The analyze of students’ creative thinking skills on Lesson Study for Learning Community (LSLC) based on Science, Technology, Engineering, and Mathematics (STEM) approach

D Yuniar¹,², Hobri¹,², A C Prihandoko¹,³, K Aini¹,², and A K A Faozi¹,²

¹LS iMel (Lesson Study in Mathematics Learning) University of Jember, Indonesia
²Mathematics Edu. Depart. University of Jember, Indonesia
³Information Technology Dept., University of Jember, Indonesia

Email: airlanggabening@gmail.com

Abstract. This research was intended to develop mathematics learning tools on Statistics material on the seventh grade of junior high school through Science, Technology, Engineering, Mathematics based on Lesson Study for Learning Community and its effect on the students’ creative thinking ability. The method used was the mixed-methods combining qualitative and quantitative researches. Thiagarajan model as the developmental research was taken as the qualitative one. This research consisted of three classes; two experimental classes and one control class. The experimental design used was non-equivalent control group design. In normality test, the data obtained were normally distributed and the data were proved homogeneous based on the homogeneity test, so that it was necessary to do parametric data analysis by using One-Way ANOVA analysis. Based on the results of this research, the conclusions were summed up into: (1) The development of learning tools were categorized to valid, effective and practical, (2) The application of LSLC-based STEM had a significant effect on the students’ creative thinking ability which was indicated by a significance value of 0.000 (p<0.05).

1. Introduction
The 21st century learning refers to a learning transition in which the curriculum being developed requires the school to change its learning approach in order to help the students have higher-order thinking skill. Zohar and Cohen pointed out that one of higher-order-thinking skill needed was the ability to think creatively [25]. The students’ creative thinking abilities on mathematics are still relatively low. Anderson stated that the low-creativity in working on mathematical problems was seen from the students who often found it hard while working on different types of problem given by teachers [2]. The students also get confused when they are given the type of questions that have been developed by teacher. Moreover, the students are only able to provide one solution to solve problems, it shows that their reasonings were less while solving problems. Ersoy and Baser said that to achieve creative mathematics learning, each individual must be able to express himself efficiently and find the similarities or differences from the problems they faced [7]. Silver revealed three criteria to measure creative thinking abilities covering fluency, flexibility and novelty [20]. Siswoyo described the level of creative thinking as shown on Table 1 below.
**Table 1.** The level of creative thinking.

| Creative thinking skill level | Description |
|-------------------------------|-------------|
| Level 4 (Very Creative)       | Student can show fluency, flexibility and novelty or flexibility and novelty |
| Level 3 (Creative)            | Student can show fluency and novelty or fluency and flexibility |
| Level 2 (Adequate)            | Student can show flexibility or novelty |
| Level 1 (Less Creative)       | Student can show fluency |
| Level 0 (Not Creative)        | Student can not show fluency, flexibility and novelty |

An approach which is predicted to be able to facilitate the students in understanding a concept and creativity is Science Technology Engineering Mathematics (STEM) approach. STEM was defined as a learning approach combining two or more fields of science contained in STEM to foster the students’ learning [18] [10] [12]. Ceylan and Ozdilek said that literacy in Science, Technology, Engineering, and Mathematics played an important role in science related to 21st century programs [4]. Daugherty stated that STEM education became a motivating factor to enhance weakened education over the past one or two decade [5]. Bybee also believed that STEM must also increase technological emphasis on school programs to solve problems related to real-life [3]. Roberts and Cantu developed three different STEM learning approaches for teachers involving Silo Approach, Embedded Approach, and Integrated Approach [16].

**The Silo Approach**

![](figure1.png)

Figure 1. Silo approach to STEM education.

Concentrated learning of each subject enabled the students to gain deeper understanding of the disciplines [16]. The instructions of STEM Silo are marked by the classes that are encouraged by the teacher. Morrison emphasized that the students were provided with little opportunity to “learn while doing”, instead of teaching them what must be known [13].

**The Embedded Approach**

![](figure2.png)

Figure 2. Embedded approach to STEM education.

The International Technology and Engineering Education Association (ITEEA) states that on practical side, an embedded approach became effective teaching since it was intended to strengthen and supplement the materials needed for learning in other classes [6]. The teacher of technology
education used this approach to foster the lessons that were beneficial to students through understanding and applying [16].

**The Integrated Approach**

![Figure 3. Integrated approach to STEM education.](image)

Merging can be done at least two disciplines [16]. Morrison and Bartlett revealed that STEM in this approach is more teaching each discipline as a subject of learning [14]. Wang in his research asked students to connect content from various disciplines [24]. Sanders mentioned that ideally, integration allowed the students to reach the mastery of competencies needed to complete the assignments [18]. In this research, the researcher used an Integrated Approach.

By applying EsciT (Entrepreneurial Science Thinking) module, this research conducted the STEM learning steps below [22].

- **Observe**
  The students were assigned to do the observations on various phenomena found in the environment of daily life which linked to the material concept being taught.

- **New Idea**
  The students observed and obtained the information about various phenomena or products related to the topics discussed, then they applied the steps of new idea. The students looked for the information and products related to the material, then they were asked to find and think of a different new idea from an existing idea or product.

- **Innovation**
  Learners described what things that must be done so that the ideas generated in the step of new idea could be applied.

- **Creativity**
  This step was the implementation of all suggestions and views from the results of discussion about the idea of a new product to be applied.

- **Society**
  In the final step students are expected to be able to apply learning in everyday life.

Since the early 1900s, Lesson Study has developed in Japan. Takahashi & McDougal explained that Lesson Study was not a method or learning strategy but a teacher professional development in which there were collaborative and ongoing learning assessment activities to build a learning community [23]. Akiba revealed that currently Lesson Study had been widely adopted by many countries in the world. Some research related to lesson study had been widely carried out by researchers, for example by Akiba, about the adoption of the lesson study to enhance the professional development of teachers in Florida [1]. Other research related to lesson study also conducted by Schipper stated that lesson study in the United States had a positive impact on teacher performance related to his professionalism in teaching and collaboration to create new teaching materials [19]. Lesson study continued to experience development in Indonesia. At the end of 2004, a Japanese International Cooperation Agency (JICA) expert was first introduced a series of follow-up program activities from the Indonesian Mathematics and Science Teaching Education Project (IMSTEP) in Indonesia. The IMSTEP activities aimed at improving the quality of mathematics and science education in Indonesia. Furthermore, through the activities program, lesson study was developed in
schools (2006-2008) in three pilot target areas included Sumedang Regency (West Java), Bantul Regency (DIY), and Pasuruan Regency (East Java).

Today, Lesson Study has developed into Lesson Study for Learning Community (LSLC). Saito revealed that the goal of the learning community was that the students learned from one another (listening to one another and hearing each other), and that the teachers must also learn from each other [17]. There were several main elements in the implementation of LSLC, including: collaborative learning, caring community, and jumping tasks. The main elements in LSLC in learning activities were as follows [9].

- Collaborative learning
  Refers to the formation of groups consists of four people of different sexes to learn from each other in small groups.

- Caring community
  Refers to the students interaction within a study group, the teacher is only a facilitator.

- Jumping task
  Provision of challenging questions to improve students' abilities.

Koivuniemi, Järvenoja, & Järvelä revealed that collaborative learning also had a positive effect on student learning atmosphere, made participation evenly distributed and further increased student learning motivation [9][11]. In this study, the elements analyzed in LSLC activities are learning in general, teacher activities, and the most important thing is collaborative learning of students in study groups. In this case, in practical learning activities, LSLC places more emphasis on assessing how students learn in their groups.

Therefore, to improve students' creative thinking abilities, it is necessary to develop learning tools with LSLC-based STEM approach. In this study collaboration was conducted between teacher and teacher, teacher and student, or between students to increase collaboration and mutual care. While the elements that can train students to think creatively are found in student worksheet and learning achievement test. The STEM learning steps used are: (1) Observe, (2) New Idea, (3) Innovation, (4) Creativity, (5) Society.

2. Research Methods
This research is mixed methods or combination methods [21]. The effectiveness of the process was examined by qualitative methods using development research while the effectiveness of the results was tested by quantitative methods using quasi-pretest-posttest control group design experiments. The development of this learning tool used Thiagarajan, Semmel & Semmel (4-D) development model consisted of four stages namely define, design, develop, and disseminate [8].

2.1 Population
The population in this study was IX grade students of Lumajang Islamic Middle School (SMI) in 2019/2020 academic year. The sampling of this study used a cluster random sampling technique and 3 classes were selected randomly from 8 existing classes. The class chosen as the control class was class VIIA, the class chosen as experimental class 1 was class VIIC, and the class chosen as experimental group 2 was class VIIE. The control class consisted of 28 students used the conventional learning model, the experimental class 1 consisted of 28 students used STEM approach, and the experimental class 2 which also consisted of 28 students used LSLC-based STEM approach.

The design used in this study was the pretest-posttest control group design. An overview of the design of the research carried out can be seen on Table 2 below.

| Class      | Pre-test | Treatment Stage | Post-test |
|------------|----------|-----------------|-----------|
| Control    | X_1      | Conventional    | X_2       |
| Experiment 1 | Y_1    | STEM Approach   | Y_2       |
| Experiment 2 | Z_1    | LSLC-based STEM Approach | Z_2   |
2.2 Instrument
This research development aims at developing mathematics learning tools with LSLC-based STEM approach on the subject of Statistics. The learning tools were developed in the form of Lesson Plan, Student Worksheets, and Achievement Tests. In addition, validation was also carried out to the research instrument, that was the observation sheet of teacher activities, student activities, open-class observation, and response questionnaire. If the device has been validated by a validator and declared valid, then the device can be used in research. But if it is not yet valid, it needs to be revised according to the validator’s input.

2.3 Task
Assignment given to students are pre-test, post-test and student worksheets arranged based on indicators of students’ creative thinking with the STEM approach. The control class and 2 experimental classes were given the same test, while the student worksheets were given to the two experimental classes. Experiment class 1 got the student worksheets with the STEM approach, and the experimental class 2 received student worksheets with the STEM approach based on creative thinking indicators, students are asked to solve Statistic problems, assignments given to students are follows:

2.4 Data collection and data analysis
In quantitative research, data were collected through tests. The quantitative data were analyzed by using SPSS software version 19, which was previously conducted a prerequisite test in the form of a normality test and a homogeneity test. The test of normality used Kolmogorov-Smirnov test, while the test of homogeneity used Levene Statistical test with a significance level of 0.05 (P <0.05). If the data were normally distributed, One Way Anova test would be carried out, and if the data were not normally distributed, non-parametric test would be carried out by using Mann-Whitney Test.

3. Research Findings
This research was conducted in the odd semester at Islamic Junior High School (SMI) Lumajang or SMP Islam (SMI) Lumajang in 2019/2020 academic year. VIIA was chosen as the control class, VIIC as an experimental class 1 and VIIE as an experimental class 2. This research was conducted in 3 stages that are "Plan", "Do", and "See". This research aimed to develop learning tools and see their
effects on students' creative thinking abilities. The learning tools in this research must meet three criteria, namely valid, practical, and effective [21]. Descriptions of the three assessments are described as follows.

3.1 The validity of learning tools

The initial stage in this research was "Plan". The research team consisted of 5 mathematics teachers prepared and designed the development of mathematics learning tools with the LSLC-based STEM approach to see their effects on students' creative thinking abilities. After designing learning tools and research instruments, they needed validation from 2 expert lecturers and 1 mathematics subject teacher to obtain input, suggestions, and improvements to the learning tools and research instruments used in research. The 2 expert lecturers were Mathematics Education lecturers at University of Jember and 1 teacher was a mathematics subject teacher who teaches at Islamic Junior High School Lumajang class VII. Validation was done by providing learning tools in the form of lesson plan, student worksheet, learning achievement test and research instruments in the form of Teacher’s Activity Observation Sheet, Student’s Activity Observation Sheet, Student’s Response Questionnaire Sheet to Students Worksheets, and the Open Lesson Observation Sheet which must be filled out by the validator. Data from the validation results for each component of the learning tools were analyzed by calculating the average score obtained by each component. The average score obtained for lesson plan, student worksheet, learning achievement test, and Research Instruments can be seen in Figure 5 and Figure 6.

![Figure 5. Validation results of learning tools.](image1)

![Figure 6. Validation results of research instruments.](image2)
3.2 The practicality of learning tools

The next step in this research was "Do". At this stage, the practicality of learning tools can be seen from the results of the Teacher’s Activity Observation Sheet, Student’s Activity Observation Sheet, Student’s Response Questionnaire Sheet to Student Worksheets, and Open Lesson Observation Sheet. Learning was carried out in 4 meetings, 2 meetings delivered Matrix material (2nd and 3rd meetings), and conducted pre-tests and posttests respectively at the first meeting (1st meeting) and finally (4th meeting). At the first meeting, a pretest was given to students in the form of 2 descriptive questions that must be done within 90 minutes. This pretest aimed to choose the sample class. This was the first step that must be done before carrying out a hypothesis test which included a normality test and a homogeneity test. The normality test using the Kolmogorov-Smirnov statistics was summarized in Table 3 below.

### Table 3. Normality test using Kolmogorov-Smirnov.

| Class          | Kolmogorov-Smirnov* | Shapiro-Wilk |
|----------------|---------------------|--------------|
|                | Statistic | df  | Sig. | Statistic | df  | Sig. |
| CREATIVE THINKING SKILLS | Control | .131 | 28 | .200* | .957 | 28 | .303 |
| Experiment 1   | .131 | 28 | .200* | .969 | 28 | .560 |
| Experiment 2   | .162 | 28 | .059 | .935 | 28 | .082 |

Based on Table 3, it is known that the significance value in the control class was sig = 0.303, the significance value in experimental class 1 was sig = 0.560, and the significance value in experimental class 2 was sig = 0.82. Therefore, it can be concluded that the post-test data in all three classes was normally distributed. Thus, the normality test was fulfilled, because the significance value was greater than 0.05, this meant that students' creative thinking abilities (post-test) in all three classes were normal. After the normality test had been carried out and had a normal distribution, homogeneity tests were then performed using the Levene Statistics, with the basic concept that the researchers’ data must be normally distributed. Homogeneous Test using Levene Statistics is shown in Table 4 below.

### Table 4. Homogeneity test using levene statistics.

| Levene statistic | df1 | df2 | Sig. |
|------------------|-----|-----|------|
| .070             | 2   | 81  | .932 |

Based on Table 4, it can be seen that Sig. the Levene Statistics test for variance equation was 0.932> 0.05 so the learning achievement of students' creative thinking skills showed homogeneity.

In the experimental class 1, the learning process used the Science, Technology, Engineering, and Mathematics (STEM) approach, while the experimental class 2 used the Science, Technology, Engineering, and Mathematics (STEM) approach based on Lesson Study for Learning Community (LSLC) on the second meeting. The activity of learning was done through collaboration with students and created groups of 4 students. The selection of group members was adjusted to the results of the pretest so that each group was heterogeneous. STEM learning was done through: (1) Observe, (2) New Idea, (3) Innovation, (4) Creativity, (5) Society. In Lesson Study for Learning Community (LSLC)-based learning, students are directed to work in groups so that students' social interaction abilities can be develop which can then improve students' academic abilities [20] [21]. Therefore, in the experimental class, students were directed to groups, asking questions, explaining, and expressing opinions so that a sense of care among students arose. Student Worksheet were given in accordance with the steps in the LSLC-based STEM approach and directed students to be able to think creatively. While in the control class, learning was carried out with the same material but using conventional learning.
The students’ activities in experimental class 1 and experimental class 2 in discussing, asking and explaining/answering and exchanging opinions in groups are presented respectively in Figure 7 and Figure 8 below (taken from one group as a sample).

**Figure 7.** Discussion activities of experimental class 1.

**Figure 8.** Discussion activities of experimental class 2.

In Figure 7, Group discussion in Experimental class 1 went quite well. Student B gave an explanation to all group members. There were 2 students who dared to ask friends in their groups, namely students A and C. In the meeting, it appeared that student D was not active in discussion because student D lacked of understanding of the material, but his friends who already understood the material wanted to explain to him. From this, it can be seen the concern between group members. At the next meeting, student D seemed more active than the previous meeting. He was more confident to express opinions to his friends. He also showed courage to help his friends who were struggling with the material. At this meeting, all students seemed to be active in study groups. They became accustomed to work together, cared for each other, and respected each other’s opinions. They became accustomed to working together, caring for each other and respecting each other’s opinion.

On the Figure 8, the group discussion in the experimental class run well. The student B explained the material to the group members. The three students namely students A, C and D were also brave to ask to their friends. In the following meeting, the students were more active in the group. They were more eager to ask, explain to other friends of the group and were more confident to express their opinion to their group members so every student understood the material learned. This condition showed that the students were capable to collaborate well so that their cognitive knowledge increased.

Meanwhile, the group discussion happened in the control class was shown on the following figure.

**Figure 9.** Discussion activities of control class.
While, different things were seen in the control class. Unlike the experimental classes 1 and 2 whose students were more active discussing, in the control class, there was no discussion happened. The student B who understood the material better gave the explanation to the students A and C. The student A then explained to the student D. There was no question and answer activities so in the control class, there was no discussion happened. The second meeting was not quite different from the first meeting. The students in the control class were less active in the group. There were only 2 students who asked each other and exchanged opinions that were the students A and D. The student D then explained to the student C. Meanwhile, the student B who understand the material better only explained to the student A. Generally, the group discussion activities were intended to answer the question from the problem given without the sense of caring to the group members who did not understand the material delivered yet. The aim of group making in the control class was only to reach the high score.

In the “see” stage, based on the observation results of student involvement including the activities of asking, debating, conducting, presenting and responding of the discussion group in the experimental class showed that most of the students were active in the teaching and learning process. The observation was done by 7 observers in each class so 1 observer observed 1 group. In the observation sheets of the student activity showed that out of 28 students in the experimental class 1, 17 students (61%) belonged to active category and 11 other students (36%) were very active. In the experimental class 2 which consisted of 28 students also showed that most of the students were active in the learning process, this was shown from the percentage results of the students who were active as much as 54% and 46% students belonged to very active students. Different condition showed in the control class where out of 28 students in the class, only 7 students (25%) who were active and 20 students (75%) were less active. Therefore, it can be concluded that most of the students were active in following Mathematics learning through LSLC-based STEM approach.

In addition to the student activity, the teacher activity was also assessed by 2 observers in each class. In the experimental class 1, the teacher activity as much as 89% was carried out and in the experimental class 2 showed the observation of teacher activity as much as 91% was carried out which means the implementation of learning tools in the experimental classes 1 and 2 based on the observation results of the teacher activity showed a very good category. Then, the researcher also gave the questionnaire of the student responses toward student worksheet which must be completed by students after the learning process. The following were the questionnaire results of the student responses shown on the Figure 10.

![Figure 10. Questionnaire results of the students responses toward student worksheet.](image)

As much as 86% students agreed that the problem given in the student worksheet was in accordance with the material they learned, as much as 83% students agreed that the activities provided in the student worksheet had clear goals, as much as 85% students agreed that the problem provided in the student worksheet stimulated their curiosity, as much as 87% students agreed that the problem solving presented in the student worksheet made them looking for facts to give reasons toward the
answers their chose, as much as 90% students agreed that the presentation of student worksheet was completed with interesting pictures and illustrations, as much as 92% students agreed that the presentation of student worksheet made them interested in doing it, as much as 86% students agreed that the material presentation of student worksheet pushed them to discuss with their friends, as much as 86% students agreed that student worksheet contained evaluation tests which were able to test their understanding about Statistical material.

Based on the results of observation sheets of the student activity, teacher activity and the questionnaire of the student responses toward student worksheet showed that the learning tools through LSLC-based STEM approach developed by the researcher was practical to use in the learning process.

3.3 The effectiveness of learning tools

The assessment of the effectiveness of the learning tools was based on the students’ cognitive learning achievement. The result analysis of the students’ cognitive learning achievement showed from the results of post-test given in the last meeting to know the students’ creative thinking skills after following the learning process. The results of post-test were shown on the Table 5 as follows.

Table 5. Results of post-test on the students’ creative thinking skills.

|                  | N   | Mean | Std. deviation | Std. error | 95% Confidence Interval for Mean | Minimum | Maximum |
|------------------|-----|------|----------------|------------|---------------------------------|---------|---------|
|                  |     |      |                |            | Lower bound | Upper bound |              |         |
| Control          | 76  | 76.40| 79.60          |            | 76.40 | 79.60       |            |         |
| Experiment 1     | 28  | 80.18| 4.372          | .826       | 78.48 | 81.87       | 71        | 90      |
| Experiment 2     | 28  | 84.68| 4.952          | .936       | 82.76 | 86.60       | 76        | 98      |
| Total            | 84  | 80.95| 5.252          | .573       | 79.81 | 82.09       | 69        | 98      |

After that, to find out the influence of the learning tools of LSLC-based STEM developed by the researcher on the students’ creative thinking skills, One Way Anova was conducted. This was because the research samples used by the researcher were more than 2 classes (control class, experimental classes 1 and 2). The results of One Way Anova test were shown on Table 6.

Table 6. Test results by using one way anova.

|               | Sum of squares | df | Mean square | F    | Sig. |
|---------------|----------------|----|-------------|------|------|
| Between Groups| 649.595        | 2  | 324.798     | 16.040 | .000 |
| Within Groups | 1640.214       | 81 | 20.250      |       |      |
| Total         | 2289.810       | 83 |             |       |      |

Based on the results of One Way Anova test on the Table 6, it was known that the significant result < 0.05 which means that the learning tools of LSLC-based STEM had an influence on the students’ creative thinking skills. Therefore, the learning tools were effective to use in the learning process.

Below this is the result of students’ creative thinking abilities carried out in 1 control class and 2 experimental classes.
Figure 11. The result of students' creative thinking abilities.

The experimental class 2 showed a significant increase in the ability to think creatively in every aspect compared to the increase in the ability to think creatively in the experimental class 1 and the control class. In this study, indicators to measure the ability to think creatively refer to Silver's opinion [4].

Table 7. The example of student worksheet.

| Data | Grade |
|------|-------|
| 1    | 40 40 45 45 60 60 65 65 65 80 |
| 2    | 40 40 45 50 60 60 65 65 65 80 |
| 3    | 40 40 45 50 60 60 65 65 65 80 |
| 4    | 40 40 50 50 60 60 65 65 65 80 |
| 5    | 40 40 50 55 60 60 65 65 65 80 |
| 6    | 40 40 55 55 60 60 65 65 65 80 |
| 7    | 40 45 45 50 60 60 65 65 65 80 |
| 8    | 40 45 45 50 60 60 65 65 65 80 |
| 9    | 40 45 50 50 60 60 65 65 65 80 |
| 10   | 40 45 50 55 60 60 65 65 65 80 |
| 11   | 40 45 55 55 60 60 65 65 65 80 |
| 12   | 40 50 50 55 60 60 65 65 65 80 |
| 13   | 40 50 50 55 60 60 65 65 65 80 |
| 14   | 40 40 45 45 55 65 65 65 70 80 |
| 15   | 40 40 45 50 55 65 65 65 70 80 |
| 16   | 40 40 45 50 55 65 65 65 70 80 |
| 17   | 40 40 50 50 55 65 65 65 70 80 |
| 18   | 40 40 50 55 55 65 65 65 70 40 |
| 19   | 40 45 45 50 55 65 65 65 70 80 |
| 20   | 40 45 45 55 55 65 65 65 70 80 |
| 21   | 40 45 50 50 55 65 65 65 70 80 |
| 22   | 40 45 50 55 55 65 65 65 70 80 |

In the Table 7, it is known that the students already had the creative thinking ability because the students’ answers showed the three aspects of creative thinking covering fluency, flexibility, and novelty aspects. The students who were very creative could be seen from the fluency aspect were able and fluent in expressing ideas to answer the question that were able write down 30 possible answers. Whereas, from the aspect of flexibility, the students were able to mention any kind of possible answers formed based on the problem’s picture, even the students were capable to find other different
possible answers from others’. Based on the aspect of novelty, the students thought about the stuffs that other people did not that were thinking various different ways to find a possible answers [4].

Here was the interview result between the teacher and the students whose answer showed above.

| Researcher | : How do you feel about learning activities using the components of a STEM based on LSLC? |
|------------|-----------------------------------------------------------------------------------------------|
| Student    | I think the activity is fun because students are invited to do project work outside class hours and can collaborate with friends. |

Researcher : What makes you happy / unhappy when carrying out learning activities using the components of a STEM based on LSLC?

Student : Very happy because the steps are clear and also help me in solving the material

Researcher : What is your understanding of the material that has been explained?

Students : Initially did not understand but after being explained by the teacher and input from the group I finally understood and I could also explain to students who did not understand

Researcher : How do you complete the problem as in the student worksheet?

Student : I follow the steps that are already on the student worksheet

Researcher : Explain what material do you find most difficult in the past learning?

Student : The material that makes it difficult for me is making a possible answers

3.4 **STEM activity in experimental classes**

Learning activities are carried out in groups so that collaboration is formed between students. Each group consists of 3-4 students. Learning is carried out in accordance with the stages of STEM learning, namely; (a) Observation, (b) New Idea, (c) Innovation, (d) Creativity, and (e) Society Value. At the Meeting 2 classes were divided into 7 groups and each group was observed by 1 observer. Each group is given student worksheet 1, they are guided to carry out the planting of seedlings (Science). Then they have to measure the height of the sprouts until the 7th day. After completing the sprouts planting activity, each group was given LKS student worksheet 2. In this student worksheet each group was directed to retrieve data on the type and number of vehicles in front of the school using Finger Counter (Engineering) within 20 minutes. Then they are directed to write down the data obtained and then write down as much statistical information (Mathematics). After that, each group works together to pour the results of their work on Microsoft Excel in laptop (Technology and Engineering). After that they presented the results of their work in front of the class.

At this 3rd Meeting the class is still divided into 7 groups and each group is observed by 1 observer. Each group is given student worksheet 3, they process the data taken on the measurement of germination height on the first day to the seventh day (Science). In addition to the height of the sprouts, students are expected to write other things that can be observed during the 7 day study. Students then write down Statistics as much as possible from the data that has been obtained during the 7 days (Mathematics). After that students are directed to pour the results of the data in Excel (Technology and Engineering). Then students in the group present in front of the class.

4. **Discussion**

In this study the STEM (Science, Technology, Engineering, and Mathematics) approach based on LSLC (Lesson Study for Learning Community) is used to improve students’ creative thinking abilities. STEM has steps that can be linked to indicators of students’ creative abilities and can also be linked to objectives that exist in LSLC. The connectedness of the three elements can be shown in Figure 12.
The class sample data were analyzed by using SPSS software version 19, which was previously conducted a prerequisite test in the form of a normality test and a homogeneity test. The test of normality used Kolmogorov-Smirnov test, while the test of homogeneity used Levene Statistical test with a significance level of 0.05 (P <0.05) [21]. Related to the effectiveness of learning tools, it can be said that the learning tools was effective. This can be known from: (1) the percentage of classical completeness of the students’ learning outcomes reached 89%, (2) the results of the students’ activity during the learning process were categorized as active, (3) there was a significant improvement of the students’ creative thinking ability in the experimental class. While, based on the observation results, it is known that the implementation of learning process in each aspect showed that it run well with the mean score of 4.88. Whereas, from the questionnaire of the students’ response, it was obtained that the students gave the positive response towards the learning tools on the implementation of LSLC-based STEM learning as much as 85%. Based on the data above, it can be concluded that the practicality test of the learning tools being developed fulfilled the criteria of: (1) the implementation level of the learning process was categorized as practical; (2) the students had a positive response toward the media as well as the implementation of LSLC based STEM learning. The results of the analysis of non-parametric showed that there was a significant different on students creative thinking skill in the experimental and control classes. The results of this study show that there was a significant improvement in the experimental class, especially on the pre-test that revealed the students who were less creative reached 83% and the students who were creative enough as much as 17%, while in the post-test there was an improvement of the students’ creative thinking ability that was the students who were creative as much as 11% and very creative reached 56%. The results of different studies indicate that the test results, students who have high, medium and low creative thinking skills have a significant increase between task 1 and task 2 and there are some students who are able to adapt quickly and well in research-based learning. In addition, the level of students' creative thinking skills based on their performance in task 1 is in the "less creative" category, while in task 2 is in the "creative" category [20].

**Figure 12.** Relationship between Creative Thinking Ability, STEM, and LSLC.
5. Conclusion
The results of the research revealed that the learning tools of LSLC-based STEM model fulfilled the criteria of validity, practicality and effectivity. The learning tools were said to be valid based on the data analysis results of lesson plan validation sheet, student worksheet validation sheet and learning achievement test validation sheet. The practicality of the learning tools were assessed through the data analysis result of teacher observation sheet, student observation sheet and questionnaire of the student responses sheet that had been validated before. The analysis results showed that the learning tools were practical to use in the learning process. The effectivity of the learning tools were assessed based on the results of the students’ cognitive learning achievement in the form of post-test and One Way Anova test was done which showed that the significant < 0.05 which means that the learning tools of LSLC-based STEM model had an influence on the students’ creative thinking skills.

Acknowledgement
We gratefully acknowledged LSiMel research group for the support and supervision to completing the paper.

References
[1] Akiba M and Wilkinson B 2016 Adopting an international innovation for teacher professional development: State and district approaches to lesson study in Florida Journal of Teacher Education 67 1 74-93
[2] Anderson J R, Lee H S, and Fincham J M 2014 Discovering the structure of mathematical problem solving NeuroImage 97 163-177
[3] Bybee R W 2010 Advancing STEM education: A 2020 vision Technology and engineering teacher 70(1) 30
[4] Ceylan S, and Ozdilek Z 2015 Improving a sample lesson plan for secondary science courses within the STEM education Procedia-Social and Behavioral Sciences 177 223-228
[5] Daugher M K 2013 The Prospect of an" A" in STEM Education Journal of STEM Education: Innovations and Research 14(2)
[6] Dugger W E 2010 Evolution of STEM in the United States In the 6th Biennial International Conference on Technology Education Research’nda sunulmuş bildiri, Gold Coast, Queensland, Australia
[7] Ersoy E 2014 The effects of problem-based learning method in higher education on creative thinking Procedia-Social and Behavioral Sciences 116 3494-3498
[8] Hobri 2010 The Methodology of Research and Development Jember: Pena Salsabila
[9] Hobri 2016 Lesson Study For Learning Community : Review Hasil Short Term on Lesson Study V di Jepang Proceeding Semnasdik 2016 12-21
[10] Kelley T R, and Knowles J G 2016 A conceptual framework for integrated STEM education. International Journal of STEM Education 3(1) 11
[11] Koivuniemi M, Järvenoja H, and Järvelä S 2018 Teacher education students' strategic activities in challenging collaborative learning situations Learning, culture and social interaction 19 109-123
[12] Lee H, Kwon H, Park K, and Oh H J 2014 Development and application of integrative STEM (Science, Technology, Engineering and Mathematics) education model based on scientific inquiry Journal of the Korean Association for Science Education 34(2) 63-78
[13] Morrison J 2006 TIES STEM education monograph series, attributes of STEM education
[14] Morrison J, Bartlett R, and Raymond V 2009 STEM as curriculum. Education Week 23(19.03) 2017
[15] Prihandoko A C, and Utomo B T 2019 Students’ creative thinking skill on scientific approach based on lesson study for learning community In Journal of Physics: Conference Series 1211(1) 012081
[16] Roberts A, and Cantu D 2012 Applying STEM instructional strategies to design and technology
curriculum *In PATT 26 Conference; Technology Education in the 21st Century; Stockholm; Sweden* 073 111-118

[17] Saito E, Watanabe M, Gillies R, Someya I, Nagashima T, Sato M, and Murase M 2015 School reform for positive behaviour support through collaborative learning: utilising lesson study for a learning community *Cambridge journal of education* **45**(4) 489-518

[18] Sanders M 2009 Integrative STEM education: primer *The Technology Teacher* **68**(4) 20-26

[19] Schipper T, Goei S L, De Vries S, and Van Veen K 2017 Professional growth in adaptive teaching competence as a result of Lesson Study *Teaching and teacher education* **68** 289-303.

[20] Silver E A 1997 Fostering creativity through instruction rich in mathematical problem solving and problem posing *Zdm* **29**(3) 75-80

[21] Sugiyono P 2015 Combined research methods (mixed methods) Bandung: Alfabeta

[22] Syukri M, Halim L, Meerah T S M 2013 Science in stem education entrepreneurial thinking "bscit": an experience of partnership for aceh smes *In Aceh Development International Conference*

[23] Takahashi A, and McDougal T 2016 Collaborative lesson research: Maximizing the impact of lesson study *ZDM* **48**(4) 513-526

[24] Wang H H, Moore T J, Roehrig G H, and Park M S 2011 STEM integration: Teacher perceptions and practice *Journal of Pre-College Engineering Education Research (J-PEER)*, **1**(2) 2

[25] Zohar A, and Cohen, A 2016 Large scale implementation of higher order thinking (HOT) in civic education: The interplay of policy, politics, pedagogical leadership and detailed pedagogical planning *Thinking Skills and Creativity* 21 85-96