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Enhancing mathematical problem solving ability through model eliciting activities

Arum Diyastanti[a,*], Nuriana Rachmani Dewi[a], Sunarmi[a]

[a] D7 Building 1st Floor, Sekaran Campus Gunung Pati, Semarang 50229

* *E-mail address: arumdiyas@students.unnes.ac.id*

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Abstract

The main purpose of this research was to comprehensively examine the achievement and improvement of mathematical problem solving ability through the use of Model Eliciting Activities and Problem Based Learning. The research method used was explanatory sequential mixed methods. The research design used was Pretest-Posttest Control Group Design. The research population was VII grade students of one of Junior High School in Kudus except students in the favourite class. The sample was taken by simple random sampling technique, so that VII F was chosen as experiment class and VII E as control class. Qualitative research subjects were taken 6 subjects based on the mathematical early ability category. The result of the research showed that (1) the achievement of mathematical problem solving ability of the students who got Model Eliciting Activities had not reached the completeness classically; (2) the achievement and improvement of mathematical problem solving ability of the students who got Model Eliciting Activities were better than the students who got Problem Based Learning; (3) the students who got Model Eliciting Activities tend to be active and brave rather than the students who got Problem Based Learning; and (4) some of the students' difficulties, students with the high early mathematical ability in the experiment class did not face any difficulties, only the students were not careful in calculating, while in the control class faced the difficulty in making plans at number 4, thus influencing the next indicator. For students with the medium early mathematical ability in the experiment class faced the difficulty in determining the correctness of the answer and were not careful in calculating, while in the control class faced the difficulty in determining the correctness of the answer and making the plan at number 4 thus influencing the next indicator. Lastly, for students with low early mathematical ability in both experiment class and control class, they faced the difficulty in determining the truth of the answer and had not finished working on the four questions because the time provided has been exhausted.

1. Introduction

According to UU Number 20 of 2003 in article 1 verse 1, education is a conscious and planned effort to create a learning atmosphere and learning process so that students actively develop their potential to have religious spiritual power, self-control, personality, intelligence, noble character, and the skills needed by him/her, society, nation and state. Mathematics has an abstract nature that has a very important role in education and often used in daily life. Although mathematics is often used in daily life, mathematics is still less attractive to high school students. Mathematics subject has many question forms, ranging from numbers to stories.

There are five standard processes in learning mathematics, namely the process of problem solving, reasoning and verification, communication, connection, and representation (NCTM, 2000: 7). One of the abilities that have to be mastered by students in the process of learning mathematics is the problem solving ability.

Problem solving is one of the most important cognitive aspects used in daily life, and mathematical problem solving is also the most important part of mathematics (Aljaberi, 2015).

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Related to the importance of problem solving ability, so the students can master problem solving with the following activities: (1) identifying the data adequacy for problem solving; (2) creating a mathematical model of a daily situation or problem and solve it; (3) choosing and implementing strategies to solve mathematical problems and/or outside mathematics; (4) explaining and interpreting the results according to the original problem, and check the correctness of the results or answers; (5) applying mathematics meaningfully (Sumarmo, 2013: 128). Therefore, the students' problem solving ability will provide convenience for students in solving various problems.

Additionally, according to Polya (1973: 5-6), the problem solving stage includes: (1) understanding the problem, (2) making plans, (3) executing the plan, and (4) re-checking. In reality, generally the problem solving ability owned by students still not maximal and still relatively low. The low ability of problem solving can be proven from the result of Trends in International Mathematics and Science Study (TIMSS) study in 2015, the achievement of mathematics learning in Indonesia is in the top 6 position from the bottom of the rank 45 from 50 countries with 397 score. Based on the interview with mathematics teacher in one of Junior High School in Kudus reveals that the ability of mathematical problem solving of grade VII students is still low seen from the work of students in doing the final assessment of the 2017/2018 academic year. In addition, the ability of the low mathematical solving problem can be proven by the result of student work in doing problem solving ability question in arithmetic chapter which has an average of 60.44 from the maximum score (100) with 34 students.

Based on Minister of Education and Culture regulations No 65 year 2013 about standard process, the learning model used in Curriculum 2013 is discovery/inquiry learning model, problem based learning and project based learning. In this research, one of Junior High School in Kudus has been used the Curriculum 2013 but not fully using it. According to Endang Tri Endraswati, S.Pd., the model used in one of Junior High School in Kudus is problem based learning. Despite using problem based learning model, there are still students who have low mathematical problem solving ability due to the students' passiveness s in the group.

Rectangular is the geometry material in grade VII even semester. In rectangular materials, students learn to discover the elements, characters, circumference, and large of two-dimentional figure that have four sides. In addition, there are a lot of daily problem that occur in rectangular material. Based on the result of interviews with mathematics teacher at one of Junior High School in Kudus, rectangular material have been introduced in elementary school but there are still some students who have difficulty in understanding and solving problems related to rectangular material, so that the success of student learning has not reached Community Development Program *(Kriteria Ketuntasan Minimal).* Community Development Program established by the the school is 75, while the classical completeness is 75%.

The low ability of mathematical problem solving ability for students, so the effort that needs to be done to achieve satisfactory results and students master the material is the use of learning models that can improve students' mathematical problem solving abilitiy. One of the right learning models is Model Eliciting Activities.

The research result of Yu & Chang (2009) shows that Model Eliciting Activities is useful to improve students' problem solving abilitiy. Therefore, Model Elicing Activities is used to help students learn more deeply and provide more opportunities to practice in solving many different problems.

According to Sholikhah (2014: 26), Model Eliciting Activities is a mathematics learning model to understand, explain, and communicate mathematical concepts contained in a problem presentation through mathematical modeling. The process of mathematics learning using Model Eliciting Activities, the students work actively in small groups and if students presented a mathematical problem, students should first create a mathematical model to solve the mathematical problems. According to Chamberlin (2008), Model Eliciting Activities is implemented in the following steps: first, the teacher reads a sheet of problem that develops the student context. Then, students are ready to be alert to the questions based on the problem sheets; furthermore, the teacher reads the problem with students and ensures that each group understands what is being asked and students try to solve that problem; after that they present their mathematical models after discussing and reviewing solutions. It can be concluded that when the process of mathematics learning using Model Eliciting Activities, students work actively in small groups and if students presented a mathematical problem students should first create

a mathematical model to solve mathematical problems.

The students' mathematical problem solving ability that are still relatively low need to be improved. This research is directed to use mathematical problem solving stage by Polya through learning process using Model Eliciting Activities. Using Model Eliciting Activities in the learning process to improve mathematical problem solving ability can be influenced by one of the factors that is students' early mathematical ability.

Based on this background the researchers conducted a research on improving mathematical problem solving ability of grade VII students through the use of Model Eliciting Activities. There are several problems studied, as follows (1) whether the students who get the Model Eliciting Activities obtained the achievement of mathematical problem solving abilitiy completely in a classical manner or not, (2) whether students who get the Model Eliciting Activities obtained the achievement and improvement of mathematical problem solving ability better than students who get Problem Based Learning reviewed as a whole and based on early mathematical abilitiy, (4) how the description of the learning implementation using Model Eliciting Activities and Problem Based Learning is, and (5) what the difficulties faced by students in completing the problem solving question.

2. Methods

The method used in this research was explanatory sequential mixed methods, an explanatory sequential mixed methods was a method in which the researchers first conduct quantitative research, analyze the results and compile the results to be explained in more detail with qualitative research (Creswell, 2016: 21). The research design used was Pretest-Posttest Control Group Design.

The population of the research was VII grade students one of Junior High School in Kudus except the students in the favourite class. The sample was taken by simple random sampling technique, so that it was obtained that grade VII F as the experiment class by using Eliciting Activities learning model and grade VII E as a control class with Problem Based Learning. Qualitative research subjects were taken using purposive sampling technique by selecting three students from the experiment class and the control class based on the posttest scores on mathematical problem solving ability and students' early mathematical ability levels.

The variables used in this research were independent variable, Model Eliciting Activities, while the dependent variable was students' mathematical problem solving ability, and control variable was early mathematical ability. The data collection method was done by interview, documentation, test, and observation method. Interview method was used as a first step to find out the condition or problem about students' problem solving ability. The documentation method was used to obtain the result data of students' problem solving ability of social arithmetic chapter, line chapter value and angle as the data of students' early mathematical ability, Final Assessment Score, and photos of learning activity during the research. Test method used was a test of mathematical problem solving ability in the form of description. While the observation method was conducted by the researchers and mathematics teachers during the learning process.

The data analysis used in this research was test analysis of mathematical problem solving ability and data analysis of research result. Analyzing preliminary data obtained from daily assessment score of line and corner chapter as prerequisite material using normality test, homogeneity test, and equality test of two mean. For the final data obtained using normality test, homogeneity test, right side proportion test, gain test, equilibrium test of two right-hand side, and correlation test.

3. Result and Discussion

The results of the preliminary data analysis showed that the preliminary data in the experiment class and the control class were normally distributed, homogeneous, and had an equivalent average. The data distribution of early mathematical ability in the experiment class and control class could be seen in Table 1 and Figure 1 as follows.

Table 1. Early Mathematical Ability Data

EMA Category	Statistic	Class	
		Experiment	Control
	n	6	5
High	$\bar{x}$	100,00	100,00
	s	0,00	0,00
Medium	n	23	24

	$\bar{x}$	71,52	71,25
	s	14,26	13,45
	n	5	5
Low	$\bar{x}$	32,00	33,00
	s	8,37	13,96
	n	34	34
Total	$\bar{x}$	70,74	69,85
	s	22,97	22,24

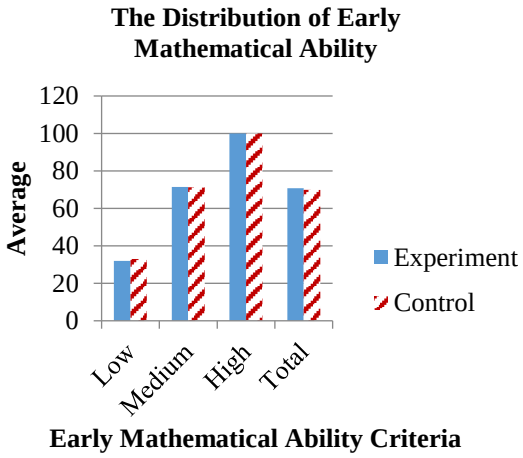

Figure 1. The Students' Early Mathematical Ability Distribution Diagram

The final data analysis of pretest and posttest of the students' mathematical problem solving ability in the experiment class and control class were normally and homogeneously distributed.

The 1st hypothesis testing aimed to find out whether grade VII students who got the Model Eliciting Activities obtained the achievement of mathematical problem solving ability in rectangular material (rhombus and kite) complete classically or not. The Minimum Mastery Learning Criteria or called as KKM (Kriteria Ketuntasan Minimal) on students' mathematical problem solving abilitiy, the researchers used school KKM which was 75 with the percentage of students who reached KKM at least 75%. Based on the right-sided proportion test, obtained zcount = -5.743 <ztable = 1.64, then H0 was accepted which means that the students' mathematical problem solving ability with Model Eliciting Activities learning has not achieved completeness classically.

The 2nd hypothesis test aimed to examine whether grade VII students who got the Model Eliciting Activities obtained better achievement of mathematical problem solving ability compared to those with Problem Based Learning reviewed entirely based on early mathematical ability. The data used were the students' posttest score of mathematical problem solving ability of the experiment class and control class. From the test results, it was obtained that tcount = 1.787> ttable = 1.669, then H0 was rejected which means the average posttest of the experiment class students' problem solving ability was better than the average posttest of the control class students' problem solving ability. The achievement of mathematical problem solving ability of students who got Model Eliciting Activities and Problem Based Learning that were overall reviewed based on the early mathematical ability were presented in a bar diagram which could be seen in the Table 2 and Figure 2 as follows.

Table 2. The Achievement of Mathematical Problem Solving Ability

Early Mathematical Ability Criteria	Class	
	Experiment	Control
Low	66.79	61.07
Medium	69.72	67.20
High	79.17	72.11
Total	70.96	67.02

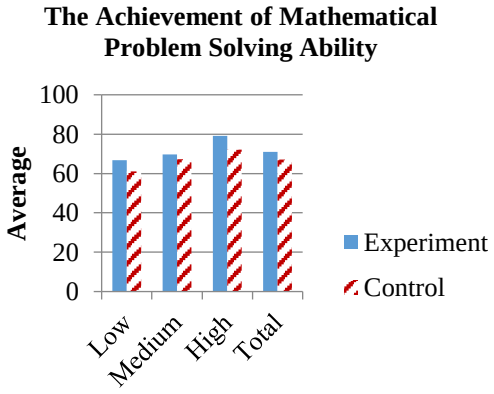

Figure 2. The Achievement of Mathematical Problem Solving Ability Diagram

The 3rd hypothesis testing aimed to test whether the grade VII students who got the Model Eliciting Activities have improved the mathematical problem solving ability were better than the grade VII students who got Problem Based Learning reviewed entirely based on early mathematical ability. The data used were the students' pretest and posttest score of mathematical problem solving ability from both experiment and control

class. The test result shows $t_{count} = 5.945 > t_{table} = 1.669$, then H_0 was rejected which means that the average improvement of experiment class students' mathematical problem solving ability were better than those in control. The improvement of students' mathematical problem solving ability who got Model Eliciting Activities and Problem Based Learning reviewed entirely based on early mathematical ability was presented in bar diagram which could be seen in Table 3 and Figure 3 as follows.

Table 3. The Improvement of Mathematical Problem Solving Ability

Early Mathematical Ability Criteria	Class	
	Experiment	Control
Low	0.54	0.48
Medium	0.55	0.53
High	0.60	0.52
Total	0.56	0.52

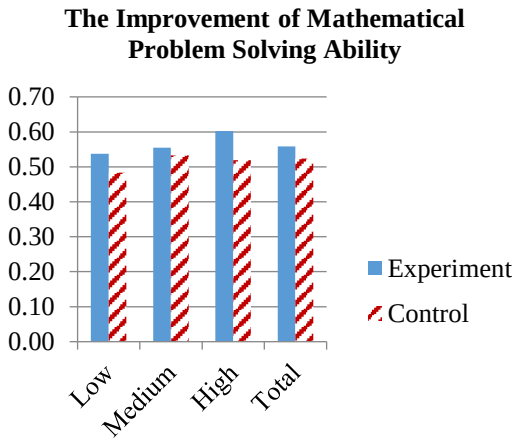

Figure 3. The Improvement of Mathematical Problem Solving Ability Diagram

From the 5th diagram, overall based on the early mathematical ability, as can be seen that the improvement of mathematical problem solving ability in the experiment class was higher than those in the control class.

3.1. The Results of Students' Mathematical Problem Solving Ability Tests

The analysis of students work results using pretest and posttest data of students' mathematical problem solving ability of the experiment class and control class which aimed to know the description of the achievement and improvement of the students' mathematical problem solving ability was described by the indicator.

Table 4. The Average of Mathematical Problem Solving Ability based on Indicators

Mathematical Problem Solving Ability Indicators	Experiment			Control		
	Pretest	*Post test*	$\langle g \rangle$	*Pretest*	*Posttest*	$\langle g \rangle$
Understand the problem	1,63 (40,63 %)	3,96 (99, 08%)	0,98	2,30 (57,54%)	3,94 (98,53 %)	0,97
Make plans	1,76 (43,93 %)	3,43 (85, 85%)	0,75	1,05 (26,29%)	3,10 (77,57 %)	0,70
Implement the plans	1,38 (34,38 %)	2,13 (53, 31%)	0,29	0,90 (22,43%)	1,97 (49,26 %)	0,35
Check again	0,01 (0,37 %)	0,38 (19, 12%)	0,19	0,04 (1,84 %)	0,38 (18,75 %	0,17
Total	4,67 (34,03 %)	9,91 (70, 80%)	0,56	4,29 (35,72%)	9,39 (67,07 %)	0,53

The diagram for the achievement of mathematical problem solving ability based on indicators can be seen in Figure 4 as follows..

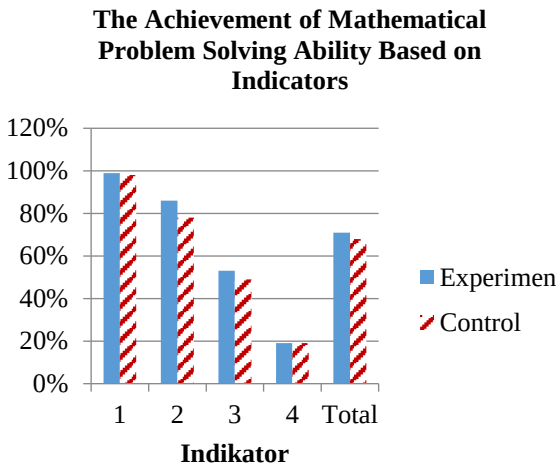

Figure 4. The Achievement of Mathematical Problem Solving Ability Based on Indicators Diagram

From the 4th diagram, it could be seen that the achievement of mathematical problem solving ability based on the first, second, and third indicators of the experiment class was higher than the control class, while based on the fourth indicator the achievement of the experiment class and control class was same. Seen as a whole, the indicator of the achievement of students' mathematical problem solving ability of the experiment class was higher than the control class.

The diagram of the improvement of mathematical problem solving ability based on indicators could be seen in Figure 5 as follows.

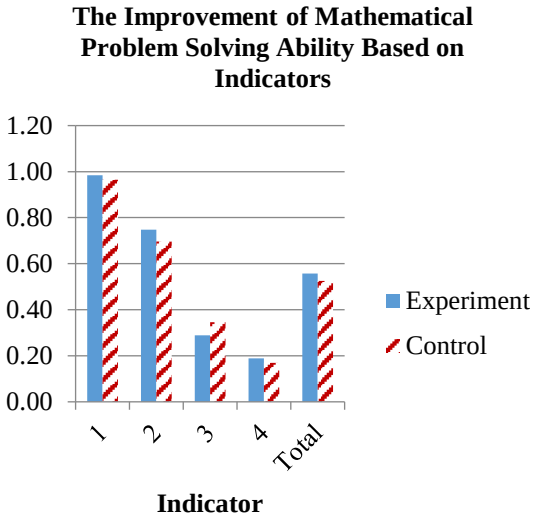

Figure 5. The Improvement of Mathematical Problem Solving Ability Based on Indicators Diagram

From the 5th diagram, it could be seen that the improvement of mathematical problem solving ability based on the first, second and fourth indicators of the experiment class was higher than the control class, while based on the third indicator the control class was higher than the experiment class. Overall, the improvement of students' mathematical problem solving ability of the experiment class was higher than the control class.

The achievement of students' mathematical problem solving ability in the experiment class that got Model Eliciting Activities has not yet achieved classical completeness. It can be proven by the right-sided proportion test in which the zcount is -5,743 <ztable and ztable is 1,64. From the results of these tests, it can be concluded that the achievement of students' mathematical problem solving ability in the experiment class that got Model Eliciting Activities has not yet achieved classical completeness. The achievement of classical mastery was certainly not a lot of students whose grades were still below the KKM due to several factors, namely (1) students were not familiar with learning using Model Eliciting Activities because the learning duration was not enough if only 4 meetings; (2) students felt bored with a lot of story problems that students thought were dizzy; and (3) students were still not using mathematical problem solving stage by Polya. Students who completed the completion of the mathematical problem solving ability test wee only 11 people who were not much different from the results of the Final Semester Assessment (PAS) in which only 10 people who successfully completed.

The achievement of students' mathematical problem solving ability in the experiment class was better than those in the control class. It can be proved by the similarity test of two right-side averages in which the tcount was 1.787> ttable and ttable was 1.669. From the test results, it can be concluded that the achievement of students' mathematical problem solving ability in the experiment class was better than those in the control class. The improvement of students' mathematical problem solving ability in the experiment class was better than those in the control class. It can be proved by the similarity test of the two right-hand parties in which the tcount was 5.945> ttable and ttable was 1.669. Hence, it can be concluded that the improvement of students' mathematical problem solving ability in the experiment class was better than those in the control class.

Additionally, Miranti's (2015) study strengthens that students' mathematical problem solving ability in MEA learning was better than PBL learning. The increase in problem solving ability was also in accordance with the research conducted by Juanda (2014), Martyaningrum (2018), and Rosyid (2018) which show that students' mathematical problem solving ability can be improved. The increase in the experiment class that gets Model Eliciting Again, Sholikhah's research (2014) and Yu & Chang (2009) also suggest that students' mathematical problem solving ability can be improved by Model Eliciting Activities (MEA).

For the achievement and improvement of students' mathematical problem solving ability in the experiment class with high mathematical initial ability category were superior to those in the control class. While for the experiment class with the initial mathematical ability category, it was superior to those in the control class with the medium mathematical ability category. Then in the experimental class with the low mathematical initial ability category, it was superior to in the control class with low mathematical initial ability categories.

Therefore, the results indicate that the category of students' initial mathematical ability is one of the factors that can influence the achievement and improvement of students' mathematical problem solving abilities. As explained by Pamungkas (2017) that students who have good mathematical knowledge will get good knowledge too. This was also reinforced by the results of Pujiastuti (2014) research that initial mathematical ability have an influence on the achievement and improvement of students' mathematical problem solving ability.

In the implementation of the Model Eliciting Activities learning, students could follow the learning well even though at the beginning of the meeting students were still busy themselves. In addition, students who got Model Eliciting Activities tend to be active and brave than those who got Problem Based Learning.

Some of the difficulties experienced by students in solving problem solving ability were as follows. For the E-34 subject with KAMT, there was not any difficulties found, but the stage of implementing the plan was not thorough in the calculation. For the K-01 subject with KAMT also did not experience difficulties only in problem number 4 which was done until stage 1 only. Yet, for E-26 subjects with KAMS, they got difficulties in re-examining since there were no stages in numbers 3 and 4 as well as inaccurate calculations. For K-21 subjects with KAMS working on number 4 only to stage 1 got difficulty in re-checking since there were no stage 3 and 4 at this stage. For E-18 subjects with KAMR, they had difficulty in re-examining since they only worked on number 3 without reviewing the stages. For the K-14 subject with KAMR, it was difficult to re-examine the stage because what was done from questions 1 to 4 there were no stage of checking again.

4. Conclusion

Based on the results of the research that has been carried out, there are several conclusions, as follows: (1) the achievement of mathematical problem solving ability of the students who got Model Eliciting Activities has not reached the completeness classically; (2) the achievement and improvement of mathematical problem solving ability of the students who got Model Eliciting Activities are better than the students who got Problem Based Learning; (3) on the implementation of Model Eliciting Activities, students could follow the learning well although at the beginning of the meeting the students were still busy themselves. For more, students who got Model Eliciting Activities tend to be active and brave rather than the students who got Problem Based Learning; (4) students with the high early mathematical ability in the experiment class did not face any difficulties, only the students were not careful in calculating, while in the control class, they faced the difficulty in making plans at number 4, thus influencing the next indicators. For students with the medium early mathematical ability in the experiment class faced the difficulty in determining the correctness of the answer and were not careful in calculating, while in the control class, they faced the difficulty in determining the correctness of the answer and making the plan at number 4, consequently it influenced the next indicator. Lastly, for students with low early mathematical ability in both experiment class and control class, they faced the difficulty in determining the truth of the answer and had not finished working on the four questions due to the learning duration had been exhausted.

Eventually, the Model Eliciting Activities in learning process was useful to improve students' mathematical problem solving ability. Teachers could pay attention to the students' early mathematical ability in which students with low early mathematical ability would influence the

level of student learning success. To solve mathematical problem solving question, the teacher must familiarize the students to use the polya stages namely understanding problems, making plans, implementing plans, and checking again.

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