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Students' metacognitive ability in mathematical problem-solving learning based on lesson study for learning community (LSLC)

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Abstract. This research aimed to analyze students' metacognitive skill through the application of mathematical problem solving learning based on Lesson Study for Learning Community (LSLC). This research used a mixed method, qualitative and quantitative. This research started by developing learning material collaboratively with peers, through Plan-Do-See. The data were analyzed by independent t-test. Researchers and some mathematics teachers developed learning materials. The learning materials included the syntax of mathematical problem solving on LSLC. Learning material was not only developed to make students able to resolve the problem solving and improve the metacognitive capability but also to create an atmosphere for the students to learn from each other and not to leave anybody neglected due to incapability. In addition, the developed learning materials also provided "jumping task," exercises designed for students who were more advanced to solve problems with a much higher level to increase their capacity. The research results showed that the implementation of mathematical problem solving based on LSLC significantly affected students' metacognitive capability. Metacognition ability is part of the core competence that must have by senior high school students. Metacognition can be established when students work on problem-solving, work in a small group through collaboration in a community which cares for and learns with one another in the form of LSLC.

1. Introduction

The purposes of the Indonesian national Curriculum 2013 are to help to establish students' metacognitive skills and to guide students' learning by questioning whether or not they have understood the lesson that they are dealing with. The correlation between problem-solving model and students' metacognitive skills has been stated in previous studies, stating that students were better in solving problems when they had a high altitude of metacognitive skills [1][2][3][4][5].

Metacognition is one's knowledge and awareness of his cognitive process. In this case, students were designed to be aware of what they know and what they do not. Metacognition per se often refers

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to the process of "thinking about thinking", which expresses that "metacognition is a high-level thinking skill involving someone metacognitive awareness during the learning process" [6][7].

Problem-solving can be interpreted as a series of learning activities, that emphasize on the process of resolving the problems scientifically. One of the problem-solving models is Polya's model. There are four steps in the problem-solving learning model proposed by Polya, namely: (1) understand the problem, (2) determine the plan of problem-solving strategies, (3) complete the problem-solving strategies, and (4) re-examine the answers obtained. Learning begins by giving a problem, then the students practice to understand, strategize, and implement a strategy to derive a conclusion [8]. In addition, problem-solving ability can be improved by applying collaborative learning, when students work effectively together on projects or tasks. The brain is a social brain and learns more effectively in a learning community than in isolation (two heads are better than one) [9].

The efforts to improve metacognition ability and student learning activity begin by designing the school habit and integrating it into the learning process. Therefore, learning tools were needed to accommodate applying these characters in learning. Learning equipment also becomes guidelines for teachers in implementing learning. Preparation of learning equipment requires a good plan [10][11][12][13]. Metacognitive capability can be monitored from the learning journal, applied during a lesson study for learning community, prepared by the teacher [14]. With the LS learning, collaboration skills can be developed and trained through group work collaborative learning to create an atmosphere that allows students to learn from each other, not leaving any student feel neglected due to incapability or two. Therefore, the problem in this research was how the learning apparatus of LSLC-based learning with Problem Solving Model was applied and how was its effect on students' metacognitive capability. The expected goal was to increase the understanding of concepts, improve students' metacognitive capability, increase the sense of belonging between the members of the learning community, and minimize the mistakes when solving problems.

2. Method

This research used a mixed Method with concurrent triangulation between the qualitative and quantitative formula to address similar problems [15]. The research was conducted in the Year 7 students Junior High School in Jember, East Java, Indonesia. In quantitative research, the sample consisted of two classes that were selected by using random cluster sampling.

In qualitative research, researchers used the phase of lesson study consists of Plan-Do-See. Researchers developed learning equipment and its instruments collaboratively with peers, refer to the development of Thiagarajan, Semmel and Semmel. Furthermore, this study employed an in-depth interview to explore more about the students' activities. Validity test was carried out on the instruments before the test, and the interview was fulfilled. The data were validated using triangulation which was based on test and interview. Then, the interview result was analyzed using data analysis framework proposed by Miles and Huberman. Research procedure was presented in Figure 1.

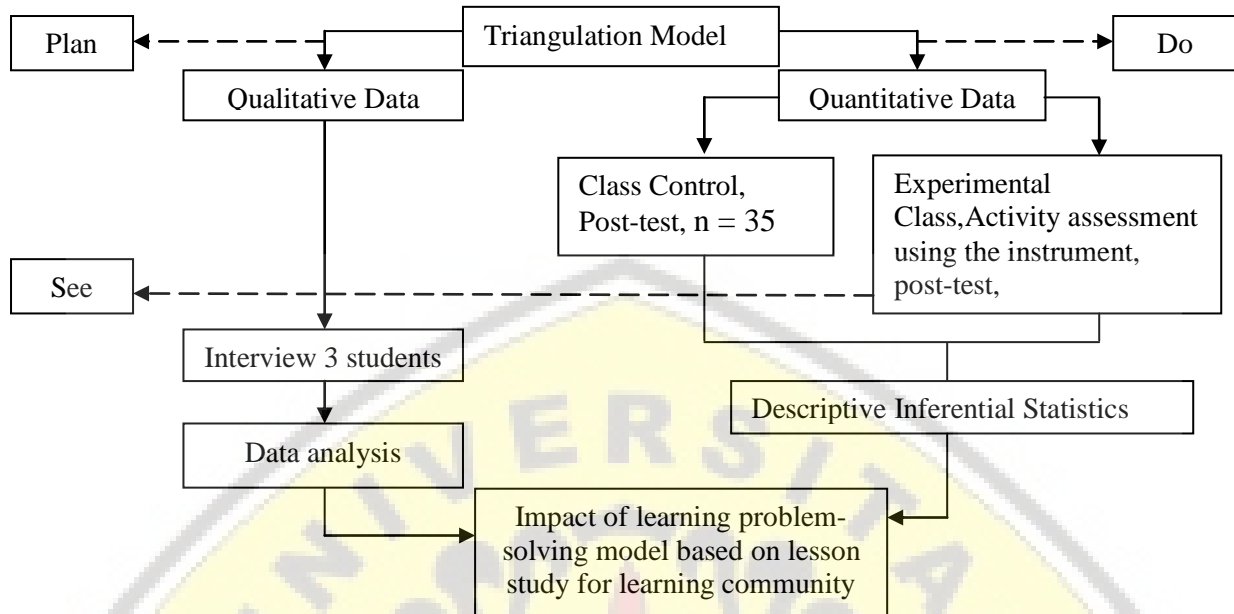


Figure 1. Research Design

3. Results and Discussion

Lesson Study for Lesson Community (LSLC) is part of the Lesson Study (LS), so its phase consists of Plan-Do-See. In the first phase, Plan, a pre-learning activity, the researchers developed learning equipment and its instruments collaboratively with peers, refer to the development of Thiagarajan, Semmel, and Semmel. According to the concept of analysis, mutual care, metacognition ability is part of the core competence that can be achieved at the senior high school level. Metacognition ability can be developed in a learning environment, which is focussing on problem-solving on the topic of matrix.

Before giving treatment to the experimental class and control class, researchers and some mathematics teachers developed learning materials according to the learning model that later was used in the experimental class. The learning materials included the syntax of mathematical problem solving based on LSLC. Learning materials were developed to allow students to be able to resolve the problem solving and improve the metacognitive capability, as well as to create an atmosphere for the students to learn from each other and not leaving anybody neglected due to incapability. In addition, the developed learning materials also provided "jumping task," exercises designed for students who were more advanced to solve problems with a much higher level to increase their capacity.

The next phase is Do, implementing the learning equipment as a development result, that was tested in the experimental class. Learning activity in experimental class and control class has been done four times meeting, the first meeting talked about matrix concept, secondly discuss the operation of matrix, thirdly discuss determinant, and fourthly discuss completion systems of linear equations with matrix and determinant.

In the experimental class has done by opening class and using the scientific approach with problem-solving learning, collaborative learning, and caring community. In control class, conventional learning has been used learning materials that were provided in the school. On experimental class, 36 students are divided into nine small groups and each group observed by one observer. Besides controlling the student activity, one observer controls the teacher activity in the learning process. One of the observer observation results in the fourth meeting to the third group discussion result illustrated in Figure 2.

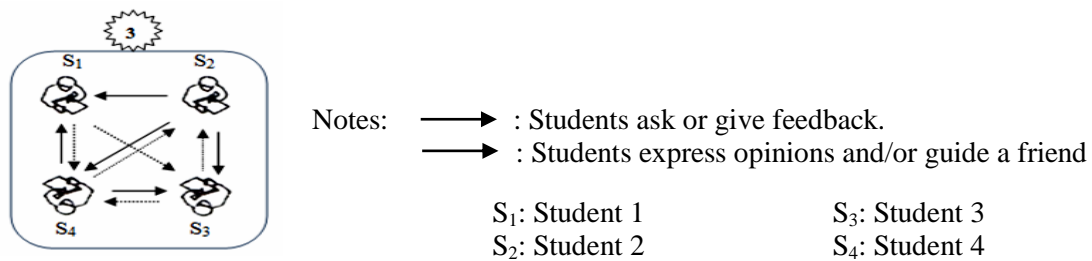


Figure 2. Illustration of group discussions 3

During the discussion of the completion of two variables linear equation system (TVLES) with the determinant method, the results are as follows.

- S₄ Friends, for TVLES completion with the determinant method, we need to distribute the task, S₂ and S₃ use Sarrus rules, S₁ and I use the Minor-Cofactor method, then we will mutually check the results of our work
- S₂ S₂ asked S₃ to change the form of TVLES, whether the equation: (1) as the first column, equation (2) as the second column, and equation (3) as the third column, as has been written in the following:

Figure 3. The result of student

- S₃ S₃ explained that what S₂ was working on, was still incorrect, S₃ mentioned that the x, y, z variables needed to put into column matrix. Therefore, to change TVLES into matrix form, the equation (1) as the first line, equation (2) as the second line, and equation, (3) as the third line.
- S₁ S₁ wanted to check his work and compare the results with S₄. The results of S₄'s work are as the following.

After checking on S₄'s work, it was found that S₄ was careless in completing the task. Therefore, he made a mistake in the next steps as well. S₁ told S₄ in which part he made a mistake so that it was easier for him to fix the answers.

Figure 4. Th result of Student

S₁ showed his conclusion that each portion of the meal cost 2,000 rupiahs, a piece of soybean cake cost 400 rupiahs, a glass of iced orange juice cost 500 rupiahs.

In the experimental class, in accordance with Vygotsky's Zone of Proximal Development (ZPD) theory, the researcher gave the jumping tasks developed in the student worksheet; this jumping task was for high-ability students in the experimental class aimed to get new challenges in learning and to creating possible knowledge. However, the activity of giving the question of the jumping task was not done well because there were no students who can solve the whole jumping problem from the problems that have been given even though they have been guided by the teacher [16].

In the learning process of the control class, students also worked in groups; each group consisted of five students. In the discussions, students were dominating the group from the first to the fourth

meeting, so those students did the tasks while other members simply relied on the group. They were copying the work of other students. When facing difficulties in answering the questions in the worksheet, they were more likely to ask for guidance from the teacher than asking friends in their group. This was due to distrust among the students about the ability of their knowledge. Moreover, the groups that already completed their task refused to share knowledge and to teach other groups that need assistance in learning. This did not increase interpersonal relationships because smart students refused to offer help and considered the work of the others as incorrect. In addition, smart students preferred to do the work on their own and gave the answers for granted to their group members.

The process of the conventional learning activities with the group discussion in the control class can be performed as illustrated in Figure 5.

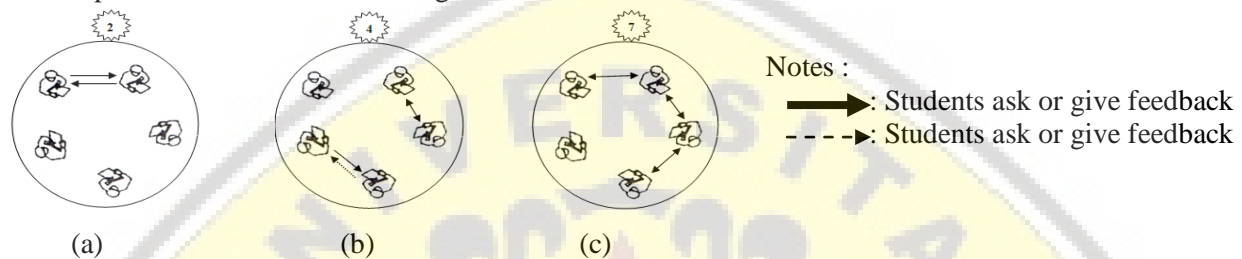


Figure 5. Students' interaction

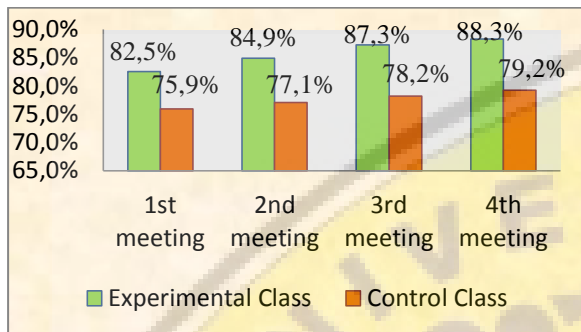
During the discussion (a) in group 2, the two students were dominating the tasks and only two of them mutually asking or responding to one another. They refused to guide the other three group members. Other three members were passive and told merely to copy the work of the domineering students, (b) in group 4, there were only two pairs communicating because they were seatmate refused to cooperate with the other group members, (c), unlike the other groups, in group seven, four members of the group asked questions in the discussion, but there was one student who refused to join the discussion because he could not understand the subject mattered and refused to ask his friends for help.

After learning activity finished, the observers present their observation result during the learning process, which is reflection phase (see) to LS phase. Explanation of the observation result during open class will be used for remedial the next learning process. In experimental class from observation result, learning activity and students interaction are supported by learning equipment with problem-solving learning model based on lesson study for learning communicate has gotten improvement for each meeting. Students' communication skill between students in-group as well as another group in experimental class. Students activity are very good, and the students learning result is very high like in the discussion activity, understand the case, solve the problem is very well, among the students appear a sense of mutual care, and not be ignored. The students, who are more capable, will use communication ability and the students who need an explanation during work in-group can receive an argument in order to their knowledge clearly. The process of functioning communication and argumentation also cannot be separated from the principles that contain in metacognition ability component are planning, information management, monitoring, revising and evaluating.

The appearance of mutual care, mutual learning, sharing knowledge so learning activity by this model, not students stand out nor students left alone and did not ignore each other. In the learning process using the problem-solving model based on lesson study for learning community is an implementation of lesson study for the learning community. This case accorded to the philosophy of learning communities formed into two main pillars namely collaborative learning and caring community [11]. Likewise also the results of research, in designing collaborative learning the elements appearance are learning that make children become as a main role, from teaching to learning and subsequently learning, learning with dialogue and collaboration. The role of the Lesson study in

collaborative learning was not prioritized to solve problem and difficulties but sharing problem, interaction and sharing and think to solve together. [13].

The results of observations in each meeting were used to reflect (See) on various findings in the learning implementation. Teachers and observers shared the findings related to students' learning activities during the learning process to make any improvement in the next meeting in the experimental class.



From four meetings, the average rate of students' learning activities in the experimental class was 85.75% while the average rate of students' learning activity in the control class was 77.60%. It can be concluded that the activities of students in the experimental class with the implementation of mathematical problem-solving learning based on LSLC is better than the activities of students in the control class.

Figure 6. Activities rate of the experimental class and the controlling Class

In line with Hobri's research, the application of student worksheets combined with the concept of collaborative learning, learning community, caring community, and jumping task, student activity is very good, and student-learning outcomes as a whole are very high. Student activities in discussing, understanding the subject matter "matrix," and solving the problem very well [12]. In addition to increasing students' activities, students also responded positively to the mathematical problem-solving learning based on LSLC. It can be seen from the results of students' questionnaire responses distributed to 36 students from the experimental class. Based on the questionnaire responses, students' response to all aspects was 91.28%. Since the result was above 80%, the student's response was positive.

In relating to the students' metacognition ability after applied problem-solving learning based on LSLC, has gotten through the task result of learning task result. Furthermore, the researcher interviewed to a student with who has high mathematics competence, one student with medium mathematics competence, and one student with low mathematics competence. The test was solved by Polya's steps, which used metacognition indicator ability in problem-solving. The same number and type task were given to students of the experimental and control class. The test has been analyzed by t-test. The result can be seen in Table 1.

Table 1. Independent samples t-test

		Levene's Test for Equality of Variances		t-test for Equality of Means			
		F	Sig.	t	df	Sig. (2-tailed)	Std. Error Difference
Student_ Metacognition	Equal variances assumed	3.176	.079	3.730	69	.000	5.8079
	Equal variances not assumed			3.742	66.08	.000	5.8079

Based on the independent sample t-test on the Table 3, the value of sig (2-tailed) is 3.742. This showed the implementation of problem-solving learning model based on LSLC has a significant effect on the students' metacognition ability on matrix topic at the grade 11th senior high school. It is caused during the implementation of problem-solving learning model based on LSLC, the students not only

aware about the benefit of learning model but also can endeavor their metacognition ability to planning, monitoring, evaluating their result task.

This learning model could potentially increase learning activities and students' metacognition ability. The implementation of LSLC showed improving the students' communication ability and argument. It can be separated from the principles contained in metacognition ability components; those are planning, information management, monitoring, revising, and evaluating. According to Polya's theory about the steps of problem-solving, can be stated that all the steps those are proposed pointing to students' awareness and arrangement to the process has been done to get appropriate solution [17]. The step of problem-solving that Polya proposed has been a basis for developing of metacognition ability and most of the researcher has become reference especially by mathematics teacher [18][19][20]. In addition, students' metacognition skills were also improved through a learning journal developed on the student worksheet on learning by applying a lesson study [14] [21]. By applying the model of problem solving-based on LSLC can increase student activity, students' ability in solving problems that resulted in increasing of students' metacognitive ability.

4. Conclusion

The student worksheet that implemented mathematical problem-solving learning based on LSLC in this study combined the concepts of collaborative learning, learning community, caring community, and jumping task. The worksheet resulted in very good student activity and a very high students' learning outcomes. The students' activities in the experimental class with the implementation of mathematical problem-solving learning based on LSLC through utilization of students worksheet was better than the activities of students in the control class with conventional learning. The implementation of mathematical problem-solving learning that was based on LSLC through utilization of students' worksheet significantly affected students' metacognitive capability, particularly on subject matter matrix and its operation. It can be suggested that the implementation of mathematical problem-solving learning based on LSLC through utilization of students worksheet is one alternative of learning models that are beneficial for classroom use. However, its effectiveness still needs to be clarified in other classes even in other schools with a variety of different conditions.

Reference

- [1] Garrett, A.J ,Mazzocco Garrett , and Mazzocco, Baker, L 2006 Development of the Metacognitive Skills of Prediction and Evaluation in Children with or without Math Disability *Learning Disabilities Research & Practice* **21**(2) pp 77–88.
- [2] Keichi, S 2000 *Metacognition in Mathematics Education in Japan* (Japan: JSME)
- [3] Mohamed, and Nai, Tan Ten 2005 The Use of Metacognitive Process in Learning Mathematics. *The Mathematics Education into the 21st Century Project (Universiti Teknologi Malaysia Reform, Revolution, and Paradigm Shifts in Mathematics Education Johor Bahru Nov 25th – Dec 1st)* pp 159 – 162
- [4] In'am, A. A 2012. Metacognitive Approach to Solving Algebra Problems. *International Journal of Independent Research and Studies (IJIRS)* **1** (4) pp 162-173
- [5] Purnomo, D., T. Nusantara , Subanji , and S. Rahardjo 2016 Metacognition Process Characteristics of The Students in Solving Mathematics Problems *IOSR Journal of Research & Method in Education (IOSR-JRME)* **6** (5) pp 26-35.
- [6] Livingston, J. A 1997 Metacognition: An Overview. Retrieved from <http://www.gse.buffalo.edu/fas/shuell/cep564/Metacog.htm>, 1-5. Retrieved February 15, 2017.
- [7] Costa, A. L. and Kallick, B 2009 *Leading and Learning with Habits of Mind: 16 Characteristics for Success* (Alexandria, VA: Association for Supervision and Curriculum Development)
- [8] Ahmadi, A. and Prasetya, J.T .1997 *Teaching and Learning Strategies* (Bandung: Pustaka Setia)
- [9] Kryza, K., Duncan, A., and Stephens, S. J. 2009 *Inspiring Elementary Learners: Nurturing the Whole Child in a Differentiated Classroom* (Thousand Oaks, CA: Corwin Press) p 31

- [10] Mariati, P. S. 2012 Development of Problem-Based Physics Learning Model for Improving Metacognition Skills and Student Concept Understanding *Journal of Physics Education Indonesia* **8** pp 152-160
- [11] Hobri, Dafik, and Hossain 2018 A The Implementation of Learning Together in Improving Students' Mathematical Performance *International Journal of Instruction* **11**(2) pp 483-496
- [12] Purwaaktari, E. 2015 The Effect of Collaborative Learning Model on Problem Solving Ability of Mathematics and Social Attitude of V Students of SD Jarakan Sewon Bantul *Journal of Educational Science Research* **8**(1) pp 95-111
- [13] Rudolph, J. et al. 2017 Metacognitive Confidence Judgments and Their Link to Complex Problem Solving *Intelligence* **63** pp 1 – 8.
- [14] Setiawan and Susilo 2015. Improving Metacognitive Skills of Biology Study Program Students through The Application of Journal of Learning with Jigsaw Strategy Combined PBL Based Lesson Study in General Biology Course *Proceedings of National Biology Education Seminar 2015* (Biology Education Prodi FKIP University of Muhammadiyah Malang) March 21, 2015 pp 359-69.
- [15] Sugiyono 2017 *Combined Research Methods (Mixed Methods)* (Bandung: Alfabeta) p 17
- [16] Vygotsky, L.S. 1978 *Mind in Society: The Development of Higher Psychological Processes* (Harvard: Harvard University Press)
- [17] Gama, C. A. 2004 *Integrating Metacognition Instruction in Interactive Learning Environment* (D. Phil Dissertation: University of Sussex)
- [18] Garrett, A.J, Mazzocco Garrett, and Mazzocco, Baker, L. 2006 Development of the Metacognitive Skills of Prediction and Evaluation in Children with or without Math Disability *Learning Disabilities Research & Practice* **21**(2) pp 77–88
- [19] Keiichi, Shigematsu and Yoshio, Katsumi 2000 Metacognition: The Role of the "Inner Teacher" (6): Research on The Relation Between a Transfiguration of Student's Mathematics Knowledge and "Inner Teacher" *Proceedings of the Conference of the International Group for the Psychology of Mathematics Education (PME)* (24th, Hiroshima: Japan, July 23-27, 2000) **1** pp 4-137
- [20] Mohamed, Mohini and Nai, Tan Ten 2005 The Use of Metacognitive Process in Learning Mathematics *The Mathematics Education into the 21st Century Project* (Universiti Teknologi Malaysia Reform, Revolution and Paradigm Shifts in Mathematics Education: Johor Bahru) Nov 25th – Dec 1st
- [21] Harlita, Riezky Maya Probosari 2010 *Use of Journal of Learning to Increase Mastery of Animal Embryology Concept of Student Education* (Study Program Biology Faculty of Teacher Training and Education UNS National Seminar on Biology Education: Semarang) 2010 pp 200-206