PAPER • OPEN ACCESS

Student's problem solving abilities in Project Based Learning (PjBL) based on Learning Community (LC)

To cite this article: A K A Faozi *et al* 2020 *J. Phys.: Conf. Ser.* **1538** 012070

View the article online for updates and enhancements.

Student's problem solving abilities in Project Based Learning (PjBL) based on Learning Community (LC)

A K A Faozi[1,2] , **Hobri**[1,2], **M Fatekurohman**[3], **K Aini**[1,2], **and D Yuniar**[1,2]

[1] Mathematics Education Departement, University of Jember, Jember, Indonesia
[2] LS iMel (Lesson Study in Mathematics Learning) University of Jember, Indonesia
[3] Mathematics Departement, University of Jember, Indonesia

Abstract. This research intended to develop the mathematics learning device with Project Based Learning which based on Learning Community and presents the effects of developing problem solving on project-based learning by providing different cases secondary level students (SMK) (n = 84). The purpose of this article is to understand clearly and deeply how the learning methodology can influence the process and learning outcomes. Project based learning by solving different problems is possible to develop creative ideas while increasing highly developed skills. The fact shows that their average of problem solving skill is still relatively low. Therefore, in this study, we will apply project-based learning to improve their problem solving. This type of research is a mixed method, which combines quantitative and qualitative research. The quantitative method is used to analyze student learning outcomes, while the qualitative method is used to analyze students' mathematical problem solving. The Respondents in this study consist of three classes, namely two experimental class of 56 students and a control class of 28 students. The research shows that pre-test result of both classes indicates that the three classes are homogeneous. While the post-test result shows that the average of the three classes is significantly different. The inferential statistic result of independent sample t-test of students learning outcomes post-test shows that the sig (2-tailed) is 0.00 ($p \leq 0,05$), thus it is significant. Furthermore, Due to the significance value is less than 0.05, it means that H0 is rejected; H1 is received. Therefore, the learning outcomes of students' problem solving abilities in the experimental class are better than the control class.

1. Introduction

Developments in the world of education today have encouraged someone to have creative and competent abilities in applying and developing mathematics as a basis in human life. The influence of advances in information technology has entered various aspects of life, including in the field of education. Educators and students are required to have the ability to teach and teach in accordance with the 21st century. A number of challenges and opportunities must be faced by students and teachers in order to survive in this age of information age. The learning process in the 21st century wants to make student can improve their critical thinking skills and be able to solve problems, be creative, innovative, and be able to communicate and collaborate [7]

One way to make students more high-level and innovative thinking is to make learning media more complex by linking the material to mathematics with contextual problem. Learning devices are a set of learning resources that allow students and teachers to carry out learning activities [1]

In the scientific approach, learning is conducted based on facts which can be logically explained. Therefore, the students can find the answers that may not be making sense but are achieved through the structured scientific process. The success of a curriculum depends on its implementation at schools. Hence, schools are demanded to facilitate the establishment of a learning community in which

1

students and teachers are learning from each other [2].

In dealing with problems that arise in learning mathematics, learning approaches are needed to improve students' problem solving abilities in learning. One of learning model that is expected to be a means for good learning is Project Based Learning. It is a learning model that is centered on students to conduct an in-depth investigation of a topic. Learners constructively conduct learning deepening with a research-based approach to issues and questions that are weighty, real and relevant. Order to increase interaction between students, students and teachers can be done by implementing Lesson Study for Learning Community (LSLC).[12] It is an implementation of Lesson study which is intended to build a learning community or Learning Community (LC). It is formed into 2 main parts, namely: 1) the values of collaborative learning, 2) the values of caring or caring community.

Learning community requires collaboration in the classrooms and encourages teachers' collegiality to work together to achieve the goal [3]. Collaborative learning is learning in a group; however, the purpose is not achieving unity through group works. The students in the group are encouraged to find various arguments or thoughts of everyone in the group [4] The vision of the learning community is that no student can be left on their own or 'no students are to be neglected.' The teachers are demanded to know, care and educate the troublesome students by facilitating them to work collaboratively [5] The linear program is the subject of class X vocational schools in the current 2013 curriculum. During the initial research, an interview was conducted with one of the mathematics teachers and the results showed: 1) students found difficulty to understand the questions given in the form of story questions, 2) students found it trouble to form mathematical models, 3) students were not able to arrange steps in solving problems.These problems indicate the low problem solving ability of students in vocational secondary schools.

The problems above shows the need of teaching by using a project based learning model based on community learning along with the development of learning instruments. It is expected to overcome the low ability of students in solving mathematical problems. It is also adjusted to the indicator of problem solving ability in the opinion of Polya [8] (1) understanding the problem, (2) planning a solution, (3) implementing a plan of resolution, and (4) re-examining the solution

2. Research Method

The research type is mixed method, research by combining two forms of research namely development research and experimental research.[11] The development model of this research used the development model of thiagarajan, Semmel and Semmel. This model consisted of four stages known as 4-D (Four D Model). The four stages are the define stage, design stage, developing stage, and the disseminate stage [8]

The product of the development must be tested with three groups receiving different treatments to test the efficacy of the product produced, the first experimental class that receives learning treatment using a Learning tools Project based learning based on Learning Community, the second experimental class receives learning treatment using a Learning tools Project based learning and learning control class with conventional learning. After the treatment ended, both groups were given a post-test (final test) to find out whether there were differences in the ability of high-level students between the control class and the experimental class.

The define phase of this stage is used to determine and define the learning conditions (Research and information collecting), and the second step in the Design phase covered the learning tools including RPP, LKS, and THB was designed. The third stage was the stage of developing, this stage included the steps to check the validity, practicality, and effectiveness of learning tools, the fourth stage of the deployment stage was the use of learning tools that had been developed on a more scale, for example in other schools, other classes and other by teachers. The purpose of this stage to test the effectiveness of the use of learning tools [4]

In quantitative research the data were are analyzed using SPSS software to analyze the results of the initial ability test and the final ability test before the normality test was conducted using Kolmogorov-Smirnov and homogeneity tests using the Levene Statistical Test with a significance

level of 0.05 P <0.05. The population used is vocational high school students of SMK Plus Darussalam Bangsalsari in the academic year 2019/2020. For sampling using cluster random sampling techniques. There are 3 classes in this study that are set first, Class X TKJ 2 as the experimental class 1, class X PM 1 is determined as the experimental class 2 and class X TKJ 1 is determined as the control class. Experimental class 1 uses a project based learning model based on community learning, experimental class 2 uses a project based learning model and the control class uses conventional learning. The number of 2 experimental classes was 56 students and the control class was 28 students. The illustration of the research design as follows.

Table 1. Pretest post test-only control design.

Class	Pre-test	Treatment	Post-test
Experiment 1	T_1	X	T_1'
Experiment 2	T_2	Y	T_2'
Control	T_3	Z	T_3'

Keterangan :

T_1, T_2 dan T_3 : the ability of problem solving test before treatment

T_1', T_2' dan T_3': the ability of problem solving test after treatment

X : *learning by applying Project Based Learning* berbasis *Learning Community model*

Y : *learning by applying Project Based Learning model*

Y : learning by applying conventional model or without treatment

In this research also developed a new syntax, which is a mixed of project based learning syntax and learning community, which consists of 6 project based learning syntax and 2 learning community syntax. Under this table the syntax development Project based learning with learning community.

Table 2. Development of project-based learning syntax and learning communities.

SYNTAX PjBL-LC	AIMS OF THE STUDY
(1) determine basic questions in group	1. students able to determine the basic questions in group
(2) designing project planning in group	2. students able to design project planning in group
(3) arrange schdule in group	3. students able to arrange schdule in group
(4) monitoring project progress in group	4. *students able to monitor* the progress of the project in group
(5) examine process and result of the study in group	5. *students able to monitor* the progress of the project in group
(6) evaluating the experience in making project within group	6. *students able to evaluate* the experience in making project
(7) determine the basic questions by caring each other	7. *students able to determine basic questions by caring each other*
(8) designing project planning by caring each other	8. *students able to design project planning by caring each other*
(9) arranging schedule by caring	9. *students able to arrange schdule by caring*
(10) monitoring the progress of the project by caring	10. *students able to monitor* the progress of the project by caring
(11) examining the process dan result by caring.	11. *students able to examine process and result of the studyby caring*
(12) evaluating the experience in making project by caring	12. *students able to evaluate* the experience in making project by caring

Assignments given to students are pretest, posttest and student worksheets arranged based on indicators of students' problem solving abilities with a project based learning approach based on learning community. There are three classes given the task, namely one control class and two experimental classes are given the same test, while the student worksheet is given to two experimental

classes. Experiment class 1 gets a student worksheet with a project based learning approach based on community learning, Experimental Class 2 gets a student worksheet with a project based learning approach. students are asked to solve linear program problems. Through learning with Project Based Learning, students are asked to carry out a project by providing opportunities for students to choose, design, and lead their thoughts and work. Learning Community Learning is carried out collaboratively (collaborative learning) with communities that care for each other (caring community). Thus the process and results of student learning become quality and more meaningful.

In this study the implementation of Project Based Learning has the steps of learning, namely: (1) determination of fundamental questions (2) designing project planning (3) arranging activity schedules (4) monitoring students and project progress (5) testing results (6) evaluating. [13]

Problems in linear programming which are still stated in sentences of general statements, are then converted into mathematical models. Mathematical models are statements that use variables and mathematical notation.

As an illustration, shoe manufacturers make 2 models of shoes using 2 different materials. The composition of the first model consists of 200 gr of the first ingredient and 150 gr of the second ingredient. While the composition of the second model consists of 180 gr of the first material and 170 gr of the second material. Inventory in the first material store is 76 kg and the second material is 64 kg. The price of the first model is Rp. 500,000.00 and the second model Rp. 400,000.00. If summarized / simplified in tabular form, it becomes as follows:

Type of Shoe Material 1 Material 2 Price of Shoe Number of Shoes

Model 1 200 gr 150 gr Rp 500,000.00 x

Model 2 180 gr 170 gr Rp. 400,000.00 y

Availability of 72,000 gr 64,000 gr

With the variable of the optimal number of model 1 is x and model 2 is y, and the optimal sales result is $f(x, y) = 500,000x + 400,000y$. With the provision of:

The maximum number of ingredients 1 is 72,000 gr, then $200x + 150y \leq 72,000$.

The maximum amount of material 2 is 64,000 gr, then $180x + 170y \leq 64,000$.

Each model must be made.

The mathematical model to get the maximum number of sales is:

Maximum $f(x, y) = 500,000x + 400,000y$

Requirements:

$$200x + 150y \leq 72,000$$
$$180x + 170y \leq 64,000$$
$$x \geq 0$$
$$y \geq 0$$

Student Activity :

(1)Respond to the problem, (2) Identify the problem of learning objectives by finding information (3) Form groups and are free to express ideas / ideas in their own language (4) Criticize or judge the ideas / ideas of other groups (5) Collect data and develop. (6) Processing data, analyzing data, compiling data, and adding data (7) Perform a careful examination to prove whether or not the hypothesis is associated with the data (8) Make conclusions (9) Make a data and present (10) Deliver the results verbally in front of the class.

3. Research Finding

This research was conducted at SMK Plus Darussalam, Jember Regency, grade 10 Vocational high school majoring in Computer and Network Engineering 2 as experimental class 1, grade 10 Vocational high school majoring in marketing 1 as experimental class 2 and grade 10 Vocational high school majoring in Computer and Network Engineering 1 as control class. Research expand learning instrument in the form of lesson plan and students based on learning community (LC). The developed instrument integrated by the ability of problem solving element. However, the instruments also connected to collaborative learning and social caring. The valid instrument, then implemented in

experiment class that last for four meetings. The first stage is giving pretest in the first experiment class,too. Learning activity conducts by Project based learning method based learning community, in the second experiment class. Learning activity conducts by applying project based learning method and in the class control, learning activity is done by conventional model (teachers mode). Experiment and control class students are divided into groups consists of four students. Observation of the students activity conducts by several observers. Each observer for a group observation. It is executed according students learning activity such as cooperation, students tuition, sharing responsibility, group discussion and environmental awareness.

The Validity of Learning Tools

After designing learning and research instrument, it needs some input, suggestion, and improvement from learning instrument used in the learning process. Validation is done by two lectures and a mathematic teacher. However, it conducts by giving text and research instrument in the form of lesson plan, students task sheet and result of the study, students observation activity sheet, students response questionnare, and teacher observation activity, and validation sheet for validator expert. The data from validation result for each learning instrument component is analyzed by counting the average of score from each components. The average score for lesson plan, students task sheet and result of the study and research instrument can be seen in the Figure 1 and 2
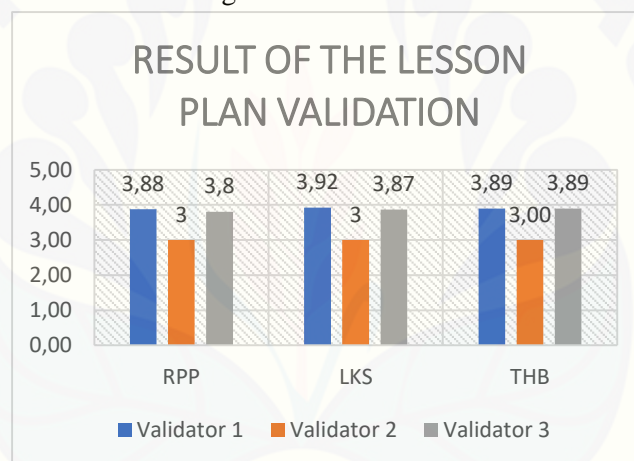

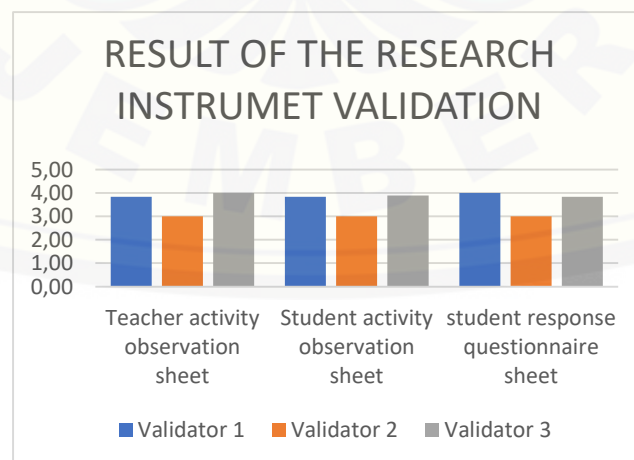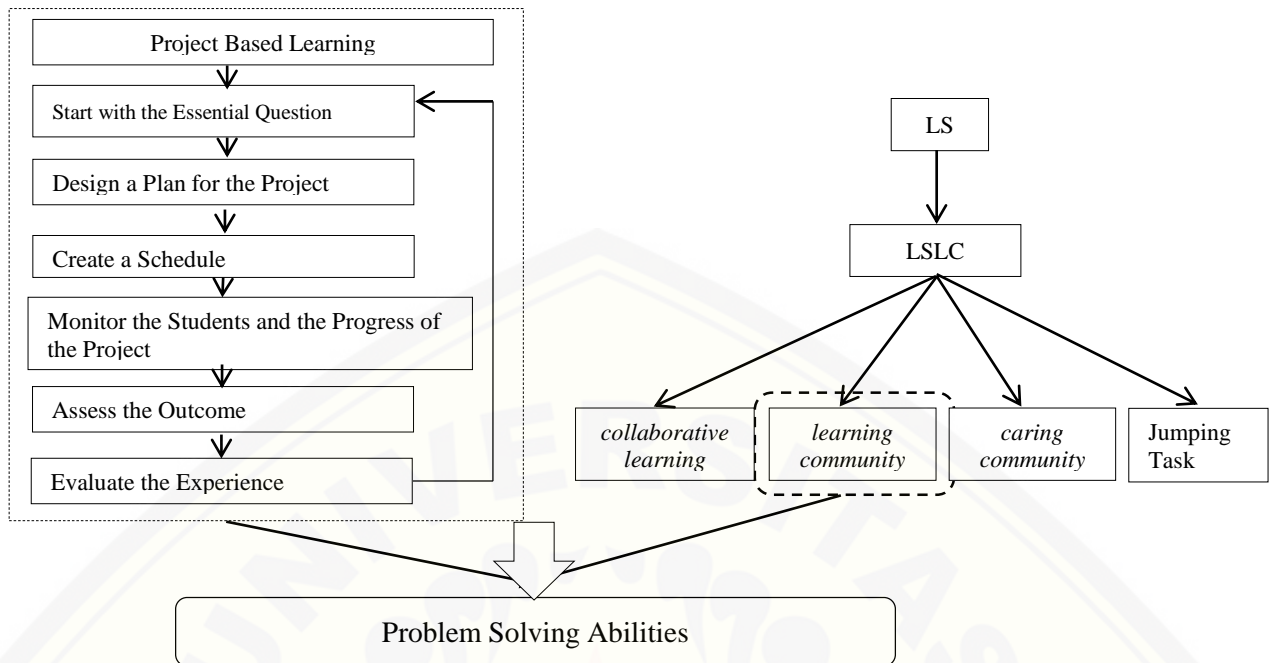**Figure 1**. Result of the lesson plan validation.

Figure 2. Result of the research instrumet validation.

From the results of the two pictures above, Figure 1 and 2 show the criteria for learning tools are valid and can be used in the research and learning process, the data obtained are quantitative data that is used to be qualitative data

Description :

- - - - - - - - - - - - - -   : The Researh Subject

The Practicality of Learning Tools

The next step in this research is "Do". It is seeing the practicality of learning tools from the results of the Student Activity Observation Sheet, Teacher Activity Observation Sheet, Student Response Questionnaire Sheet to Student Worksheets, and Open Learning Observation Sheets. Learning is done in 4 meetings. The first meeting is pretest that consist of two descriptive questions within 90 minutes, the purpose of the pretest to choose a sample class, the second and third meetings deliver material based on the learning device matrix,

Table 3. Normality test (kolmogorov-smirnov).

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Class	Statistic	df	Sig.	Statistic	df	Sig.
Problem Solving	Control	,131	28	,200[*]	,957	28	,303
	Eks 1	,131	28	,200[*]	,969	28	,560
	Eks 2	,162	28	,059	,935	28	,082

Based on Table 3. the results of the significance value in the experimental class 1 is sig = 0.506, the significance value in the experimental class 2 is sig = 0.820, and the significance value in the control class is sig = 0.303. Therefore, it can be concluded that the post-test data in third grade is normally distributed. Thus, the normality test is fulfilled, because the significance value is greater than 0.05, this means that the students' problem solving ability (post-test) in three classes is normal. After doing normality test and normal distributy, Then hemogenity test used Levene Statistics is applied.

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' problem solving abilities showed homogeneity.

In the experimental class 1, the learning process uses the Project based learning (PjBL) approach based on Community Learning (LC), while the experimental class 2 uses the Project based learning (PjBL) approach at the second meeting. Learning activities are carried out through collaboration with students and form groups of 4 students. The selection of group members is adjusted to the results of the pretest, thus each group is heterogeneous. PjBL learning is done through: (1) Start With The Essential Question (2) Desain A Plan For The Project (3) Create A Schedule (4) Monitor The Students And The Progress Of The Project (5) Evaluate The Experience (6) Assess The Outcome. In the Lesson Study for Community Learning (LSLC) based learning, students are directed to work in groups, hence student's 'social interaction abilities can be developed. Then improve students' academic abilities. Therefore, in the experimental class, students are directed to group, asking questions, explaining, and expressing opinions, thus a sense of care arises between students. Student Worksheets (LKS) are given according to the steps in the LC-based PjBL approach and direct students to be able to think through problem solving. While in the control class, learning is done with the same material but using conventional learning. The activities of students in experimental class 1 and experimental class 2 in discussing, asking and explaining or answering and exchanging opinions in groups are presented respectively in Figure 3 and Figure 4 below (taken from one group as a sample).
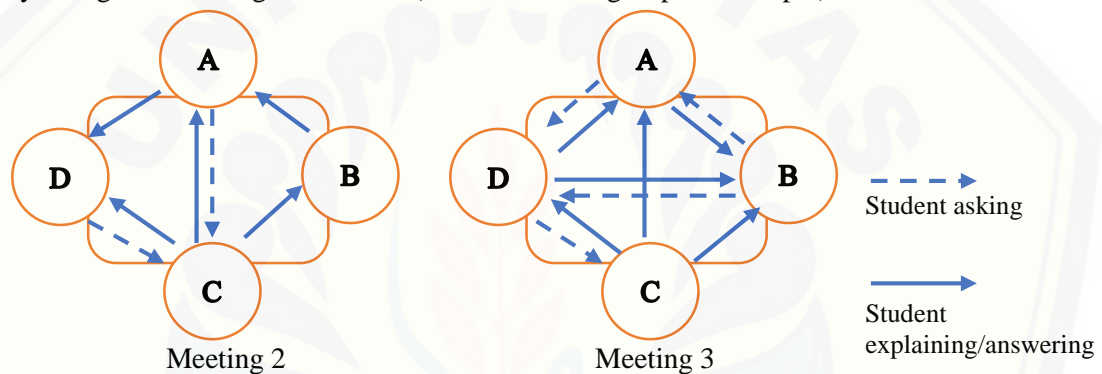

Figure 3. Discussion activities of experimental class 1.

In Figure 3. it can be seen that the group discussion went quite well. Student C gives an explanation to all his group friends. students A and D dare to ask friends in their groups who was not active in the meeting was student B, maybe because student B lacked understanding of the material, but his friends who understood the material wanted to explain to him. From here, among other group members can be seen worrying about their group friends. At the next meeting, student D seemed more active than the previous meeting. He is more confident to express opinions to his friends and also shows courage to help his friends who are in material difficulty. At this meeting, all students seemed to be active in study groups. They become accustomed to working together, respecting each other, and paying attention to each other's opinions. They become accustomed to working together and respecting each others opinions.
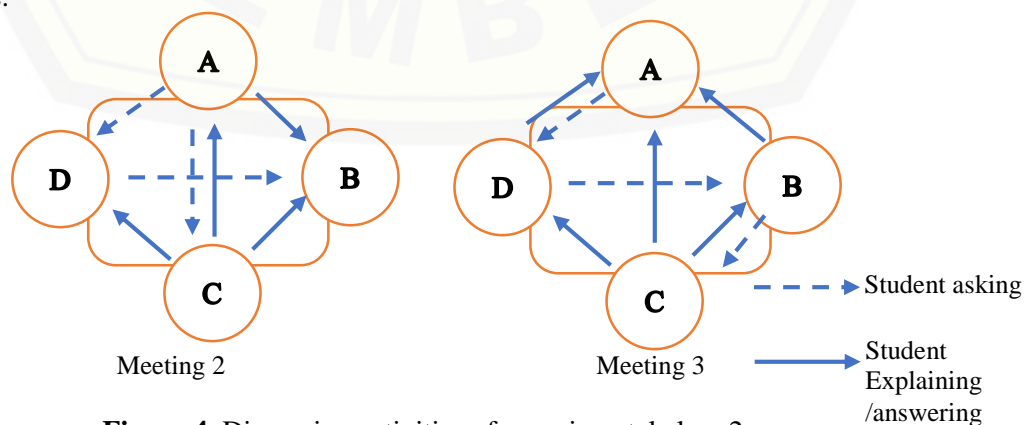

Figure 4. Discussion activities of experimental class 2.

In Figure 4, the group discussion in the experimental class went well. Student C explains the material to group members. Three students namely students A, B and D also dare to ask their friends. In the next meeting, students are more active in groups. They are more eager to ask questions, explain to other friends in the group and more confident to express their opinions to their group members, thus each student understands the material being studied. This condition shows that students are able to collaborate well so that their cognitive knowledge increases
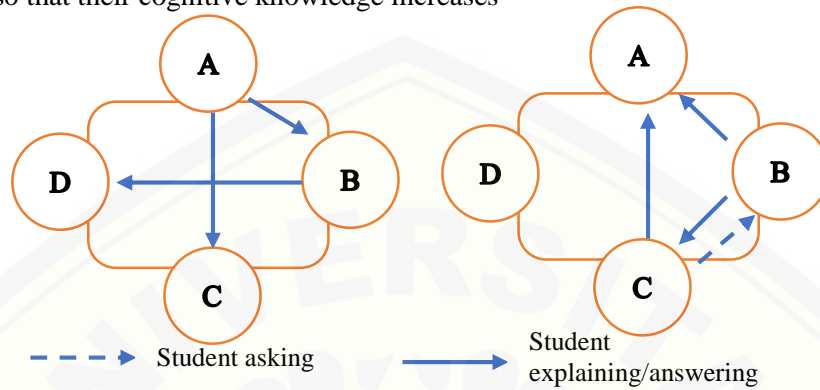

Figure 5. Discussion activities of control class.

In Figure 5, Student A who better understands the material often gives explanations to students B and C. Student B then explains to student D. No discussion took place and there were no questions and answers in the control class. The second meeting is not to different from the first meeting. Students in the control class are less active in groups. There were only 2 students who asked questions and exchanged opinions namely students B and C. Student C then explained to student A. Meanwhile, student B who understood the material better explained to student A. In general, group discussion activities were only to answer questions from the problems given without caring to group members who do not understand the material presented. They only aim to have high score.

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' problem solving abilities.

(I) Class	(J) Class	Mean difference (I-J)	Std. error	Sig.	95% Confidence interval	
					Lower bound	Upper bound
Control	Ex. 1	-2,179	1,203	,172	-5,05	,69
	Ex. 2	-6,679*	1,203	,000	-9,55	-3,81
Ex.1	Control	2,179	1,203	,172	-,69	5,05
	Ex. 2	-4,500*	1,203	,001	-7,37	-1,63
Ex.2	Control	6,679*	1,203	,000	3,81	9,55
	Ex. 1	4,500*	1,203	,001	1,63	7,37

then, to find out the influence of LC-based PJBL learning tools developed by researchers on students' problem solving abilities, One Way Anova was conducted. all done because the study sample used more than 2 classes (control class, experimental class 1 and 2.

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			
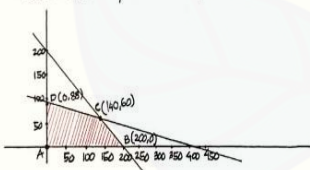
Based on the results of One Way Anova test on the table 6, it was known that the significant result < 0.05 which means that the learning tools of LC-based PJBL had an influence on the students' problem solving abilities. Therefore, the learning tools were effective to use in the learning process. The following is also displayed one of the results of student work.

Figure 6. Student's work result.

After students solve problems related to project based learning based on learning communities in linear program material, researchers conduct interviews to find out students' perceptions about the implementation of learning with the project based learning method based on learning communities. Researchers conducted interviews with experimental class students, students were chosen because students had obtained high criteria of problem solving ability. Data obtained through the interview process are filed below:

Researcher : *How do you feel about learning activities using the components of a mathematics learning tool project based learning model based on learning community?*

Student   : *I think the activity is fun because students are invited to do project work outside class hours and can collaborate with friends, so when there are students who feel they don't understand the material, other students can help explain.*

Researcher : *What makes you happy / unhappy when carrying out learning activities using the components of a mathematics learning tool project based learning model learning community-based learning?*

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

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 graph of linear equations. However, after following the steps of the student worksheet I can understand how to make graphics in a linear program*

4. Discussion

The findings of mathematics learning used project based learning integrated to collaborative learning based LC has been fulfilled. It is indicated by (1) the average of X TKJ's grade increased from 45,43 into 91,45 after the post test. The students finished the Linear Equation system of two variabel matter clasically.(2) the ability of students to finish learning activity is high. There is a significant raising in the average score of problem's solving skill of X TKJ. The observation shows that the learning process run well by the average of 3,65 in each aspect. The results of student's questionnaire responses were more than 94.50%. They have a positive respond to learning instruments and integrated implementation from collaborative questions based LC. Therefore, practically test to education instruments achieve several criterias, such as: (1) the learning implementation is categorized into a good category and (2) Students response positively to learning instruments and the implementation of integrated collaborative study based LC.

This outcome is in line with Hobri et.al (2018) result. It is stated that the result of the study, concern to the problem which faced by the group is shown through the activity. Furthermore, the willingness to share their work on the group, asking and giving their idea are kind of concern and collaborative. That is the implementation of learning community. In the default learning community, we can see the interaction and concern between students increased.[14] Moreover, this research also in line with Retno et.al (2019) . The results test indicate the average of cognitive learning outcome and the ability of solving problem are higher than the control class. It point out that there is raising on the student's result study if the learning process used an appropriate method and attractive material for students [15].

5. Conclusion

The results showed that the learning model of project based learning (PjBL) based on community learning (LC) fulfilled valid, practical and effective criteria. The learning device is declared valid based on the results of data analysis that has been filled out by the validator. Practicality Learning tools are measured through research instruments that have been validated before. The results of the analysis shows practical learning tools for use in the learning process. Effectiveness of learning the device was measured based on students' cognitive learning outcomes in the form of post-test and One Anova Way test was carried out and showed that the significance was <0.05. That is, learning tools forProject-based lerning models based on learning communities have an effect on students' mathematical problem solving abilities.

Acknowledgements

References
[1] Hobri *et all* 2010 High-order thinking skills in contextual teaching and learning of mathematics

based on lesson study for learning community *International Journal of Engineering & Technology (IJET)* **7**(3) 1576-1580

[2] Saito E and Atencio M 2015 Lesson Study for Learning Community (LSLC): Conceptualising teachers' practices within a social justice perspective *Discourse: Studies in the Cultural Politics of Education* **36** 795

[3] Widjajanti and Djamilah B 2008 *Semnas Mathematics and Mathematics Education: FMIPA UNY*

[4] Hobri 2016 Theme: The Role of Mathematics and Learning in Developing Local Cultural Wisdom to Support Nation Character Education *Proceedings of The National Seminar on Mathematics Education*

[5] Sudirtha I 2017 Building learning community and increasing competence through lesson study *Journal of Indonesia education* **6** 30

[6] National Education Standards Agency 2006 *Content Standards for Basic and Secondary Education Units* Jakarta: National Education Standards Agency

[7] Sato M 2012 Reform Learning with Learning Community and School Development Creation Model 21st Century *Jakarta : International Lesson Study Conference*

[8] Hobri 2016 The Methodology of Development Research [Application on Mathematics Education Research] *Jember: Pena Salsabila*

[9] Hobri and Susanto 2016 Mathematics Opportunity and Learning in Facing ASEAN Economic Society *Proceeding*

[10] Hobri, Septiawati I and Prihandoko A 2018 *Int. J. of Eng & Tech* **7** 1576-80

[11] Sugiyono 2017 Mixed Methods Bandung: Alfabeta

[12] Saito, Eisuke, *et all* 2015 School reform for positive behaviour support through collaborative learning: utilising lesson study for a learning community *Cambridge Journal of Education* 37 – 41

[13] Ergül N R and Kargin E K 2014 The Effect of project-based learning on students' science success *Procedia - Social and Behavioral Sciences* **136** 537-541

[14] Safitri J, Romlah S, and Nazareth E 2018 Students' collaborative ability in learning geometry transformation using a scientific approach based on learning community In *Journal of Physics: Conference Series* **1088**(1) 012027

[15] Retno N H D, Sunarno W, and Marzuki A 2019 Influence of physics problem-solving ability through the project based learning towards vocational high school students' learning outcomes. In *Journal of Physics: Conference Series* **1307**(1) 012009