The application of Lesson Study for LearningCommunity (LSLC)- based collaborative learning - integrated Realistic Mathematics Education (RME) to improve the students’ mathematical reasoning ability class IX D of MTSN 5 Jember on quadratic equation material

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Abstract. Students in each level of education are required to have mathematical reasoning ability. Students’ mathematical reasoning abilities were very low. Therefore, this research investigated the application of lesson study for learning community-based collaborative learning-integrated realistic mathematics education to improve the students’ mathematical reasoning ability. The method used was classroom action research and the material was quadratic equation in class IXD of MTSN 5 Jember in odd semester in 2019/2020 academic year. Mathematical reasoning was assessed through essay test. The data were obtained from the results of learning achievement test, conducting the observation, interview and observation of activity results of the teacher and students during the learning through lesson study for learning community-based collaborative learning-integrated realistic mathematics education. The mean result of pre-test on the students’ mathematical reasoning ability was around 42.50. While the mean result of post-test on the students’ mathematical reasoning ability improved as much as 88.13. This means that in the cycle I, the students’ mathematical reasoning improved. This indicated that lesson study for learning community-based collaborative learning-integrated realistic mathematics education improved the students’ mathematical reasoning ability.

1. Introduction

Reasoning and logical thinking were one of abilities developed through learning mathematics [1]. The students’ mathematical reasoning was obtained from the mathematical concept by instructing the students’ knowledge, so they would understand and use the procedures flexibly and precisely. The students’ mathematical reasoning developed through the learning objectives was encouraging students to be an individual who thought analytically and innovatively, learned to be active, creative and initiative, design of technology and programming, leadership, emotional intelligence and mathematical reasoning in solving problems as well as to equipped students with abilities needed in the 4.0 industry era [2].

The students’ mathematical reasoning was very minimums due to the low intake. Based on the observations and the teacher’s opinions other than the mathematics teacher class IX at MTsN 5 Jember, obtained information: (1) the students were lazy to read, (2) the teacher provided the formulas available in books and the students memorized the formulas, (3) the students’ worksheets used only contained exercises, (4) the students chatting with friends, (5) the students were accustomed to waiting for their friend who were appointed by teacher in collaboration with the learning group. Generally, the
problems occurred were the students’ knowledge was not meaningful, the students’ mathematical reasoning ability was not trained well and the less collaboration between students so they tended to think about their selves and ignored other friends around them. The students’ mathematical reasoning ability on quadratic equation material through realistic mathematics education as follows (1) understanding contextual problems, (2) explaining or describing contextual problems, (3) solving contextual problems, (4) comparing and discussing the students’ answers and (5) concluding the results of discussion [4, 5, 9, 11, and 12].

Collaborative learning-integrated realistic mathematics education was one of approaches where students learned to associate the material with the real world situation so they obtained the meaningful learning. LSLC was the form of modern lesson study by using collaborative learning and learning community construct [3, 13, and 14]. Several things needed to consider were how the students learned from one another and there was no one who was left behind, student gesture or study body movement [5, 6, and 13]. Thus, LSLC was described to more emphasize on examination on how the students learn and collaborate by giving jumping tasks according to the 2013 curriculum, compared to the examination on how the teacher teaches and masters the materials. The phenomenon above motivated the teacher to apply LSLC - based collaborative learning - integrated RME to improve mathematical reasoning abilities of the students’. This approach was implemented on quadratic equation problem by involving several teachers.

Previously, the research of S Rohman [5] aims to explore descriptively the ability of student literacy and teacher responses in learning mathematics with RME based on LSLC. The research of R Kusumawati [7] aims to improve students' creative thinking skills by using inquiry learning integrated collaborative learning based on LSLC. Meanwhile, this study explain the process of learning mathematics through students' mathematical reasoning with RME integrated collaborative learning based on LSLC.

2. Research Method

This research was a classroom action research. First, collecting quantitative data, it followed by qualitative data that presents findings from quantitative data. The quantitative research analyzes student learning outcomes after applying RME learning integrated collaborative learning based on LSLC to improve students' mathematical reasoning abilities. Then, the qualitative research aims to analyze data from observations and interviews of selected students.

In this design, there were six groups where each group consisted of four students who were selected heterogeneously based on the levels of high, moderate and low abilities. The research was done in 5 meetings with 3 times of treatments. Researchers ways to see changes in students' mathematical reasoning abilities are given pre-test and post-test in IXD class.

2.1 Sample

The sample of this research was IXD class MTsN 5 Jember, East Java, Indonesia, with 24 students consisted of 8 boys and 16 girls. Data were collected from September to mid-October 2019 in class IXD.

2.2 Instrument

John Elliot used the model which each cycle consists of several actions, namely between 3-5 actions. Each action might consist of several steps, which were realized in the form of teaching and learning activities [8], can be seen in Figure 1 below.
The instruments used by this research were learning tools which included Lesson Plan, Student Worksheets, and Learning Achievement Tests. The tools were the result of collaboration between mathematics teachers at MTsN 5 Jember. While the learning achievement test used pre-test and post-test to examine mathematical reasoning abilities of the students’ in the IXD class as experiment class. Beside the learning instruments, students’ activities observation sheets, observation of the learning instruments implementation, observations of the open class, and questionnaires of the students’ response.

2.3 Questions
The quadratic equation problems can be seen in table 1.

| Type of problem | Problem | Indicator |
|-----------------|---------|-----------|
| Essay           | In the image below, determine the area. | 1. Understand the contextual issues  
|                 | ![Image](image.png) | 2. Resolve the contextual problems  
|                 | | 3. Make conclusions |
| Essay           | The circumference of a rectangular city park is 90 m. If the park area is 450 m\(^2\), what are the length and width? | 1. Understand the contextual issues  
|                 | | 2. Resolve the contextual problems  
|                 | | 3. Make conclusions |

3. Research Finding
A pre-test consisted of two problems was carried out for one hour twenty minutes in the 1st meeting. The results of this pre-test were used to examine the students' mathematical reasoning abilities before the learning. The pre-test results can be seen in table 2.

| Information       |  |
|-------------------|---|
| The highest scores | 55 |
| The lowest scores  | 30 |
| Mean              | 42.50 |
| Standard Deviation| 7.37 |
In the plan stage, pre-learning activities, researchers expand learning tools and instruments collaboratively with colleagues [15]. Previously, the model teacher collaborated with mathematics teachers in grades 7 and 8 to formulate learning goals that were in line with core competencies and basic competencies and student intakes. This activity was attended by religious teachers (Al Qur’an Hadith, Islamic creed, history of Islamic culture, Fiqh). The instrument discussed was the implementation plan of learning as well as learning media, student worksheets and learning achievement tests adjusted to the moves of the RME approach with quadratic equation problems.

The open class is the main action of the LSLC. Five instructors and madrasah principals are involved in the open class with different tasks and roles. I myself became a model teacher in class IXD MTsN 5 Jember. Technically, the model teacher greets, prays together, validates students.

In the do stage, the teacher gives worksheets to each group, each group reads and understands contextual problems, applies and resolves to quadratic equation form, the teacher facilitates class discussion after one of the students present in front of the class and concludes the learning outcomes. Observer observed each group during the learning process and students’ activities.

In IXD class, students work together, ask each other questions and feel caring grows between friends. Student activities taken from one of the groups as a sample are presented in the following figure.

![Figure 2. Group Discussion Activities in class IX D.](image)

Figure 2 informs one form of interaction in class IXD during collaborating while working on the worksheets of the fourth meeting student was that S22 asked S23, for example length = p and width = l and obtained an explanation related to the form of the equation in algebra length + width = \( \frac{1}{2} \) circumference of a rectangular, by substituting the circumference value to be \( p + l = \frac{1}{2} \times 100 \), then simplified. S24 answered 50 to S22 and then S23 gave an explanation \( p + l = 50 \) and changed the form of the equation to \( l = 50 - p \). S21 answered the area of rectangle = \( p \times l \). Then, the value of the rectangle area was substituted. S22 justified the S21’s answer to be true, was \( p \times l = 400 \), then the substitution \( p \times (50 - p) = 400 \), \( p^2 - 50p = 400 \) with the root of solution \( (p - 40)(p - 10) = 0 \), so \( p - 40 = 0 \) or \( p - 10 = 0 \), where \( p = 40 \) or \( p = 10 \). S21 answered, for \( p = 40 \), and then the width was \( 50 - 40 = 10 \). S24 commented for \( p = 10 \), and then the width was \( 50 - 10 = 40 \). S22 concluded the length and width of the city park was 40 meters and 10 meters. S21 understood the material of quadratic equation from the process of caring community in his group. The students will be actively bounded in the learning legal action, so that their interests and motivations and interests grow and develop into confident to ask the group. In the context of LSLC, the most important part was granting the students the opportunity to inquire for a rescue from other students and those students provided responses [5, 6, 7, and 10]. Generally, the results of observations of student participation include activities to understand contextual problems, explain contextual problems, solve contextual problems, compare and discuss student answers, conclude the results of discussions in class IXD as an experimental class. It proved
that most of the students were active in the teaching and learning process. By 24 students in the class IXD as the experimental class, the very active 7 students were (29.17%), the active 13 students were (54.17%) and the other 4 students (16.67%) were less active. The results of students’ activities are presented on Figure 3 below.

The results of observation from the initial condition, the students' mathematics reasoning ability were obtained and increased in cycle I. It is presented on table 3.

| No | Indicator | Pre-treatment | Achievement indicator | Post-treatment Cycle I |
|----|-----------|---------------|-----------------------|------------------------|
| 1  | The students can understand contextual problems | 5 students (20, 83%) | ≥ 50% | 7 students (29, 17%) |
| 2  | The students can solve contextual problem | 2 students (8, 33%) | ≥ 50% | 12 students (50%) |
| 3  | The students can discuss about of the problem | - | - | - |
| 4  | The students can attract conclusion | 1 students (4, 17%) | ≥ 50% | 5 students (20, 83%) |

Indicator number 3 was not implemented because it was done individually by the students at the beginning of the meeting (pre-test) and at the end of the meeting (post-test). The activity was carried out while working on the student worksheet during the group discussion process, then it was presented to the class and other groups listened to the group's explanation and refuted it if there were incorrect of answers. It is illustrated in the student activities on Figure. 2. There was an increase as many as 7 students with the percentage of 29.17% on the indicator of understanding contextual problems. The biggest increase was in the indicator of solving problems with a percentage of 50% consisted of 12 students. The improvement of indicator concluded that as many as 5 students with percentage of 20.83%. This showed the ability of students' mathematics reasoning increases after the implementation LSLC - based collaborative learning-integrated RME to improve the students’ mathematical reasoning ability.
In the last meeting was conducted post-test to find out mathematical reasoning abilities of the students'. The post-test results can be seen in table 4.

**Table 4. Mathematics reasoning abilities of the students (post-test).**

| Information |   |
|-------------|---|
| The highest scores | 100 |
| The lowest scores | 75 |
| Mean | 88.13 |
| Standard Deviation | 8.70 |

Based on the analysis of the achievement test, 24 students were all got scores of more than equal to 75 out of maximum score of 100. The students were completed individually, so the percentage of students’ completeness learning classically reached 100%.

Students' answers on the achievement test in the first cycle that showed the students' mathematics reasoning abilities, whether it is improved quite well and presented with pictures.

![Student number 15 does not look for the value of x first with the Pythagorean theorem, but directly writes the triangle area formula. Students have not done three indicators of realistic mathematics education.](image1)

![Student’s number 6 and 19 used the concept of the Pythagorean Theorem, looking for the root value of solving the quadratic equation but not proceeding to substitute the value of x on the base of the triangle and the height of the triangle. Students have done indicators understanding contextual problems and solving imperfect contextual problems.](image2)

![Students number 4, 14, 21 and 22 uses the concept of the Pythagorean theorem, looking for the root value of solving the quadratic equation, then substituting the value of x on the base of the triangle and the height of the triangle. Because the size of a triangular base is never negative, students have understood and understood. Students are able to understand contextual problems, solve contextual problems, and make conclusions.](image3)
The students who possessed low-level mathematical reasoning were capable to show two indicators (understanding contextual problems, solving contextual problems) even though they did not write the correct answers. S15 only remembered the area of triangle, he immediately tried to solve it, and there

Students’ number 7, 8, 10, 17 and 20 used the concept of the Pythagorean Theorem; they looked for the root value of involving the quadratic equation, and then substituted the $x$ value on the base and height of the triangle. Because the size of the triangle base is never negative, they had already understood. They were to understand the contextual problems, solve them and draw conclusions.

**Figure 6.** The Answers of Higher-order student (for question one).

Students number 7, 8, 10, 17 and 20, looking for the root value of completing the quadratic equation, obtained $l = 60$ meters, because the size of the soil width is never negative. Students substitute $l = 60$ meters to the length of the ground $= (12 + l) = (12 + 60) = 72$ meters. Students are able to understand contextual problems, solve contextual problems, and make conclusions.

**Figure 7.** The Answers of Higher-order student (for question two).

The students who possessed low-level mathematical reasoning were capable to show two indicators (understanding contextual problems, solving contextual problems) even though they did not write the correct answers. S15 only remembered the area of triangle, he immediately tried to solve it, and there
was no final answer found since he forgot the concept of Pythagorean Theorem which required seeking the x value first.

Student responses to RME learning integrated collaborative learning based on LSLC, and then in-depth interviews were conducted with one male student and one female student from class IXD at MTsN 5 Jember. The excerpt from the interview is presented below.

"... The problem is challenging ma'am, because I have never learned this lesson before, which combines the concept of Pythagorean Theorem and the area of a triangle. But I Think it is fun, Mom, it makes us interested in learning ..." (S7). "... Mom, the time is not enough for me as I still find it hard to solve the roots of the quadratic equation ..." (S6).

The difficulties faced by most students were they did not memorize the multiplication, for example on essay number 2, with of $a = 1$, $b = 12$, $c = 4.320$. The students looked for multiplication factor in which its result was 4.320, if the result was added or subtracted, became equal to the value of $b = 12$. They felt confused and their concentration was reduced, so that the students' mathematical reasoning had not been well developed. It is in line with the objective of PISA study, which referred to find out the students' abilities in reasoning, identifying, and understanding, and using the basic mathematics needed in daily life, they must have mathematical literacy. The concept of mathematics literacy in question was the ability of students to formulate, utilize and associate mathematics in various problems. This includes mathematical reasoning and applying mathematical concepts, methods, proofs, and instruments to elaborate, affirm, and project events.

4. Discussion

The findings of LSLC - based collaborative learning - integrated RME to improve the students' mathematical reasoning ability of IXD grade students at MTsN 5 Jember on quadratic equation material were fulfilled. It was indicated by (1) the mean scores of pre-test in class IXD increased from 42.50 to 86.88 after given the post-test in which the students completed the quadratic equation material system, (2) the students' activities when they put themselves in the lesson very well, (3) the students' mathematical reasoning increases because students have been able to understand the problem, solve the problem and make conclusions even though in presenting the results of the discussion with timid lack of confidence. The learning goes well with an average of 3.53 in every aspect of realistic mathematics education indicators. Students' reasoning in solving mathematical problems can be seen from each indicator as follows: (1) the ability to understand contextual problems in presenting written mathematical statements in the initial conditions 20.83% increased to 29.17%, (2) the ability to solve contextual problems in conditions initial 8.33% increased to 50%, (3) the ability to make conclusions after checking the validity of an argument in the initial condition 4.17% increased to 20.83%. Regarding the results of students' responses, they gave positive responses more than 93.23% to the learning instruments and the application of LSLC-based collaborative learning-integrated RME.

Thus, for learning devices to achieve criteria, namely (1) the application of learning is categorized well, (2) the students respond absolutely to the learning tools and the application of RME integrated collaborative learning based on LSLC.

5. Conclusion

There was a significant effect of the LSLC - based collaborative learning - integrated RME to improve the mathematical reasoning ability of IXD grade students at MTsN 5 Jember on quadratic equation material. They were able to learn by interacting with each other and help others in understanding the contextual problems, solving contextual problems, discussing the problem solving and drawing conclusions. Teacher must be open-minded and provide opportunities for all of the students to find and share a variety of ideas/opinions/suggestions that they obtain and help or stimulate the students who have some difficulties in mathematical reasoning. Both students and teacher in the mathematics field, and teacher who take part in open-class activities gave positive responses to LSLC - based collaborative learning - integrated RME.
For future researchers, a RME approach should plot the time for implementing learning as effectively as possible so that it goes according to plan which can be practiced by students at different levels of education, other subjects with different sub-subjects and use other learning designs without eliminating the special characteristics of this learning namely LSLC.

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