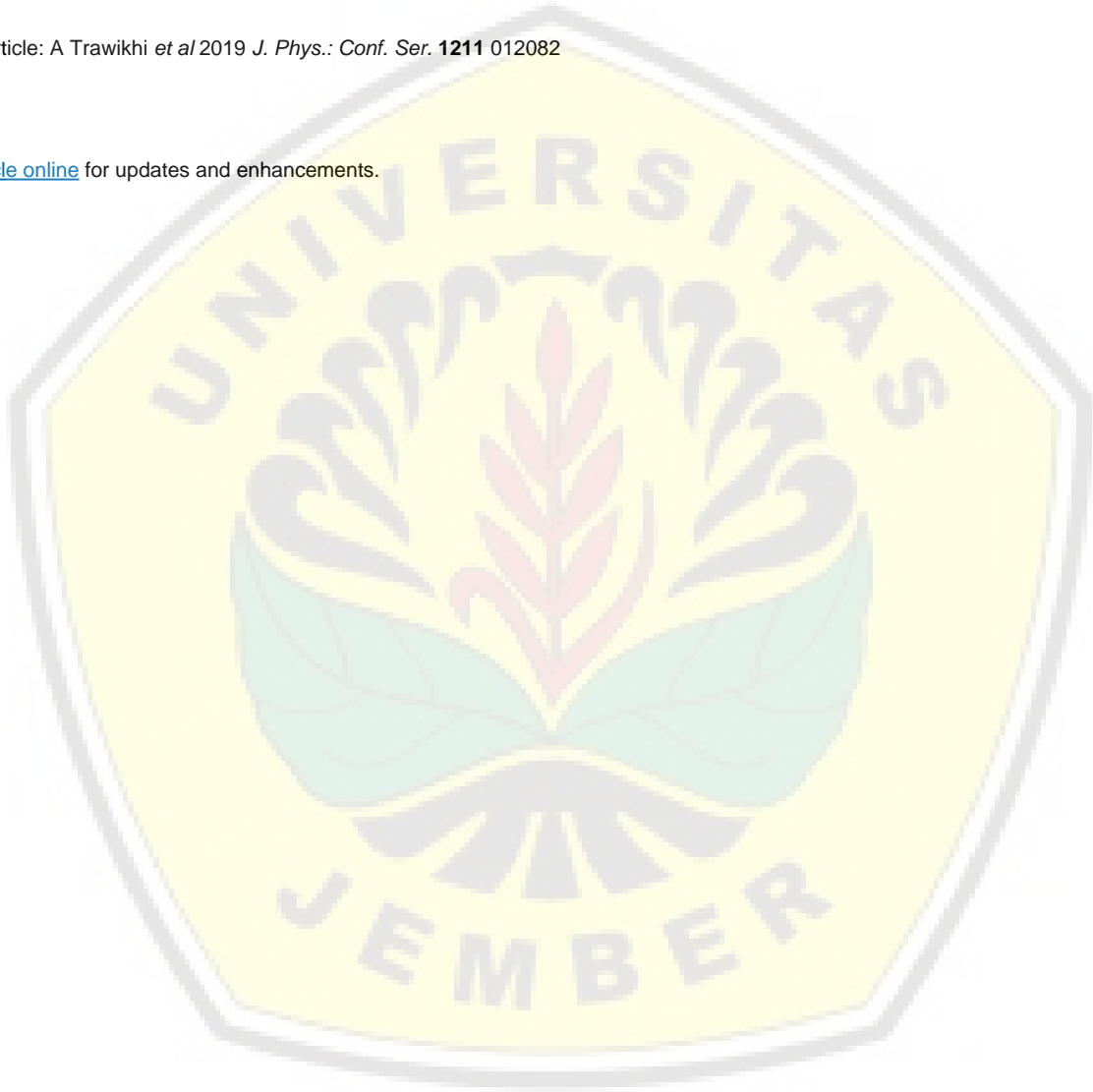


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Development of mathematical learning tools through discovery learning based on lesson study for learning community and their influence with students' problem solving

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Abstract. Problem solving ability is one of the competencies that students must have to face various complex problems. However, in reality, the students' problem solving ability is still low. Therefore, this research aimed at developing the mathematical learning media through Lesson Study For Learning Community-based discovery learning on the Linear equation system of two variable material on the VIII grade and its influence on the students' problem solving ability. This research used Mixed-Methods method. Qualitative research using the Thiagarajan model with the R and D method, while the quantitative method used quasi-experimental non-equivalent control group design. The research subjects were the students of MTsN 1 Lumajang consisted of 2 classes that were class 8C (control class) and class 8A (experiment class). Based on the results of normality and homogeneity variance tests, it obtained the data that are normally and homogenit distributed. Therefore it needed data analysis by using independent sample t-test analysis. Based on the results of the research revealed that: (1) produced the learning media that were categorized as valid, practical and effective (2) LSLC-based discovery learning had a significant effect on the students' problem solving ability in solving problems with the significant value of 0,000 ($p < 0,05$).

1. Introduction

Along with the development of an advanced era, the nation generations are required to have competencies to face challenges that are increasingly changing, one of them is problem solving ability to a complex problem. The aim of learning mathematics is to train the students' thinking process, one of which is the ability to solve the problems [1]. Problem solving ability is the heart of mathematics [2]. Solving problems area process of applying the knowledge that has been obtained previously into a new situation that has not been known [1]. Therefore, students must be provided with the problem solving ability to familiarize them in facing the daily problems that are getting more and more complex. There are four problem solving

strategies, each of which consists of several indicators. The indicator of problem solving strategies are shown in the tabel 1 [3].

Table 1. Indicators of Problem Solving

Problem Solving Strategies	Indicator
Understanding The Problem	a. Able to understand questions by writing b. Smoothly express ideas
Devising a Plan	a. Able to think of the right way to solve a problem in the problem. b. Able to choose and determine the completion steps that are easier according to the problems in the questions given.
Carrying Out The Plan	a. Able to solve problems in the problem by carrying out detailed steps. b. Able to solve problems carefully.
Looking Back	a. Able to try or examine the details to see the direction to be taken. b. Able to connect and find the concept of answers with questions on questions

The factors that determine the successfulness of a learning process are the learning model and method used by the teacher. Discovery learning is one of learning models that is student-centered because in this learning model learning activities are mostly carried out by students while the teacher only acts as a facilitator. "Discovery learning is a learning which occurs as a result of the learner manipulating, structuring and transforming information so that he or she find new information which means discovery learning is a learning that doesn't provide the material concept directly but asks the students to find the concept by themselves so that they get new knowledge [4]. Whereas, Lesson study can increase the professionalism of the teacher in teaching as well as determine the learning material or new learning method [5;6]. Lesson study experiences development until it becomes Lesson Study for Learning Community (LSLC). The purpose of Lesson Study for Learning Community is the students who learn from each other (listening to each other) and the teacher also must learn from each other [7;8]. Giving jumping task on LSLC also can improve the students' problem solving ability so that it can train the students' thinking ability.

One of materials that closely related to the students' problem solving ability is linear equation system of two variables. Based on the interview results with the mathematics teacher, it was obtained the information that the students' problem solving ability had not been trained well. In solving mathematical problems, the students always do the step of simply answer it, while the steps to understand, plan and looking back to the answers sometimes not done [9]. Besides, the teacher sometimes gets difficulties to teach the students related to the ways in solving mathematical problems so that learning process only focuses on the final results. In this case, the teacher's role as the facilitator in the learning process is importantly needed. Discovery method explains the students learn to know the problems, characteristics of the solutions, looking for the relevant information, building strategies to find the solutions and applying the chosen strategy [10]. One of the most important things in guiding to discovery learning is that the teacher must try to lead the students to understand the concepts by asking some questions and suggesting various ways to see the problems [11].

Based on the problems above, it needs to develop a learning media that is effective like a learning media with LSLC-based discovery learning to improve the students' problem solving ability. LSLC-based discovery learning is done collaboratively between the teacher with teacher, teacher with students, or between students in the stage of plan, do and see that

contains elements of mutual care. As for the problem and material exercises given at the time of group discussion can train the students' mathematical problem solving ability.

2. Research Methods

The method used in this research was Mixed Method, which combine sequential qualitative and quantitative research methods and used Sequential Exploratory Design model [12]. Every development research aimed at developing mathematical learning tools including Lesson Plan, Student Worksheet, and Student Learning Outcomes Test through Lesson Study for Learning Community based-discovery learning. Thiagarajan, Semmel & Semmel (4-D), on their research consisted of four stages, namely define, design, develop, and disseminate [13]. Explanation of development research procedures was illustrated in the chart as follows.

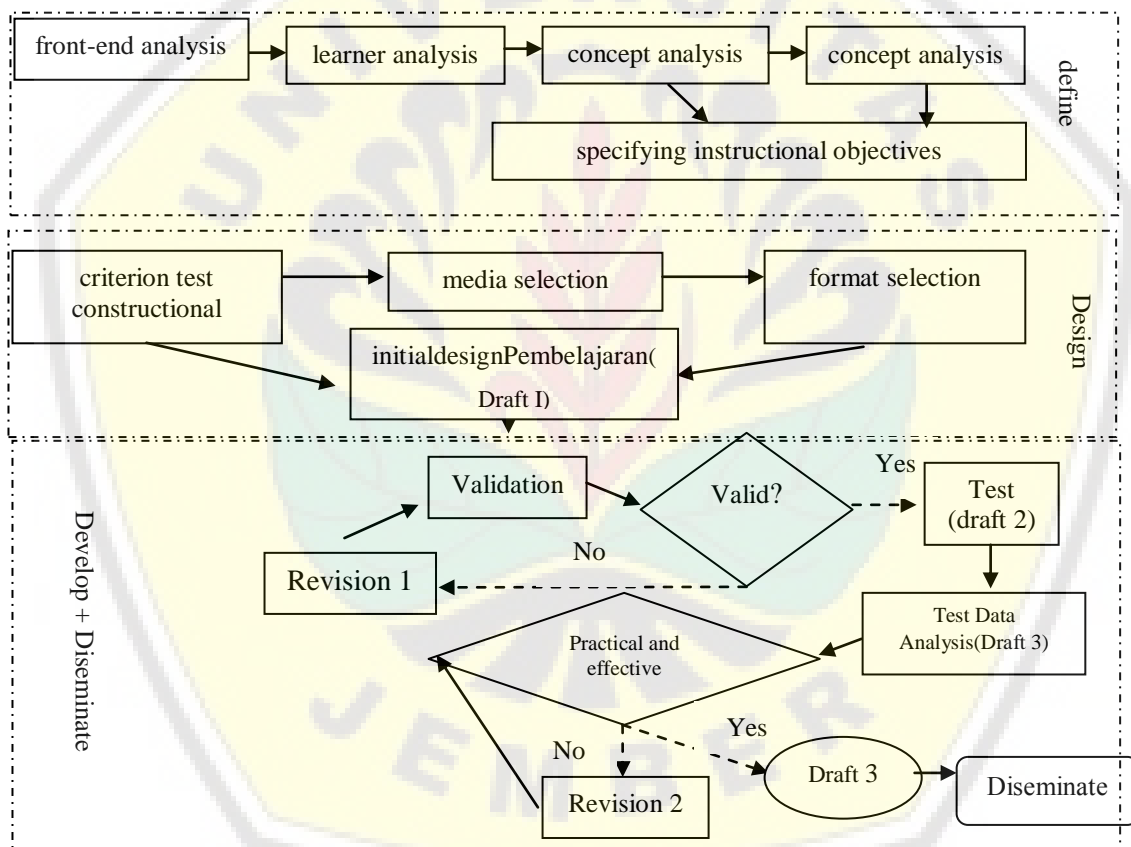


Figure 1. The Model of Research and Development (4-D)

The validation of the research instrument covered observation sheets of student activities, observations on the implementation of learning tool, open class observations, teacher's interview sheets and response questionnaires. The research tools and instruments were able to be used if they have been declared as valid. However, if it was not valid, the research tools and instruments needed to be revised according to the suggestions and input given by validators. The experimental research brought up a quasi-experimental non-equivalent control group design pretest. The population of this research were the VIII grade students at MTsN 1 Lumajang in the academic year of 2018/2019. The sample used in this research were divided into 2 classes, the experimental class (VIII E) which taught by using learning tools with

LSLC-based scientific and the control class (VIII F) got Direct Instruction learning. The data collection results of this research were in the form of test results and observations. The data were then tested for the assumptions of normality and homogeneity of variance by Kolmogorov-Smirnov test and Levene's test with each significance level on 0.05 ($p < 0.05$). If the data were normally distributed and homogeneous then it used t-test, but if the data were not normally distributed or homogeneous, then Mann-Whitney test would be used.

Population

This research was done to the eighth grade students of MTsN 1 Lumajang in the odd semester of the 2018/2019 academic year. The sampling technique used was random sampling by randomly selecting two classes, the first class was the experimental class with the implementation of discovery learning based lesson study for learning community which was consisted of 34 students, and the second class was class control with the application of direct instruction that consisted of 34 students.

Instrument

The instruments used in this research were tests, observation, and interview. The instruments of observation is observation sheet of student activities, observation of the implementation of learning tools, open class observation, and response questionnaire. Explanation of exsperiment research prosedures was illustrated in the chart as follows.

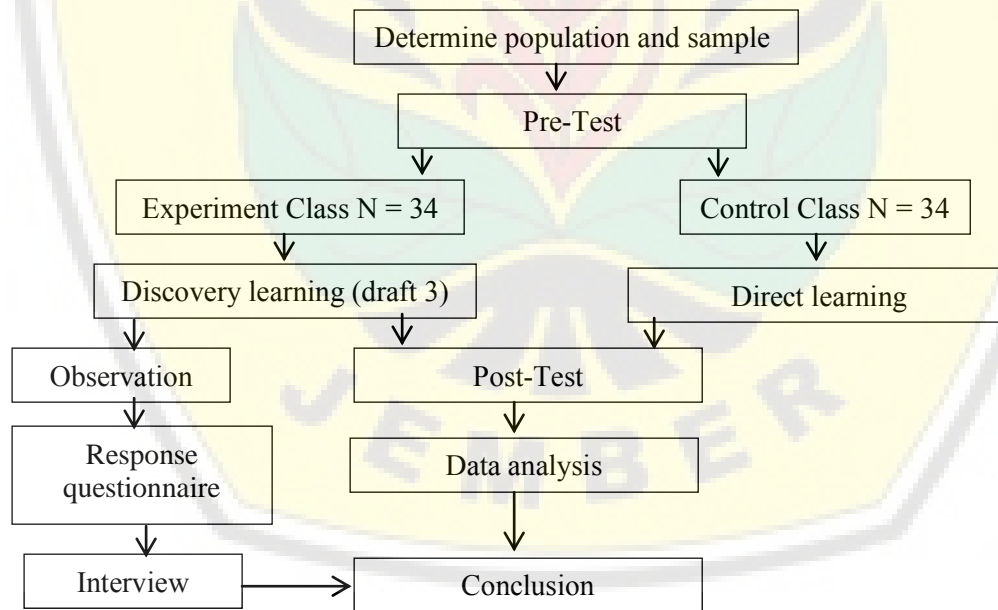


Figure 2.The Exsperiment Research

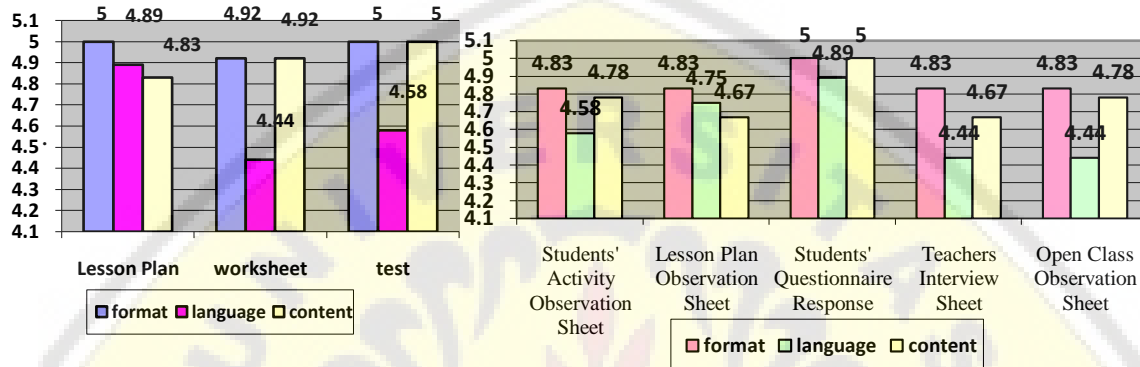
3. Research Finding

The Result of Data Analysis

The first step before doing the development research was the stage of plan in which it asked collaboratively for advice and opinion from the teacher of MTsN 1 Lumajang related to the tools to be developed. Through discussion and collaboration with the teachers, they would be able to learn and improve the professionalism of teachers [14]. The tools developed in this

research included lesson plan, student worksheet and test. The tools were validated by 3 validators consisting of 2 mathematics education lecturers and a practitioner or mathematics teacher at MTsN 1 Lumajang. Besides the learning tools, the validators also validated the research instruments consisting of observation sheets of student activities, observations on the implementation of learning tools, open class observations, and students' response questionnaires. However, the results of tools validation are presented in chart 1 below.

Chart 1. The Validation Result of Learning Tools and Instrument



As drawn on chart 1, it can be seen that the validation results of three validators on learning tools as if was viewed from the format, language and content aspects, it could be said "valid" since the average of validity value was at $4 < V_r < 5$ and was said to be very valid if (V_r) was in interval $V_r = 5$. Meanwhile, the instruments of learning tools were also included in the same category which were valid and very valid. The overall average could be considered said to be valid. Thus, learning tools and research instruments could be used in the research.

After the validation process, the next stage was the implementation stage of discovery learning based lesson study for learning community. This stage was divided into "Do" stage, which was carried out in VIII E class and consisted of 6 meetings, they were 4 times of learning and 2 test activities (pre-tests at the first meeting and tests at the last meeting). This was also implemented to the control class but with different treatment, direct learning.

On the first meeting, the students in the control and experimental classes were given pre-test questions consisting of 3 items about linear equation system of two variables. The results of this pre-test were used to determine the students' initial abilities in problem solving before being in the learning. The pre-test results were shown in the following table 2.

Table 2. Pre-Test Results

	N	Minimum	Maximum	Mean	Std. Deviation
pretest_eksperimen	34	3.00	77.00	33.5588	14.51267
pretest_control	34	3.00	77.00	35.1176	14.50552
Valid N (listwise)	34				

In the next meeting, that was meeting 2 up to meeting 5, different treatment was given to both classes in which the experimental class was given LSLC-based discovery learning by using the learning tools that has been developed while the control class was given direct learning as usual. The early learning activity of the experimental class was dividing the students into a group consisted of 3-4 students. The stages in LSLC-based discovery learning were stimulation (giving stimuli), problem statement (statement/problem identification), data collection (collecting data), data processing (processing data), verification (verifying), and generalization (drawing conclusion/generalizing) [11], where the students in group

collaborated each other and it was expected to emerge care among the students (caring community). In a LSLC-based learning, the students are expected to be motivated to learn from their friends about what they do not understand and those who already understand gives response in the form of help that can support their friends learning within the group [15]. In group discussion activity, it seemed that some students within the group collaborated each other to solve problem stated in their students' worksheet. Even, in one of the groups the students were solid to help one friend who did not understand. On the contrary, the students of the control class tend to finish their task in students' worksheet regardless to their friend within the group so that it seemed some students were dominant in finishing the worksheet. The students' activity in the experimental and control class were presented in the following Figure 3.

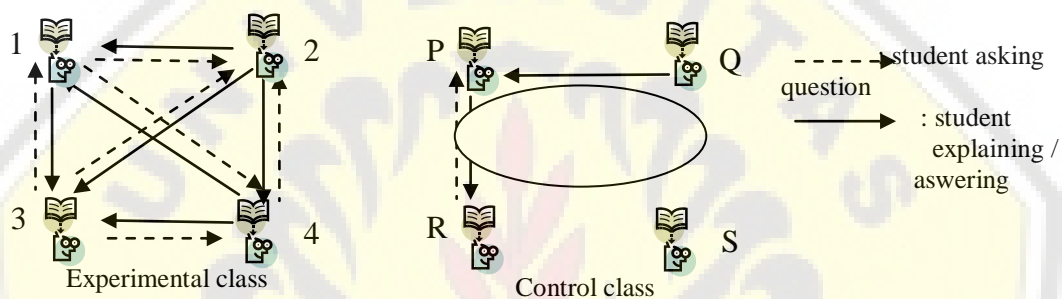


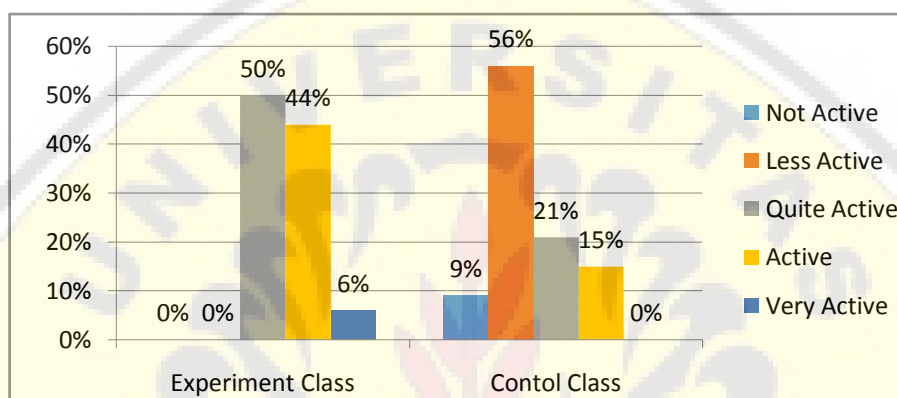
Figure 3. Students' activity in group discussion in the experimental class.

Based on Figure 3 above, it seemed that in the experimental class, all students involved in collaboration process in finishing students' worksheet. The students were courage to ask if there was a material they did not understand and, in reverse, the students who understood the material helped their friends who still struggling. During the group discussion, there was one quiet student that was student 3 who did not understand the material so that his three friends helped to give explanation about the material. One of the interaction forms in the experimental class during the discussion of students' worksheet 3 was a student 1 asked student 2 related to the equivalent form in algebra $x+2y = 7000$ became $x = 7000 - 2y$, then student 2 answered the form $x+2y=7000$ should be changed into other equivalent form that was x equal which had purpose to ease the substitution process into other mathematical sentence form. Students 1 seemed unsatisfied with student 2 answer so student 4 gave other explanation if only $x+2y=7000$ was changed into other equivalent form which is certainly allowed but later on it would be a decimal form which would be too long to be counted. Finally, student 3 convinced student 4 answer by saying that surely it much easier to change the sentence $x+2y= 7000$ to be $x=7000 - 2y$ by inviting student 4 to try finished it. Student 4 became more understand about the material from caring community process in his group. By applying this caring community process, the students who did not understand and less courage to ask, finally, became enthusiastic to ask his group. In LSLC context, the essential part is giving students a chance to ask for help and other students give positive response [15]. Such condition was different form the discussion activity in the control class.

The students in control class tend to finish the students' worksheet individually or sometimes just few of them conducted discussion. During the group discussion, there was one student who was shy to ask his group, that was student Q. He was very quiet although he did not understand the material. It was very clear that the students in control class tend to ignore their friend within the group so that the collaboration process went less good.

Students' activity observation in the experimental class covered students' activity in giving attention to the teacher or friend explanation, questioning or reasoning as well as discussing, finishing group task and presenting it in class. The results of the students activity observation in the experimental class showed that, from 34 students, there were 44% students was categorized as active, 50% students were quite active, and 6% students were less active. Whereas, in the control class, from 34 students, there were 15% students were categorized as active, 21% students were quite active, 56% students were less active and 9% students were not active.

Chart 2. The results of The Students Activity Observation in The Experimental Class.



Open Class activity was conducted in the third meeting by 10 teachers from MTsN 1 Lumajang consisted of some various lesson subjects. This model is easy to adapted and adopted by the teachers of different lesson subject in some various contexts [14]. This activity was one of the series of learning activity based on lesson study for learning community in which included in see stage that was observation stage toward students' activity during the class. In this stage, the observer focuses on how students learn, while the observation towards how teacher teach as well as mastering the material is given a small percentage [16]. The teacher who was also the observer presented their observation results in class during observation activity toward the students as well as giving suggestions related to the learning process in the class. They found out that one positive side from open class was the students were more motivated to be actively involved in group discussion. Moreover, they saw that in group discussion, there was a sense of care within the individual to help the member of the group who did not understand the material so that finally understand it. Thus, the teacher of open class became more convinced that this learning gave significant effect toward the students ability in solving problem because in group discussion, the collaborative process was actualized so that the students could learning meaningfully through their friends.

In the last meeting that was the seventh meeting, posttest was given to the experimental and control class to know the improvement of students' problem solving skill after following discovery learning based on LSLC. The results of posttest was presented in the following Table 3.

Table 3. Post-Test Results

	N	Minimum	Maximum	Mean	Std. Deviation	Classical Completeness Percentage
Experimental posttest	34	40.00	100.00	90.1176	17.65625	82%
Control posttest	34	37.00	93.00	68.0000	13.32576	38%

Table 3. Post-Test Results

	N	Minimum	Maximum	Mean	Std. Deviation	Classical Completeness Percentage
Experimental posttest	34	40.00	100.00	90.1176	17.65625	82%
Control posttest	34	37.00	93.00	68.0000	13.32576	38%
Valid N (listwise)	34					

The first stage before conducting data analysis was administering normality test and homogeneity test by using statistical test Kolmogorov-Smirnov for normality test. The distribution of the data would be said as normal if the value was higher or the same with 0,05. The results were presented in the following table 4.

Table 4. Kolmogorov-Smirnov Normality Test

Class	Kolmogorov-Smirnov ^a		
	Statistic	Df	Sig.
pretes_experiment	.138	34	.127
pretes_control	.116	34	.200
posttest_experiment	.127	34	.156
posttest_control	.137	34	.128

Based on Table 4, it was shown that the significant value of students' problem solving skill in pretest for both classes was $\text{sig} = 0,127 \leq 0,05$ (experiment class) and $\text{sig} = 0,200 \leq 0,05$ (control class), while the significant value for posttest of the experimental and control classes was $0,156 \leq 0,05$ and $0,128 \leq 0,05$ respectively. Therefore, it can be concluded that pretest and posttest of both classes was normally distributed. In the other hand, homogeneity test was administered by using Levene's test. The distribution of the data would be said as homogenous if the value was higher or the same with 0,05.

Table 5. Levene's test of homogeneity test

	Levene Statistic	df1	df2	Sig.
Pre-test	.097	1	66	.757
Post-test	2.183	1	66	.144

Based on Table 5 above, the sig value of students' problem solving skill was $0.757 \geq 0,05$ for pretest and $0.144 \geq 0,05$ for posttest so it can be concluded that the data assumption of homogenous was fulfilled. This was because the significant value obtained from the test was more than 0.05, therefore, the data about students skill of problem solving (pretest and posttest) of both classes had homogenous variance. The further analysis was parametric test because the pretest and posttest data was normally distributed and homogenous. The parametric test used was *independent sample t-test*. The data analysis result was shown in table 6.

Table 6. Data Analysis by Using *independent sample t-test*

	Post-Test Result
Mean Difference	11.61765
Std.Error Difference	3.68748
Df	34
Sig. (2-tailed)	.002

Based on the table above, the significant value was sig. 0.002 ($p < 0.05$), therefore it can be concluded that there was a significant different from students' problem solving skill in the experimental who was taught by using discovery learning based on Lesson Study for Learning Community and control classes which was taught by using direct learning. The criterion of pretest and posttest results of students' problem solving skill was shown in the following chart.

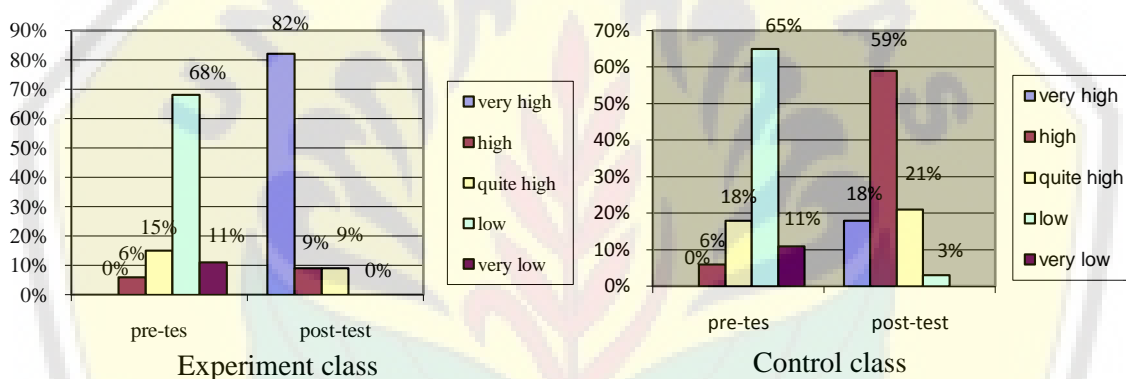


Chart 3. Data of the Students' Problem Solving Skill Level

Based on chart 3 above, the average problem solving skill of the students in the experimental and control classes was categorized as low. Yet, after having different learning, the result of posttest of the experimental class was positively improved with the average results of very high problem solving skill and the classical completeness percentage of 82%. Whereas, the control class was categorized as high although there were some students that were categorized as low with classical completeness percentage of 41%.

The aspects and indicators of students' problem solving skill which covers understanding problem, devising a plan, carrying out the plan, and looking back [3]. There was some increase of average of each students' problem solving skill aspects in the experimental and control class. It was presented in the following chart 4.

Chart 4. The average increase of each aspect of Problem solving skill

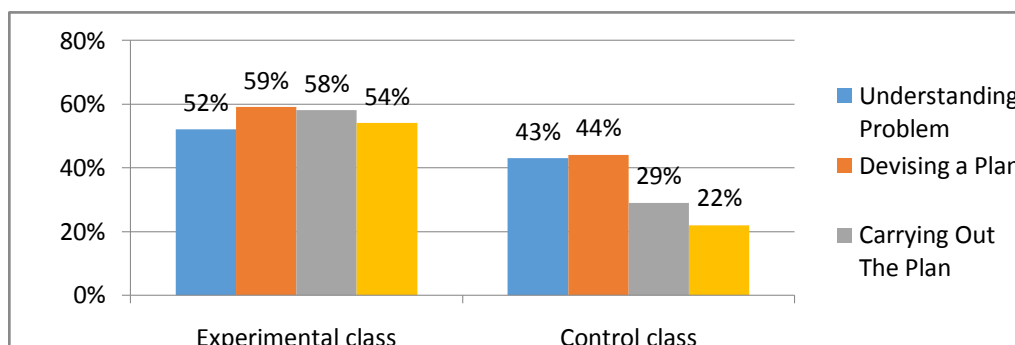


Chart 4 shows that there was an increase on the students' ability to solve problems in both classes, but a more significant increase occurred in the experimental class compared to the control class. This increase occurred in all four indicators of problem solving ability. The following is presented in figure 4 related to the results of the students' answers with the ability to solve problems on very high criteria.

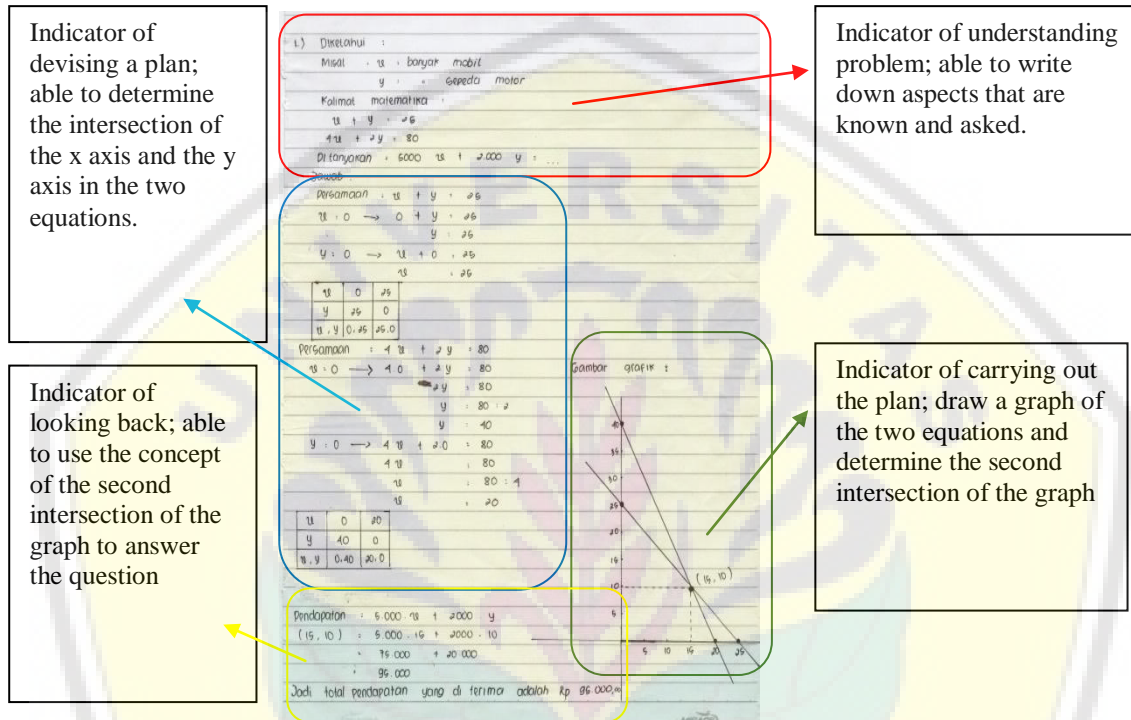


Figure 4. Results of students' answers on the Problem Solving Ability with Very High Criteria.

In students' answers that classified as very high problem solving category, students had been able to fulfill the four indicators in problem solving. This can be seen from the results of students' answers starting from the indicator of understanding problems that students had been able to write in detail what was acknowledged and asked on a question, while the indicator devising a plan that the students had been able to think of appropriate ways to draw a graph of straight line equations by determining the intersection of the x axis and the y axis in the two equations. On the indicator of carrying out the plan, students had been able to solve problems with more detailed steps, which was by drawing graphs of the two graphs carefully so that they were found intersection points, and on the looking back indicator, the students were able to check the results of the answers and apply the concepts that had been found to answer a problem. Thus students with very high problem solving abilities had been able to fulfill the four stages of problem solving [3].

Above was very different from the results of students' answers on problem solving skills in the low category. Students with low problem-solving abilities, had not been able to show the results of answers that met the four indicators as shown in the following figure.

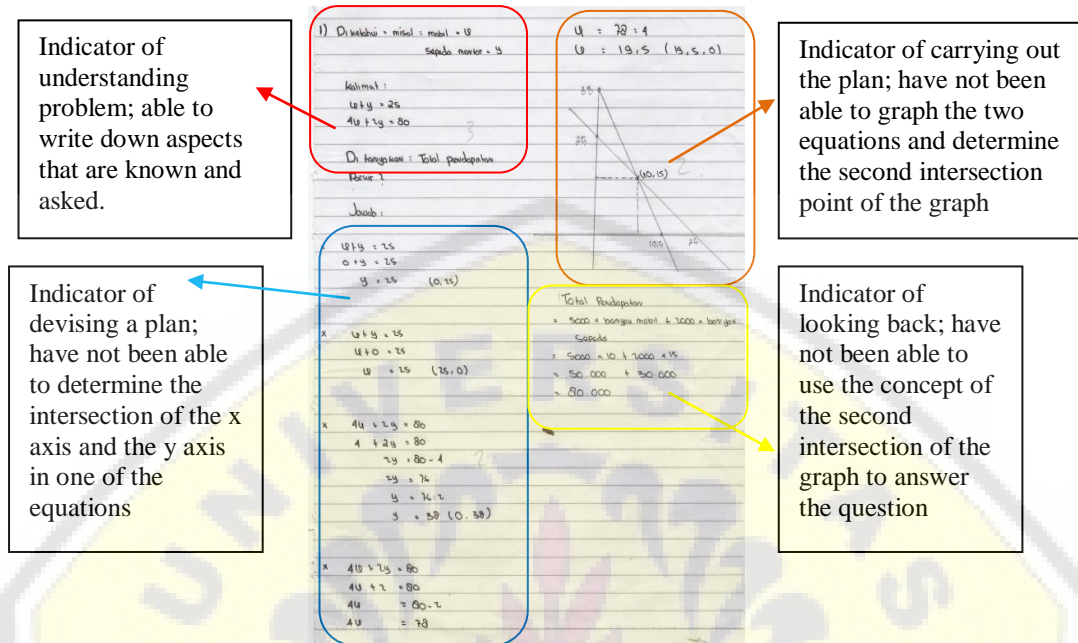


Figure 5. Results of students' answers on Problem Solving Ability with Low Criteria

Based on Figure 5 above, it was known that students had problem solving abilities with a low category, the results of students' answers still did not fully meet the four indicators for problem solving. These students still seemed only able to indicator understanding problems, but for the second indicator (devising a plan), students were still having difficulty determining the intersection point on the x axis and y axis. On the carrying out the plan indicator, students are actually able to draw graphics but there were still inaccuracies in students so that students in determining the intersection of the two graphs were only estimation, so that in looking back indicator, students were not able to use the concepts to answer the next problem. Thus the students were still weak when in the devising a plan, carrying out the plan and looking back indicators.

4. Discussion

The findings that students improve their comprehension and problem solving skills require the participation of many parties (caring community based learning), besides that caring community based learning is very effective in increasing students' understanding and self-confidence in communication [17]. In line with this research, the results of the development of learning devices were carried out of LSLC-based discovery learning to influence their influence on problem solving abilities and raises students' awareness of friends in their groups who still lack understanding of the material, so students who feel able to help their friends in learning really understand the material in the worksheet.

Findings in the control class found the level of problem-solving ability of students 3% in the low category, 20% in the high enough category, 59% in the high category, and 18% in the very high category. while in the experimental class it was found that there were no students whose level of problem solving ability was in the low category, 9% were in the high enough category, and 82% in the very high category. Based on the results of *independent sample t-test* analysis, it shows a significant value of 0,000 ($p \leq 0,05$), which means that there is an effect of a significant increase in the experimental class.

5. Conclusion

Based on the overview and data analysis, it can be concluded that the discovery learning tool based Lesson Study for Learning Community-based discovery learning on the material linear equation system of two variables in the class VIII of junior high school is valid, effective and practical. In addition, the development of these learning tools had a significant influence toward the students' problem solving ability. In the experiment class, there was a significant improvement of the students' problem solving ability that were high enough reached 9%, high 9% and very high 82%. Students and teachers on average gave a positive response to learning by using the results of the development of learning tools of discovery learning based on lesson study for learning community.

Acknowledgement

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