Students’ creative thinking skill in the flipped classroom-blended learning of mathematics based on lesson study for learning community

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Abstract. Creative thinking skill is a thinking skill that generates new idea by combining any existing ideas to solve problems by using non-algorithmic, unusual, and unique methods. This research aimed to explore the development of mathematics learning instruments with the flipped classroom-blended learning based on lesson study for learning community and its implementation effect on students’ creative thinking skill. This research is multiphase mixed method research. This research was begun by research and development using 4D models to develop the learning instruments. Furthermore, a quantitative quasi-experimental research was conducted with non-equivalent pretest-posttest control group design. This research subject were 96 students on Class VIII at State Junior High School 2 Panji 2019/2020 academic year, consist of three treatment classes with two experiment classes and one control class. The research data were collected by questionnaire, observation, test, and interview. The research data were analysed statistically by Kruskal Wallis test. The results of this research show that (1) the mathematics learning instruments were valid, practically, and effective, and (2) the Kruskal Wallis test obtained significance value 0.017 (p<0.05), which indicated the implementation of the flipped classroom-blended learning model based on lesson study for learning community has significant effect on students’ creative thinking skill.

1. Introduction
At present and the next few years, the global society life was entering 21st century. In order to get well-being life in the 21st century, people need a combination of three types of skills known as 21st century skills, including character quality, literacy, and competency. Expected competency aspects were creativity, critical thinking skills, communication skills, and collaboration skills [1]. In addition, the world was also entering the fourth industrial revolution era which presents the latest technological developments with a combination of the physical, digital and biological fields that will affect all disciplines, economics, industry and government [2]. The World Economic Forum also released a report that, to compete in the 4.0 industrial revolution, people need complex problem solving skills, critical thinking skills, creativity, and seven other skills incorporated in "top 10 skills in the fourth industrial revolution" [3]. The report is strengthened by the research result which suggests that skill needed in the 4.0 industrial revolution is solve problem creatively in a harmonious group work [4]. Thus, creativity in solving problems is needed to be developed in faced the life challenges in the 21st century and the 4.0 industrial revolution.
Creativity is a product of creative thinking, while creative thinking is a thinking process to bring up new ideas by combining existed ideas [5]. Someone is said to have creative thinking skills if he be able to fulfills three indicators including fluency, flexibility, and novelty [6].

Creative thinking skills need to be developed through various subjects in the educational curriculum, including mathematics. The objective of mathematics subjects is equip students with the ability to think logic, analytic, systematic, critical, innovative and creative, as well as the ability to work together. Thus, students are able to obtain, manage, and utilize information and also solve life problems in ever-changing, uncertain conditions, and very competitive life. Until now, the mathematics learning objective is still not yet achieved.

The previous research results stated that students' mathematical creative thinking skills in solving open-ended problems were classified as less creative [7]. In fluency aspect, students were not fluent. In flexibility aspect, only 25% of students can use different ways to solve the problems. And students also unable to provide new or different ways for novelty aspect. In addition, junior high school students’ creative thinking skills are still low, both on the total score (18.03, on a scale of 0-100) and the scores on each indicators [8]. This results from the dominance of lecturing and practice questions. Small proportions (11%) have applied inquiry learning, simulation, and cooperative learning. However the problem based learning and project based learning models have never been applied in learning.

The lack of students' creative thinking skills in mathematics can be caused by many things. First, the teacher still emphasizes the learning process on mastery of the material rather than developing students' thinking skills and competencies. Second, both teachers and students are still of the view that the learning process is centered on the teacher or conventional learning, such as lectures, giving examples of questions, and giving assignments to do exercises, and not yet accustomed to carrying out learning that is centered on student activities or student centered learning. The third factor was the limited time and teachers’ ability in developing learning and assessment instruments that were oriented to the growth and improvement of creative thinking skills. As a result, as a fourth factor, the teacher only gives routine questions, which does not facilitate students to think creatively, think critically, and solve non routine problems.

To overcome this problem, the government has implemented the 2013 curriculum that was developed with a competency-based curriculum by conducting student-centered learning as a standard learning process. With the 2013 curriculum, teachers can implement various learning models so the learning process becomes meaningful that students are active in building their own knowledge and be able to achieve the mathematics learning objectives, especially creative thinking skills.

One learning model that is suitable with the development of current digital technology and can facilitate intensive student learning processes in gaining knowledge and thinking skills is a combination or blended learning model, known as the flipped classroom-blended learning model. The flipped classroom-blended learning model divides the learning sessions into independent learning sessions and face-to-face sessions with the teacher [9], [10]. Independent learning sessions enable students to utilize learning resources independently, thus students have a higher level of freedom in terms of speed of learning and time utilization. Conversely, face-to-face learning sessions that are directly guided by the teacher can be utilized to give students a learning experience through direct interaction with classmates to increase student activity collaboratively. In the flipped classroom, material was first given through learning videos that students must watch in their homes, while class sessions are used for group discussions and assignments [11].

The learning process will be more effective if the learning model was integrated with lesson study for learning community (LSLC). Lesson study is a model of fostering teaching profession through learning activities conducted by a group of teachers collaboratively and continuously to improve the learning qualities [12]. By contrast, lesson study for learning community (LSLC) is a modern paradigm of LS which is more oriented to the assessment of student activities and how students learn and collaborate rather than assessing how teachers teach. Learning community has a vision that students should not be left alone in the learning process [12]. Teachers must know, care, and educate to students who are troubled and facilitate them in order to learn collaboratively. LSLC has supporting
elements including learning community, collaborative learning, caring community, and jumping tasks. The results of previous studies indicate that the implementation of LSLC-based learning affects the students’ creative thinking skills [13]–[16]. LSLC-based learning also influences student’s higher order thinking skills [17].

Based on the mismatch between the expected objectives and the facts related to the mathematics learning in enhancing students’ creative thinking skills, it is necessary to conduct research about students’ creative thinking skills in mathematical learning with flipped classroom-blended learning models based on LSLC. This research aims to explore the development of mathematical learning instruments with flipped classroom-blended learning model based on lesson study for learning community and its implementation effect on students’ creative thinking skill in relation and function material.

2. Research Methods

2.1. Research Design

This research is mixed method research that combines qualitative and quantitative research to obtain more comprehensive, valid, reliable and objective data. The mixed methods research design was multiphase mixed methods with the QUAL - QUAN - QUAL scheme [18]. The following figure is the scheme of multiphase mixed methods research design.

![Figure 1. Multiphase Mixed Methods Research Design](image)

The first phase is developmental research, which will be implemented using the Thiagarajan, Semmel Semmel developmental model and to develop flipped classroom-blended learning based on LSLC learning instruments, including lesson plan, learning video, students’ worksheet and learning outcomes test. The research design of the Thiagarajan, Semmel and Semmel developmental model consists of four stages known as the 4D model [19]. The four stages were define, design, develop, and disseminate.

The second phase is quantitative research using quasi experimental research design. The design of this experimental design was said to be quasi, because researcher cannot controls other variables that affect the experiment [20]. The type of quasi-experimental research design which applied in this research is non-equivalent pretest-posttest control group design. The following table presents a form of non-equivalent pretest-posttest control group design.

| Table 1. Nonequivalent Pretest-Posttest Control Group Design |
|-------------------------------------------------------------|
| Treatment Group   | Pretest | Treatment | Posttest |
| Experiment I      | O1      | X1        | O4       |
| Experiment II     | O2      | X2        | O5       |
| Control           | O3      | X3        | O6       |

Explanation:

O1 = Pretest on the first experiment class
O2 = Pretest on the second experiment class
O3 = Pretest on control class
X1 = Treatment implementation of flipped classroom-blended learning based on LSLC with student worksheet
X2 = Treatment implementation of flipped classroom-blended learning based on LSLC without student worksheet
X3 = Treatment implementation of conventional learning or other learning model.
O4 = Posttest on the first experiment class
O5 = Posttest on the second experiment class
O6 = Posttest on control class

This research design involved students who came from three classes at the same level. Before conducting the research, all three groups/classes were given a pretest to determine the students’ initial abilities. During the research, the first group was given treatment the implementation of flipped classroom-blended learning based on LSLC assisted by student worksheets as the first experiment class. The second group was given treatment the implementation of flipped classroom-blended learning based on LSLC without assisted by student worksheet as the second experiment class. While the third group was given treatment other learning model as a control group. At the end of this research, the three treatment groups were given a posttest to find out the students' creative thinking skills.

While the third or final phase is descriptive qualitative research, which aimed to describe the profile of mathematical creative thinking skills between students who learn with the flipped classroom-blended learning based on LSLC and students who do not participate in the flipped classroom-blended learning based on LSLC.

2.2. Research Subject
The research subjects were students of class VIII in State Junior High School 2 Panji Situbondo on 2019/2020 academic year. The students was determined to be a participant of the trial test of flipped classroom-blended learning instruments and also quantitative research subject by using cluster random sampling. And the determination of qualitative research subjects use purposive sampling by selecting two subjects which categorized as very creative and not creative students in each class.

2.3. Data Collection Techniques
In this research, there were two types of research data, namely quantitative and qualitative data, as a consequence of applying mixed methods research. The quantitative data include (1) data from the learning and research instruments validation, (2) learning observation data, (3) students' response, and (4) data from the pretest and posttest of students' creative thinking skills in mathematics. While the qualitative data include (1) comments and suggestions of learning and research instruments validator, (2) observers’ comments and suggestions during the learning, and (3) the results of student interviews regarding the profile description of students' creative thinking skills. The research data were collected by (1) questionnaire, (2) observation, (3) tests, and (4) structured interviews.

2.4. Data Analysis Technique

2.4.1. Data Analysis of Research and Development. The research and development data were analysed to ensure whether the flipped classroom-blended learning based on LSLC learning instruments fulfilled valid, practical and effective criteria or do not. Data which obtained in research and development were analysed using descriptive statistical analysis techniques, such as presentation of tables, averages, medians, modes, and variances [19].

2.4.2. Data Analysis of Quantitative Research. Data which obtained in quantitative research were posttest scores of creative thinking skills that will be analysed statistically with the Kruskal Wallis Test data analysis technique through the SPSS Version 22 software. The Kruskal Wallis Test data analysis technique was chosen, because that the Kruskal Wallis test was used for comparative statistical analysis of three independent samples or more with nominal or ordinal data [20]. Before the quantitative data were analysed, the data needs to be examined for normality and homogeneity as a prerequisite for conducting inferential statistical data analysis. The data normality test using the
Kolmogorov-Smirnov Test with the significance of Lilliefors, while the data homogeneity test using the Analysis of Variance Test with the significance of Levene’s Statistic.

2.4.3. Data Analysis of Qualitative Research. Qualitative data analyses in this research were (1) data reduction, (2) data display, (3) triangulation, and (4) conclusion drawing/verification.

3. Results and Discussion
The research began by conducting research and development to develop mathematics learning instruments with flipped classroom-blended learning models based on LSLC including lesson plans, learning videos, students’ worksheets, and creative thinking skills tests. The four learning instruments have been validated by three validators consisting of two lecturers from the Mathematics Education Department and a mathematics teacher. The following figure will presented the results of learning instrument validation by validators.

![Figure 2. Results of learning instruments validation](image)

From the Figure 2 above, it obtained learning instruments validation average value 4.20 on a scale of 1 – 5. This result shows that the learning instruments were declared valid. The validated learning instruments then tested to determine the level of practicality and effectiveness. The practicality value was obtained through observing the implementation of the learning instruments in the class. While the effectiveness of learning instruments was assessed based on learning activities, responses, and students’ learning outcomes. The following figure will displayed the result of learning instruments implementation observation.

![Figure 3. Observation results of learning instruments implementation](image)

Based on the feasibility of the learning instruments observation results, it obtained an average practicality score 4.27. This can be stated that the learning instruments have a high practicality value. The results of learning instruments effectiveness test was based on learning activity data and students’ responses were presented through the figure below.
The results of students’ learning activities observation during mathematics learning instruments trial showed an average value of learning activities 69.94% with “active” category. The average value of students’ mathematics learning outcomes in the learning instruments trial is 68.77 with “enough” category. It was also known that as many as 26 of 31 students or 83.87% of students scored above 60 or reached the “enough” category. In addition, 87.74% of students gave positive responses to mathematics learning instruments using flipped classroom-blended learning models based on LSLC. Student responses stated that they liked and were interested in learning mathematics with the learning instruments that had been developed. Based on data from observations of learning activities, questionnaire responses, and the value of students’ learning outcomes, mathematics learning instruments with flipped classroom-blended learning models based on lesson studies for learning community that have been developed can be declared effective. Thus, as a whole the learning instruments fulfilled the valid, practical and effective criteria, so that it is feasible to be implemented in mathematics learning.

The next stage is conducting quantitative research to test the effect of the implementation of mathematics learning instruments using flipped classroom-blended learning models based on LSLC on students’ creative thinking skills. Before being analyzed statistically, the pretest and posttest data of students’ creative thinking skills were tested for homogeneity and normality of the data. The following will present the results of data homogeneity test through Levene's test and the results of data normality test through Kolmogorov-Smirnov with Lilliefors significance.

| Table 2. Data Homogeneity Test Results |
|----------------------------------------|
|                                      |
| **Levene Statistic** | df1 | df2 | Sig. |
|----------------------|-----|-----|-----|
| pretest              | .120| 2   | 93  | .887|
| posttest             | .023| 2   | 93  | .977|
Table 3. Data Normality Test Results

| treatment                        | Kolmogorov-Smirnov with Lilliefors Significance Correction |
|----------------------------------|----------------------------------------------------------|
|                                  | Statistic | Df | Sig. |
| pretest                          | .153      | 32 | .055 |
| first experiment                 | .150      | 32 | .064 |
| second experiment                | .148      | 32 | .071 |
| control                          | .153      | 32 | .056 |
| posttest                         | .150      | 32 | .064 |
| first experiment                 | .148      | 32 | .071 |
| second experiment                | .148      | 32 | .071 |

Based on the tables above, the homogeneity test results showed Levene statistic 0.120 for pretest data with significance 0.887 and 0.120 for posttest data with significance 0.023. So, it can be stated that pretest and posttest data of students’ creative thinking skill were homogeneous. On the other hand, the normality test results by Kolmogorov-Smirnov with Lilliefors Significance Correction showed significance degree more than 0.05 for pretest and posttest data overall the treatment groups, so it also can be stated that pretest and posttest data of students’ creative thinking skill were normal distributed.

After examining the homogeneity and normality test, students’ creative thinking skill data can be analyzed statistically to prove the research hypothesis. Because of students’ creative thinking skill data was ordinal and there were three treatment groups in this research, it will be conducted Kruskal Wallis Test for data analysis by using SPSS Version 22 software as follow.

Table 4. Kruskal-Wallis Test Results

| posttest | Chi-Square | df | Asymp. Sig. |
|----------|------------|----|-------------|
|          | 8.192      | 2  | .017        |

Based on the table 4 above, the Kruskal-Wallis test results showed chi-square value 8.192 with significance 0.017. By obtaining significance degree less than 0.05, it can be stated that there was significance effect of mathematical flipped classroom-blended learning based on LSLC to the students’ creative thinking skill.

This research results proved that the flipped classroom-blended learning model based on LSLC was effective to be implemented in mathematics learning, especially in enhancing students’ creative thinking skills. In this research, the learning model has been implemented in both the first experiment and second experiment class. The different between them are using students’ worksheet or not. In the first experiment class, students learn with the flipped classroom-blended learning based on LSLC assisted by students’ worksheet. But in the second experiment class, students learn with the flipped classroom-blended learning based on LSLC without students’ worksheet. And the other one, students in control class learn using conventional learning without students’ worksheet.

The flipped classroom-blended learning model reversed the learning material delivery activities by teacher from the class into watching the learning material delivery by video in each students’ home, while the face to face learning session in the class was used to conduct group discussions, problem solving, and project activities collaboratively among the students with teacher guidance [9]. In flipped classroom, students have been a theoretical knowledge and problem understanding to be solved when they were entering or joining the face to face learning session in the class [21].

The face to face learning session in flipped classroom-blended learning will be more effective by implementing the learning model based on lesson study for learning community (LSLC). LSLC has supporting elements including learning community, collaborative learning, caring community, and jumping tasks. By implementing LSLC in face to face learning activities, students can learn with each other’s collaboratively and there was no student left behind [12]. Students who still not understood the material, they will ask and discuss with their friends which have been understood the learning
material. This condition will be realized if teacher implementing collaborative learning. Collaborative learning enables students to learn, give a respect, care, and receive each other, so students will not feel isolated in the learning group [22].

In the experiment classes, before attending the face to face learning session, students watched the learning material delivery about relation and function by video in each home. When attend the face to face learning session in the classroom, students can ask and discuss about the learning materials video which have been watched with their friends and teacher. The learning process in the classroom will be developed into group discussion, problem solving, or project activities in a learning group collaboratively by implementing LSLC philosophy. Each group consists of 4 students with heterogeneous gender and learning capacity. In the experiment classes, students with each group tried to discuss and solve the problems by sharing task about relation and function materials collaboratively. Teachers’ roles were facilitates a collaborative learning among students in order created learning community in each students’ group. Teacher must know, care, and educates the students who have a problem by facilitated them in order can learn collaboratively. Students who still didn’t understood about the materials immediately asked to their friends in group, and other student who has been understood give an explanation about the materials, so that all students in each group have a same understanding and learning outcomes about relation and function material. The figure 6 below will presents one group as a sample of students’ learning activities in mathematical flipped classroom-blended learning based on LSLC.

![Figure 6. Students' learning activities in the first experiment class](image)

In the control class which implemented conventional learning, group discussions and students’ learning activities did not run well. Students in the control class can’t learn collaboratively. Students who still didn’t understood feel shy and didn’t tried to ask a question about the learning material to the other students in the group, and students who have understood didn’t care to share and giving explanation to their friend who still didn’t understood about the material. So, there was no learning and caring community created in the control class. The figure 7 below will presents one group as a sample of students’ learning activities in the control class.

![Figure 7. Students' learning activities in the control class](image)

Based on students’ learning activities among the treatment classes and the results of data analysis in this research, it has been proved that the mathematical flipped classroom-blended learning based on LSLC was effective on enhancing students’ creative thinking skills. The following table will show students’ creative thinking skills profiles among experiment and control classes.
Table 5. Students’ Creative Thinking Skill Profiles

| Level of Creative Thinking Skills | First Experiment Class | Second Experiment Class | Control Class |
|----------------------------------|------------------------|-------------------------|---------------|
|                                  | Frequency | Percentage | Frequency | Percentage | Frequency | Percentage |
| 0 (Not Creative)                 | 1         | 3.13%      | 4         | 12.50%     | 6         | 18.75%     |
| 1 (Less Creative)               | 5         | 15.63%     | 7         | 21.88%     | 9         | 28.13%     |
| 2 (Adequate)                    | 11        | 34.38%     | 9         | 28.13%     | 10        | 31.25%     |
| 3 (Creative)                    | 6         | 18.75%     | 7         | 21.88%     | 5         | 15.63%     |
| 4 (Very Creative)               | 9         | 28.13%     | 5         | 15.63%     | 2         | 6.25%      |

From table 5 above, it seems that the frequency of creative and very creative students in the first experiment class is more than the second experiment and control classes. This finding showed that students’ creative thinking skill in mathematics can be enhanced by implementing flipped classroom-blended learning based on LSLC assisted by students’ worksheet. By using worksheet which developed, students were trained to think creatively refer to fluency, flexibility, and novelty aspect. Fluency pointed to many ideas in responding questions or problems. Flexibility pointed to posing much ways and ability to change the methods or thinking approach in problem solving. While the novelty pointed to ability in posing new and unique ideas which think rarely by other people.

Figure 8. The snapshot of students’ creative thinking skill in solving relation and function problems

The figure above showed the snapshot of creative thinking skill in solving problem about relation and function material from one student in the first experiment class. From the left figure, it seems that student fulfilled fluency aspect of creative thinking skill by answering three relation rules from two sets given with two ways in present the relation consist of arrow diagram and ordered pair set. On the right figure, it also seems that student fulfilled fluency, flexibility, and novelty aspect of creative thinking skill by presenting two ways in solving function problem. The student can modify the function pattern to find the general pattern of the function, and determine the value of the function. The student also presents a new and unique ways to determine the value of the function without modifying the function pattern, so that student has fulfilled novelty aspect. And based on creative thinking skill level, this student has the 4th level of creative thinking skill which categorized as very creative.
This research results was similar with other researchers’ research finding which stated that flipped classroom-blended learning was very useful and effective in enhancing students’ learning outcomes and also stimulating their learning motivation [23], [24]. The flipped classroom-blended learning also can enhance students’ teamwork ability [25]. In addition, students’ learning achievement, motivation, and their problem solving skills which learn with the flipped classroom-blended learning were better than students who learn with conventional learning [21], [26].

On the other hands, some of research findings from other researchers also stated that the implementation of learning models based on LSLC have a significant effect to the students’ learning outcome, especially creative thinking skills [13]–[16], [27]–[32]. And the implementation of open-ended based collaborative learning has a significant effect to the students’ creative thinking skills in solving two variable equation system problems [16].

4. Conclusions
Based on the research results and discussions, it can be concluded that the mathematics learning instruments of flipped classroom-blended learning based on lesson study for learning community fulfilled valid, practice, and effective criteria. Besides that, the implementation of mathematical flipped classroom-blended learning model based on lesson study for learning community has significant effect on students’ creative thinking skill.

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