Developing students critical thinking ability through lesson study

Risnanosanti, D Susyla, M Syofiana
Department of Mathematics Education Muhammadiyah University of Bengkulu
Bengkulu, Indonesia
email: risnanosanti@umb.ac.id

Abstract—there are many aspect that can make students literate in mathematics, one of the important is critical thinking ability. The ability of critical thinking is very important when students learn in mathematics. The mental processes like a categorize, attention, selection, and decide can make a students to think critically. The ability to think critically in providing assistance to students in thinking and working, besides that critical thinking skills are also students helping in determining the relationship between materials. When students are faced with a problem or task, critical thinking are needed to solve it. To develop students critical thinking can be done through the learning process in school. The aim of this is to identify the effects of mathematical learning process based on lesson study to critical thinking skills at junior high school students in Bengkulu. This study involved a total of 33 student grade 8 state junior high school (SMPN 11) in Bengkulu in academic year 2017-2018. The design of the study was descriptive qualitative method. The data in this study were analyzed descriptively. Based on the finding that there are effects of the use of lesson study activity to enhance the ability of critical thinking skills in mathematics students based on level of thinking skill in Taxonomy SOLO.

1. Introduction
The very rapid technological and scientific development today has implications for various changes in life. In this very rapid change, everyone is required to have readiness and ability to survive. The main ability to have to survive in world today is the ability to be a great problem solver. One important component that must be possessed to become a good problem solver is the ability to think critically. Critical thinking ability becomes a crucial problem in recent years.

Some studies related to the ability to think critically, especially in the field of mathematics which has been carried out included description of students’ critical thinking skills based on students achievement and gender differences [1], improvement of students’ critical thinking skills using mathematical inverted approaches [2], use of problem-based learning and cooperative to improve students’ critical thinking skills [3]. The results of the research [4] found that the ability to think critically of student teachers was at a moderate level but not high enough. Other studies stated that learning that was based solely on curriculum content had not made students better thinkers. This is the reason why teachers must provide learning activities where students are given the opportunity to think flexibly and creatively, solve problems and make good decisions [5]. Furthermore, there were also research results mentioned that students’ critical thinking skills were successfully improved and developed in learning mathematics activities by choosing certain tasks that trained students to develop their thinking abilities [6].

The use of the word of high-order thinking skills (HOTS) and thinking reflectively can often be exchanged with the terms of the ability to think critically as can be seen in several references [7], [8],
Some experts defined the ability to think critically in different ways, including the ability to think critically as the nature of a person's capability to live according to his era [11]. According to Sumarna [2] critical thinking ability is an intellectual process that provides direction for someone to act. Critical thinking ability is a mental activity that requires high-order thinking skills to solve problems and make a decision [12]. The prior opinions of experts showed that the significant role of the ability to think critically in increasing the capacity of students as subjects in learning activities.

The development students' critical thinking ability can be done through classroom learning activities. The teacher has a strong influence on students' academic abilities and successes [13]. Besides, teacher is one aspect of the mathematics learning environment that is related to student learning achievement [14]. Therefore the teacher has an important role in improving students' critical thinking skills through the selection of models, strategies, or methods of learning that are appropriate, not only for the material but also for students.

One of the teacher’s task is to design and prepare learning activities. It is the responsibility of the teacher to decide how learning activities will be carried out, what methods or learning materials will be used, and how to evaluate student learning outcomes [15]. Improving the quality of classroom learning can be done by teachers through lesson study-based learning activities.

1.1. Critical Thinking Ability

The ability to think critically has become an issue discussed by many experts. The 21st century learning now also implies the importance of critical thinking ability in solving problems for students in school. It is not only an important ability but also a major goal of education in Indonesia [16]. It also important because of its role in analyzing information that matches the existing data so that students can make correct proper in solving problems [17]. Further, it can make students be able to solve problems more perfectly, make decisions quickly and correctly, and can find links between facts. In addition, someone who has the ability to think critically will be a sober-minded person when he is faced with stressful conditions.

Critical thinking ability in learning activities, especially learning mathematics, is almost the same as the ability to think critically in general. Critical thinking ability in mathematics is a thinking ability which involves the ability to identify concepts, to generalize, to analyze algorithms and to solve problems [18]. The linkages between aspects of critical thinking skills can be seen in Table 1 [19].

1.2. Lesson Study

Classroom learning activities are a series of planning procedures implicating several components including teachers and students. In the implementation of learning activities, there are often sundry problems both from the teacher's factor and from the student's side. This problem comes about due to various things such as factors of teachers, students, facilities and infrastructure, and learning resources used. The lesson study-based learning activity is a learning activity implemented to assist teachers see problems that emerge during the learning process.

Etymologically, the word ‘lesson study’ can be understood as learning from learning. Lesson study is a concatenation of entire and continuous learning activities designed to expand the quality and bring learning to preferable direction [20]. Lesson study involves a group of teachers who assemble regularly in a certain period of time to jointly design, implement, test and renew one or more research lessons [21]. Research lesson is actual learning in a class with components (a) focused on specific problems that come about to the teacher, goals, or pedagogical vision and practices, (b) made a careful planning, conducted collaboratively with one or more team members, (c) observed by other peer teachers, (d) recorded for analysis and reflection, (e) discussed through lesson study activities with group members, other colleagues, administrative staff, and / or inviting outside commentators [22].
Table 1. The linkages between aspects of critical thinking skills

| Related content aspect concepts | Concepts | Generalization Algorithm and skills | Problem solving |
|--------------------------------|----------|------------------------------------|----------------|
| 1. Concept characters identification | 1. Determining concept found in the generalization and relation between them | 1. Clarifying basic concepts of a skill | 1. Determining same form to solve problems |
| 2. Comparing concepts | 2. Determining conditions of concept generalization applications | 2. Comparing through examples | 2. Determining the given informations |
| 3. Identifying the concept example and making its justification | 3. Determining the generalizations formula (special situations) | 3. Determining the given informations | |
| 4. Identifying the concrete examples through giving justification | 4. Giving supporting evidence for generalization | 3. Determining the relevance and reliable information | Selecting and justifying the strategies to solve the problems |
| | | | 5. Determining and deciding on sub-objectives to achieve goals |

2. Methodology
This research was a descriptive research type that reflects the learning process in a classroom environment through lesson study-based activities with the aim of improving students' critical thinking skills.

2.1. Lesson Study Participants
Lesson study was a learning environment that entangles a team of 5 people, one teacher and 4 observers. The observers in the learning activities consisted of lecturers in mathematics education study programs and mathematics teachers. This learning activity implicated 33 class VIII students of SMP Negeri 11 Bengkulu city in the 2017/2018 academic year.

2.2. Data Collection Procedures
The primary focus of the lesson study-based learning activities was to rectify students' critical thinking skills. Students' critical thinking skills were gauged before and after learning activities through the provision of preliminary tests and post-tests. It was conducted in 4 cycles.

The instrument employed to measure students' critical thinking skills was in the form of essay questions consisting of the ability to argue, evaluate, express problems, draw conclusions, and synthesize [23]. The level of critical thinking skills was based on SOLO taxonomy. Whilst the lesson study based learning process data was gained through using observation sheets.

2.3. Data and Data Analysis
There were two types of data acquired in this research, specifically students' critical thinking ability and lesson study based learning processes. The data of students' critical thinking abilities were gained
through conducting preliminary tests and post-tests. The criteria employed in evaluating students' critical thinking test results used the indicators and sub indicators as seen in Table 2.

Built upon Table 2, data regarding critical thinking abilities were analysed and presented descriptively. Whilst the data regarding the learning process was obtained through completing observation sheets during the implementation of lesson study-based learning activities.

3. Result And Discussion

Learning activities with lesson study-based that were conducted in mathematics subjects, were implementing 4 cycles. Each cycle contained a discussion process for the planning of learning activities (plan), application of planning in the classroom (do) and discussion of the results of classroom learning activities (see). Learning activities that used problem-based learning models were started by providing an open problem to students.

Table 2. Indicators and Sub Indicators Critical Thinking Ability

| No | Indicators | Sub Indicators |
|----|------------|----------------|
| 1  | Basic Explanation | Identification of conclusions |
|    |             | Identification of reasons |
|    |             | Clarifying questions |
| 2  | The basis of initial decision making or support | Carry out existing procedures |
|    |             | Have the ability to give a reason |
|    |             | Record the result of observation |
|    |             | Have the competence or the suitability with technology. |
| 3  | Conclusion or Inference | Make an explanation of the hypothesis : Make a causal relationship in general |
|    |             | Induction: Activities of investigation especially aspects of experimental design |
|    |             | Induction: Provide acceptable reasons |
|    |             | Induction: making graphs in general |
|    |             | Based on the facts, a statement of value can be made. |
|    |             | Based on their alternatives, a statement of values can be made. |
|    |             | Based on the consequences, a statement of values can be made. |
| 4  | Advanced Explanation | Provide an assessment of the definition contained in the report |
| 5  | Strategies and tactics | Doing a strategy of interacting with others coherently |

Based on the results of observation, in the first and second cycles, the implemented learning activities indicated that the students' ability to express the given problem was still not visible and the ability to contribute or provide arguments was also still exceptionally low. This was obtained based on the results of the reflection put forward by the observers. In this cycle, students also still could not afford to synthesize and provide the correct solution of the problem given. The end results of this observation denoted that the level of thinking ability of students is still at the pre-structural stage.

The results of the first cycle reflections became a basic for lesson study team in improving learning activities. The lesson study team has discussed the right way through stimulation in order students were not afraid for expressing opinions and ideas as well. Because from the observations conducted by team, basically, students have enough thinking skills, even though still afraid to give their opinions.

In the next cycle, a discussion plan recommended learning activities by using media small and large cubes made of cardboard. They were asked to calculate the volume of large cubes based on small cubes. They worked collaboratively in groups of 4-5 persons; the first students worked individually and then were asked to discuss the results of their thoughts in the group. Each student was given the opportunity to express her/his opinions. This activity provided an opportunity for them who were passive to express their opinions about the problems given. Students who still did not understand would get knowledge through explanation given by other group members. If all member of the group still did not understand, the teacher provided an opportunity and chance to ask to other groups. The results of the group discussions were brought in class discussions. The teacher chose one group to present the results of his work in front of the class. Based on the results of observations from learning activities for cycles 3 and
4, it can be seen that some students have shown an increase of their ability to express the opinions regarding the problems given. In groups, students were able to find relevant facts in providing explanations related to the solution that they have chosen. According to observers, students who were given the opportunity to be involved in the discussion could provide answers to the problems given, even though, some of them were still not perfect. This showed that there has been an increase in students’ critical thinking skills in learning activities. In cycles 3 and 4, the level of critical thinking ability of students has reached the stage of multi-structural thinking.

Learning activities that gave students an opportunity to actively participate starting with determining the topics to be studied, planning learning activities that will be carried out by students, and providing an open problem that allows students to find solutions by linking the available facts that can provide a learning environment which stimulates students’ critical thinking skills. The ability to think critically can be learned when students learn, so the ability of thinking can be implemented correctly and students become better thinkers [24].

The process of lesson study-based learning activities that carried out provided many benefits that can be learned by the lesson study team. Lesson study became a tool in improving the quality of the learning process. In addition, lesson study was also a learning tool for all members involved ranging from planning activities to reflecting learning outcomes. All team members in their respective classes can apply the results of observations. Through lesson study-based learning, there were several important things that could be considered by the team, namely (a) considering the given objectives of learning and teaching materials, (b) learning and developing the best learning, (c) considering the long-term goals of learning related to ability that should be mastered by students, (4) re-exploring knowledge related to the material to be taught, (5) doing collaborative planning activities, (6) observing the learning process through students’ activities, (7) observing the results of learning through both students and the results observations [25], [26].

Through the results of the lesson study-based learning process, students’ critical thinking skills different were obtained before and after in learning activities as shown in picture 1 below.

In the beginning of learning as seen from picture 1, most of students or 45.87% were in structural stage, 38.54% were in semi-structural stage, 13.32% were at the uni structural stage and 2.27% were in multi-structural stage. While, in the extended relational stage there was no student was able to reach this stage. After learning activities throughout the 4 cycles, students were given back critical thinking skills tests and the results obtained were 3.56% in the structural stage, 19.23% in semi structural stage, 60.38 in structural level, 10.56% in multi structural stage and 6.27% of students were in relational stage.

The lowest stage of thinking is the pre-structural stage where students were unable to organize the information given properly, misunderstanding the concept, and did not comply the instruction. The indicators of semi-structural thinking stage were; inability to organize information, misunderstanding of the concept, and did not do the tasks accordance with instruction, and still found many mistakes. Phase of thinking of unistructural has indicator of managing simple information and giving simple answers in solving problems. Multi-structural is a stage of thinking with the ability to analyze information from several points of view, but the information was still incomplete. Relational thinking has an indicator better ability to analyze information obtained from several sources so that it became more complete. Based on figure 1, it can be seen that there were students who have relational thinking skills after obtaining lesson study based learning activities.

The application of lesson study based on learning activities can increase students’ responsibility for their own learning process. The focus on each stage of lesson study activity was how to stimulate students’ ability learning [22]. In addition, students’ motivation and confidence also increased in each cycle by providing a problem that requires completion. Problems given were related to real events or contextual facts relating to the lesson material. The lesson study-based learning activities given student opportunity to find their own, analyze, and find solutions related to problems and present them [22]. This all may help students to improve their critical thinking skills.
4. Conclusion

Based on the results and discussion above, it can be concluded that the learning process based on lesson study can improve students' critical thinking skills. In the lesson study based learning process, the teacher has the opportunity to examine the best things that can be used in learning activities through the learning process from other teachers [27]. So that the teacher can design appropriate tasks to improve students' critical thinking skills. Lesson study based learning also provides benefits in observing student behavior in learning through the presence of observers. Through the Observer, the teacher can observe the improvement of students' thinking skills. Pedagogical dialogue that arises between students becomes data in categorizing students' critical thinking abilities [20]. In addition, the teacher also received feedback from observers, and was made an evaluation material through reflection activities [26]. Giving assignments that have been well designed make learning activities actively involve students, so they can improve students' thinking skills, especially critical thinking skills. The tasks given to students are assignments in the form of open problems and allow students to discover the concepts themselves. This can be the basis for improving the quality of learning.

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