in Posttest were more difficult than the test items in Pretest. This thing was not noted by the researcher. The researcher should pay more attention to the equality of the test items.

The researcher's less attention to the equality between Pretest and Posttest resulted in very low improvement of the students' critical thinking ability, that was 35.29% with Very Low (VL) category. Yet, the researcher predicted that these learning tools could improve the students' critical thinking ability because of the learning tools' validation (valid, practical and effective).

Based on the result of students observation, it was obtained that:

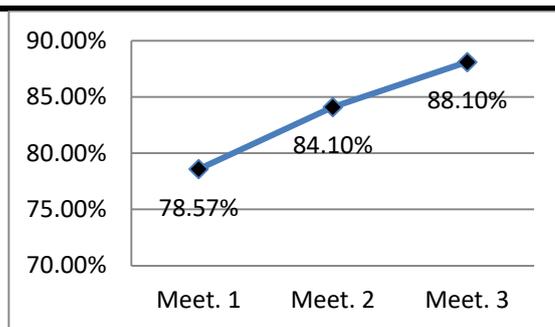


Fig.2: Diagram of Students' Activities Observation

From the diagram of Students' Activities Observation above, it was known that there was an improvement of the students' active participation in every meeting. The improvement was about 83.74% which meant that the students were active every joining the lesson.

From the Students' Responses Questionnaire, it was gained a result that 75.13% of the students were "Happy" with the lesson, 20.05% of the students were "Quite Happy" and 4.82% of them were "Not Happy" with the lesson. Based on the result, it could be said that the learning tools were effective with good category based on students' responses.

Based on the analysis, it could be summarized that there was an improvement of the students' critical thinking ability by using Mathematics learning tools taught with problem-based learning model of scientific approach. This alternative way could be used to help solving the problems faced by the eighth grade students on "Linear Equation System of Two Variables" learning material. Moreover, it should be tested on the other schools with different condition to obtain more qualified learning tools.

IV. CONCLUSION

Based on the results of the research, it can be concluded that teaching and learning Mathematics "Linear Equation System of Two Variable" material by using problem-based learning model of scientific approach can improve the eighth grade students' critical thinking ability in SMPN 2 Balung. It increased as much as 35.29% with Very Low (VL) category. This low improvement was due to the researcher's less attention of the test items equality. This condition can be an opportunity for the further researchers to extend the research. Therefore, the other researchers can give contribution to this classroom action research.

V. SUGGESTION

In relation to the result which has been reviewed, the researcher wants to give some suggestions for the readers and the further researchers who want to conduct a similar research as follows:

- a) The learning tools in this research can be used as an alternative learning in classroom, especially for the

- learning material “Linear Equation System of Two Variables” for eighth grade students who have similar problem with the eighth grade students of SMPN 2 Balung.
- b) The learning tools still should be tested to the other schools with different conditions to obtain the more qualified learning tools which are developed by using problem-based learning model of scientific approach to improve the students’ critical thinking ability on the learning material “Linear Equation System of Two Variables” for the eighth grade students.
- c) Teachers can use the learning tools as an alternative way to make students not bored and more motivated than the usual activities.
- d) The other researchers who want to extend this research are suggested to pay more attention to the equality among the test items so that the improvement of the students’ critical thinking ability can be measured accurately.

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