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Student's Creative Thinking Skills in Mathematical Problem Posing Based on Lesson Study for Learning Community

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Student's Creative Thinking Skills in Mathematical Problem Posing Based on Lesson Study for Learning Community

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Abstract. The objective of this research is to find out the differences in terms of creative thinking ability between one class taught using implementing Mathematical problem posing based on Lesson Study for Learning Community (LSLC) and another class taught in conventional fashion. This research applied Mixed-Method study which was initiated by developing instructional instruments based on Lesson Study for Learning Community (LSLC) to train students' creativity, collaboration, and communication. This quantitative study applied experimental method with quasi experimental design. The results of this research indicated: (1) that the developed instruments meet validity, practicality, and effectiveness criteria; (2) There is ability difference of creative thinking in mathematical problem posing between the experimental class and the control class. The application of different learning in the two sample classes has an effect on the level of students' creative thinking skills. Mathematical problem posing based on Lesson Study for Learning Community can help students to understand the lesson.

1. Introduction

Life in the 21st century requires people to master skills in dealing with and preparing themselves for future challenges. The learning of the 21st century focuses on high-level capabilities and innovation abilities. There are 4 basic principles of learning in the 21st century, including student-center learning, education based collaboration, contextual learning, and schools are integrated with environment. The main skills that must be have is critical thinking, creative, communication, and collaboration [1], [2].

Various efforts have been made to grow these four skills, one of them is by implementing them in the learning process from elementary education to higher education. Learning models and methods should be aligned with 21st century skills. 21st century education requires learning process which has the power to stimulate students to think critically and creatively, communicate actively with learning community, and make meaningful learning by means of group learning. Problem posing based on Lesson Study for Learning Community (LSLC) may be the solution of these needs, because this learning can escalate students' creative thinking skills, while the application of LSLC can foster collaborative work and mutual awareness among the learning communities in the classroom.

Problem posing is student-centered learning. Students are asked to formulate or raise questions based on preliminary information that has been provided, then provide an opportunity to find a solution of the problem. The purpose of problem posing learning is to develop students' mathematical thinking skills, assist students in solving problems, and to develop creative thinking skills. In addition,

the application of problem posing also aims to improve students' learning and understanding of a material [3].

Creativity is a key skill of 21st century life and is seen as one of the skills given primary emphasis in education and employment. The application of problem posing is one of the efforts to train and develop creative thinking skills as it provides opportunities for students to develop the knowledge being studied, to understand the problem at hand, to build ideas of learned knowledge, and to train students to think comprehensively [4]. Creativity is an importance for humans because with creative thinking humans can develop their potential talents and can understand problems from different points of view [5], [6]. In this study, the ability to think creatively focused on filing a problem, measured using 3 creativity criteria, including fluency, flexibility, and novelty. Fluency is indicated by skill of students to generate many problems with correct solutions. Students are said to fulfill the flexibility aspect if they can create a question with different solutions or ways. Novelty aspect is evident when a student can come up with new and different problem than usual.

Other skills essential in 21st century life are collaboration and communication. Collaborative learning is interpreted as a condition where two or more people try to learn something together. Someone involved in collaborative learning takes the advantage of resources and skills with each other (asking each other questions about information, evaluating ideas for each other, monitoring each other's work, etc.) [7]. Problem posing based on Lesson Study for Learning Community Learning (LSLC) is the right answer to develop both of skills.

Lesson Study for Learning Community (LSLC) is part of Lesson Study (LS) which in practice is not only related to plan-do-see, but also involves collaborative learning, caring community, and jumping task. LSLC-based learning teaches students to learn in groups, care about each other, and most importantly, make sure that no student are left behind. The learning process involves not only students, but also teachers. Students and teachers learn from one another.

An important requirement in learning is that everyone should feel compelled to ask about what is not known [8]. In the context of LSLC-based learning, students are given the opportunity to ask questions and ask for help when they find it difficult to learn certain material. In addition, students are also trained to respond positively when their friends need help. As such, all students have a role in the learning process and no one feels neglected.

This research is different from previous research by Siska Ari Andini who discusses about students' activity on learning Problem Based Learning (PBL) oriented to LSLC [9]. Peni Anggareni, Dwiyana and Swasono Rahardjo studies discuss students' creativity in mathematical problem posing activities based on Intelligence Quotient [10]. What is more, the present study is also different from another work done by Tressyana Diraswati Novi Anggraeni about improving students' creative thinking ability through method of learning problem posing-geogebra [11]. This research focuses on the development of learning instruments based on Lesson Study for Learning Community (LSLC) designed to stimulate students in collaboration, communication, awareness in learning, and creative thinking ability. The developed instruments were then tested in two sample classes, the experimental class and the control class. Then analysis is performed to see whether differences are evident in students' creative thinking skills in both classes.

2. Methodology

The type of research is used Mixed-Method, which is a combination of qualitative methods and quantitative methods [12]. The first phase of research employed qualitative method by developing instructional instruments in the form of lesson plans, work sheets and test of creative thinking skills. The development of instructional instrument in this research was carried out using the Thiagarajan development model, which started with defining phase, designing stage, and development stage. The instrument was then tested to determine the instrument's validity and reliability. These instruments were considered eligible to use when they meet validity, practicality, and effectiveness criteria.

The next stage applied quantitative method. This part applied experimental research. The research design was quasi experiment with non-equivalent control group design. The population in this study were the seventh-grade students of Public Junior High School 1 of Jember. The sampling was done by cluster sampling, which relied on homogeneity test. The researcher took 2 classes as the samples, the experimental class and the control class. The experimental class, which was class VII A, was a class taught using mathematical problem posing based on LSLC. The instructional instruments proven valid and eligible were applied in the experiment class. Meanwhile, the control class (the class VII B) was a class taught in conventional learning, but was still based on LSLC. The following is a pattern of the treatments on the research sample.

Table 1. Proposed Design Patterns of the Research

Group	Treatment	Post-Test
Experimental Class (n=36)	X	O1
Control Class (n=35)	-	O2

X : Treatment by applying problem posing based on Lesson Study for Learning Community (LSLC)
O1 : The value of a creative thinking ability test of experimental class students
O2 : The value of a creative thinking ability test of control class students

Data collection techniques applied in the research were observation, tests, and questionnaire. The observation was carried out in open lesson by some observer to know an activities of teachers and students during learning. This observation data was reviewed as a further improvement in learning materials. Second technique, the test, was given in both classes, i.e. control class and experiment class. The questionnaire was mainly meant to know the student's response to the learning process. The research instruments in this research were observation sheet, creative thinking skill test, questionnaire, and students worksheet.

The results of Mathematical problem posing tests were checked and assessed according to the creativity aspects were met by the students. This data was used to determine students' creative thinking skills in both classes. The analysis of creative thinking skills tests was determined according to the student's creativity aspects, fluency, flexibility and novelty. The level of creative thinking skills [4] will be presented in the table below.

Table 2. Creative Thinking Level of Students

Aspects	The Level of Creative Thinking Skills	Description
Fluency, Flexibility, Novelty	4	Very Creative
Flexibility, Novelty		
Fluency, Flexibility	3	Creative
Fluency, Novelty		
Novelty	2	Fairly Enough
Flexibility		

Aspects	The Level of Creative Thinking Skills	Description
Fluency	1	Hardly Creative
Did not satisfy any criterion of creativity product	0	Not Creative

3. Results And Discussion

The study was initiated by developing instructional instruments in the form of lesson plan and worksheet of problem posing based on LSLC. These instruments were developed by integrating the creativity elements. Developed instrument were not only focused on creative thinking, but also concerned with collaborative learning and social awareness. There was also Jumping Task which was a means of students to innovate and develop thinking skills. In addition to lesson plan and worksheets, the researchers also developed test to measure creative thinking skills in the filing of problems. It is called the lesson plan. Prior to implementation, the developed instrument was validated by an expert, which resulted in the following validity profile.

Table 3. Learning Tool Validation Results

Tool	Validation Value	Validity Criteria
Learning Implementation Plan	3.76	Valid
Student Worksheet	3.76	Valid
Tests of Creative Thinking Skills	3.75	Valid

Validation was done by three lecturers of Mathematics Education at University of Jember. The validator was not only in charge of assessing the product, but also providing input as well as feedbacks to improve and produce appropriate and high quality instructional instruments. The validation result indicated that the developed instrument was valid and feasible to use.

Instructional instruments proven valid were then implemented in the experimental class in a series of treatments lasting for 3 meetings. In the Lesson Study stage, this process was called open lesson, while in the control class, the learning was carried out in conventional model (teacher model) but it still looked like LSLC. During the process, the students in both the experimental class and control class were divided into groups of four students. The observation on students' activity was done by some observers. Each observer observed 1 group. Observations were done based on students' learning activities, such as cooperation, peer tutoring, group discussion, sharing responsibility, and environmental awareness.

Lesson Study For Learning Community (LSLC) based learning was implemented in both sample classes. The implementation generated satisfactory results. Student activity in groups indicated improvement in each meeting. Students were more active in expressing their opinions while studying in groups. Students communicated with each other when working on the worksheets, where they compared the questions that had been made and cooperated in problem solving. When the students found some difficulty, students preferred to discuss with a group of friends, but some were asking the members of the nearest group. The students' engagement, ability of arguing, discussing, making

decision, and solving problem were well honed in this learning [13]. More competent students ran peer tutoring with other friends, so low-achieving students were aided to understand the material, leading to more active engagement. An important requirement in learning was that everyone had to feel compelled to ask about what was not known [8]. In this case, the teacher acted as a companion to students' learning, guiding and assisting the students when they found difficulty. This was also in line with the results of Siska Ari Andini's research, which showed that LSLC-based learning makes students more actively involved in meaningful learning [9]. This activity occurs because students interact in the discussion group (collaborative learning) and they grow a sense of attention among students so they feel comfortable when learning (caring community).

The last stage of the Lesson Study was a reflection activity, which was performed after the open lesson. In this study, reflections were performed during school breaks, where all observers took part. Both model and observer teachers made corrections to the lessons learned. Observation and reflection activities were important because teachers found many learning problems related to students' activities. These issues were the study material in improving the learning activities in the next meeting. This statement is in line with the opinion of Sato quoted by Saito in his article [14].

This is the advantage of implementing Lesson Study for Learning Community. Not only is this approach potential to improving the quality of learning during the Plan-Do-See process, but also is encouraging students for cooperation, active interaction between students, and mutual care to their environment, especially the classroom learning community. LSLC-based learning can be regarded as a place for students to practice learning together (learning together). The application of shared learning will train students to help each other [15]. Students with more ability will provide intensive assistance to low-ability students to solve mathematical problems. In learning Mathematics is not only focus on the mastery of the material, but also on the learning process that emphasizes on quality activities.

The effectiveness of learning was indicated by students' activities, completeness of learning achievement test, and students' response to learning. The students' activity in the experimental class increased, and the average percentage of the implementation of cooperative activities based on students and teachers' opinions was indicated to reach at least 80%. Student response to problem posing based on LSLC was also very good. This was known from the analysis results of questionnaires given to 36 students in the experimental class, stating that 86% of the students gave positive response to the learning. Students' learning mastery was seen from the value on the achievement test. Students were said to pass the course when they achieved a minimum score of 75 (according to Minimum Passing Criteria in school). Of the 36 students in the experimental class, 30 students, 83% of the total class, passed the criteria. Based on these three aspects, the study concluded that the developed instructional instruments met the effectiveness criteria.

The experimental treatment was given 3 times. Test of creative thinking skills held in the next meeting. Both sample classes were required to take the creative thinking tests of the same type with the same number of questions. Students' work results were categorized into creative thinking levels according to the creative aspects they met. The results revealed the students' creative thinking skills in both classes. To find out whether significant difference in the creative thinking skills was evident, the Mann-Whitney Test was performed. The Mann-Whitney test was performed to test the comparative hypothesis of two independent samples when the data was ordinal. Statistical analysis is presented in the following table.

Table 4. Mann-Whitney Test

	The Level of Creative Thinking Skills
Mann-Whitney U	251,000
Wilcoxon W	881,000
Z	-4,480
Asymp. Sig. (2-tailed)	, 000

Grouping Variable: Sample Class

Table 4 indicates that the significance value of thetest Mann-Whitney is 0.000. Because the significance value is less than 0.05, then the hypothesis stating that there is a difference of creative thinking ability between the experimental class and the control classis approved. The frequency of students' creative thinking level will be presented in the following table.

Table 5: Frequency of Creative Thinking Level in Sample Classes

Level of Creative Thinking Skills	Experimental Class (n = 36)	Control Class (n = 35)	Total
0	1	5	6
1	1	11	12
2	6	9	15
3	13	7	20
4	15	3	18

Table 6: Percentage of Creative Thinking Level in Sample Classes

Level of Creative Thinking Skills	Experimental Class (n = 36)	Control Class (n = 35)
0	2,8%	14,3%
1	2.8%	31.4%
2	16.7%	25.7%
3	36.1%	20%
4	41.7%	8.6%

The application of different learning methods in the two sample classes posed an effect on the students' creative thinking skills. Table 5 shows the distribution of students at each level of creative thinking level in each sample class, while table 6 shows the percentage. The data reveals that the creative thinking skills in problem posing of the students of the experimental class are better than those in the control class. A total of 36.1% of students in the experimental class were proven to reach creative category and 41.7% were found to attain very creative level. Meanwhile, a few others fell into the comprising of fairly creative, hardly creative and not creative. This value can be said to be quite substantial when compared to students in the control class. In the control class only 8.6% of students were considered very creative and 20% of students were proven to be at creative level. The findings concluded that the application of instructional instruments stimulated students to train their creative thinking in Mathematical problem posing. In addition, the learning was designed with the atmosphere of collaborative learning also, which thus helped students in understanding the material. Students learnt together and helped each other solve a problem [9].

Providing treatment in the form of Student Worksheet was proven very effective in training students' creative thinking. Students were trained in the fluency of asking questions, making and working on flexible questions, and they were given the opportunity to ask different questions. This treatment was given in several meetings because the stimulus to students required time.

Mathematics teachers should view students' creativity as an orientation of Mathematical activity developed and trained extensively at all levels of education [16]. Mathematics learning that includes problem solving and problem posing can help students develop their creative abilities to mathematics. Problem posing is a cognitive activity that requires students to develop their minds to improve their understanding of the structure and objectives of more complex tasks. [17] Through periodical assignments, teachers can enhance students' creative capacity.

Here is an example of student work that meets all three creative criteria. This student is one of the most creative students, based on the creative aspect that is fulfilled.

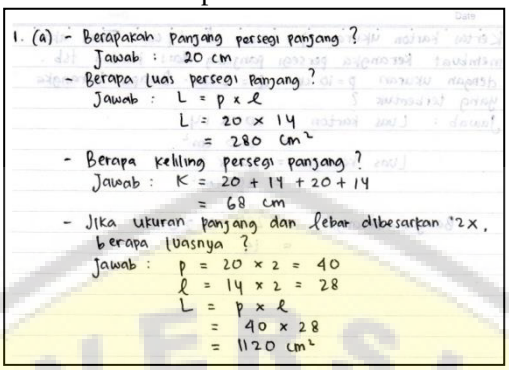

Figure 1. Students Work that Fulfill the Fluency Aspect

The picture above is the result of student work that fulfill the fluency aspect. For question number 1a on the test of creative thinking, students are required to make at least 3 questions based on the initial information that has been given. Initial information is a rectangular with a length of 20 cm and a width of 14 cm. Students are said to meet the fluency aspect in problem posing if they are able to make at least 3 questions with completion. The figure clearly indicates that the student is able to make 4 questions with the correct answer. In addition, he can be said fluency in problem posing. If there are students who are able to make at least 3 questions but there is one wrong solution, then this condition does not meet the smoothness aspect.

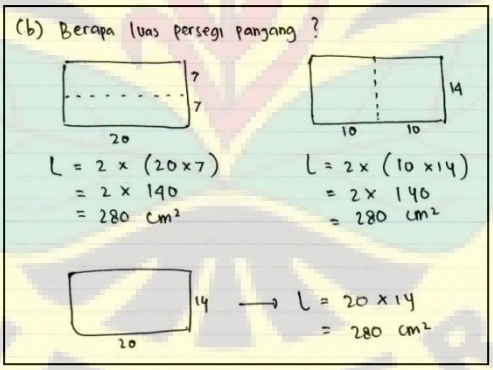

Fig. 2: Students Work that Fulfill the Flexibility Aspect

Problem 1b on a creative thinking test requires students to ask questions which are open to more than one alternative answer. The submission of this question is still based on the same initial information. The figure also reveals that students are asking questions about the area of the rectangular. There is no difference when it is seen in terms of the questions asked by the students. This question has been raised on the previous 1a. However, on the answer to question 1b, the students managed to show how he searched the rectangular area with 3 alternatives. At first, students divided the rectangles vertically and horizontally, then calculated the area. This is a different way of showing. The first attempt written on the answer to 1a problem is to directly calculate the area of the figure using the length and width as the initial information. The example proves the flexibility aspect in problem posing, because students can show other ways of finding the area of the rectangle.

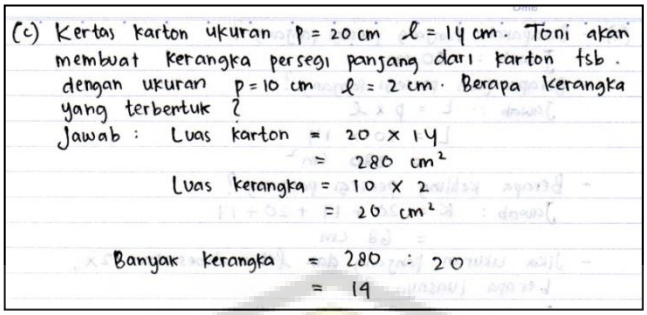

Fig. 3: Students Work that Fulfill the Novelty Aspect

Problem 1c on a creative thinking test requires students to ask new and different questions from others. The difference in this case is the question unfamiliar or rarely thought of by most students. When there are students who ask questions regarding broad, circular or diagonal figure, they are considered able to ask new questions. The previous picture shows that the student is able to make a question with different condition from the question asked by his friends. He not only raised comprehensive questions, but also added a few new problems. This is the reason the student meets the aspect of novelty in problem posing.

4. Conclusion

The present study has developed learning instruments for problem posing based on Lesson Study for Learning Community (LSLC). The instruments has gone through various processes and is declared valid, practical, and effective. The application of problem posing based on Lesson Study for Learning Community has been proven successful in stimulating student activities in collaborative learning, training communication with classroom learning communities, and training students' awareness.

Not only has the method been successful in increasing students' activity, developed instruments were also effective to train students' creative thinking ability, especially in problem posing. Classes that apply problem posing based on Lesson Study for Learning Community have better creative thinking abilities than those that do not.

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