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IMPLEMENTATION OF OPEN-ENDED PROBLEMS ON MATHEMATICAL PROBLEM-SOLVING SKILL OF ELEMENTARY SCHOOL STUDENTS

Diana Ermawati, Eka Zuliana

University Of Muria Kudus

diana.ermawati@umk.ac.id

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Abstract

This research is a quasi-experimental research with the purpose to find out the effect of open ended problem on mathematical problem solving skill of elementary school students. The research was conducted on grade 5 students of Gemiring Kidul 1 and Gemiring Kidul 2 Elementary School. These two classes used for research have an equivalent level of skill. Elementary School 1 Gemiring Kidul as an experimental group with 21 students of grade 5 and Elementary School 2 Gemiring Kidul as a control group with 20 students of grade 5. This research has two variables; the independent variable is the implementation of open-ended problem, while the dependent variable is the skill to solve mathematical problems. Both groups were given a pre-test and post-test. The instrument used to measure the problem-solving ability was obtained through a description test of five questions that had been declared valid by experts. Data were analyzed using a t-test. The results of the research revealed that the average pre-test score was 54.62 to 82.29 after the post-test was done using the open-ended problem. The results of t-test calculations obtained t_{count} of 8.456 and t_{table} of 1.677 with a significance level of 0.05. The data can be interpreted that $t_{count} > t_{table}$, so H_0 is rejected. This shows that learning by implementing open ended problems can significantly improve mathematical problem solving skill.

Keywords: Open-Ended Problem; Mathematical Problem Solving

A. Introduction

Mathematics is a subject that is available at every level of education, including at the elementary school level. Yandari (2017) states that mathematics contains various concepts and knowledge related to everyday life. This is in line with the Regulation of the Minister of National Education of the Republic of Indonesia No. 64 of 2013 concerning the standard content of elementary and secondary education unit level explains that mathematics learning aims to show a logical, critical, careful and thorough, honest, responsible, and not easily give up in solving problems. So to achieve these objectives students must truly understand the application of mathematical science in solving everyday problems. The mathematics understanding itself requires a process, in accordance with the opinion of Sidik (2016) that in the learning process, the emergence of difficulties to understand a concept is a natural thing. This illustrates that students are doing the thinking process.

The process of mathematics learning can be done by presenting various types of problems, including closed-ended problems with one solution and open-ended problems with various solution. mathematics learning through the presentation of closed-ended problems tends to make students think statically and restrict students to think more broadly. Contrast with open-ended problems that require students to think comprehensively. Thus providing opportunities for students to develop their competence in exploring solutions in solving mathematical problems. Mahuda (2017) Mahuda added that the open-ended problem approach is not only required to find solutions to the problems given, but also provides arguments for the answers and explain how students can reach the answers. The students' ability to apply mathematics to explore solutions to deal with this problem is called problem-solving ability.

Mathematical problem-solving ability is a very important ability in mathematics learning because in its learning activities students learn about mathematical concepts while emphasizing the development of students' ways of thinking. The important position of problem-solving

in mathematics learning requires the teacher to provide opportunities for students to solve problems (Lahinda, 2015). This was confirmed by Nurfatanah (2018) that the creation of learning that can develop problem-solving skills is inseparable from the material to be studied and how to create and process the material, so students can be actively involved in utilizing their thoughts to form concepts in the problem-solving process. Problem solving learning does not only focus on results, but rather prioritizes the process and strategy in solving the problem. The measurement of students' problem-solving abilities can use everyday problems.

The questions to measure the problem-solving ability can be in the form of story problems. Story problems according to Wahyuddin (2016) is useful to apply the knowledge possessed by students previously. Working on a story problem requires several stages so the question can be answered perfectly. These stages include: students have to understand the problems on the story problem, plan the solution, work on the problem according to the plan made, and look back on the work that has been done. The stages of problem-solving are reinforced by Polya (2004: 91) that the problem-solving solution contains four steps settlement stages, namely understanding the problem, planning the solution, solving the problem according to the plan, and re-checking all the steps that have been done. The steps that tend to be long, inflict stigma on students who working on difficult story problems and makes the problem-solving ability story problems is low as well.

The low ability of students' mathematical problem-solving is closely related to the low achievement of students in mathematics. Based on the results of observations and interviews conducted by researchers at Elementary School 1 and 2 of Gemiring Kidul on Friday, September 7, 2019 found that students' mathematical problem-solving ability were still very low. The low ability of students' problem-solving is known from the daily test scores on the material of Count Operations that are still below the score of the minimum completeness criteria. The low ability of students' problem-solving in Elementary School 1 and 2 of Gemiring Kidul is influenced by several factors, including: 1) students

have difficulties to understand the story problems, 2) students often work on closed-ended questions that only have one correct answer, 3) students memorize practical formulas without understanding the concept, and 4) learning is still teacher-centered.

The solving-problems ability is very closely related to understanding the problem. The initial step in problem-solving activities is to understand the problem of a story problem. Mathematical story problems are arranged by prioritizing problems that are in accordance with students' daily lives. Then the story problems are used to evaluate students' mathematical abilities. Someone can be said to have mathematical abilities if they skilled in solving mathematical problems (Retna, 2013). The material of mathematical stories has several goals according to Dewi (2014) namely that students can practice and think deductively, can see the relationships and uses of mathematics in daily life, can master mathematical skills, and strengthen students' mastery of mathematical concepts. If the problem understanding is not done properly, then the next step cannot be carried out properly. Therefore, we need questions that can stimulate students' understanding ability by giving open-ended problems. Open-ended problems train students to develop their understanding of a problem that has correct answers or various solutions. So students have the opportunity to express their ideas in solving mathematical problems. Agree with Cindrayanti (2016) that the open-ended problem approach is a learning approach that uses Mathematics problems and has more than one solution. Besides that essentially the open-ended approach according to Kowiyah (2016) is learning that emphasizes the way to an answer. So students have the freedom to solve problems in their own way and they can improve students' mathematical problem-solving abilities. The steps of open-ended problems learning are (1) exposing students to open-ended problems, (2) guiding students in constructing their own problems, (3) giving students opportunity to solve problems with a variety of different solutions and answers, and (4) ask students to present their findings.

Research conducted by Ariani (2014) shows that learning with open-

ended problems on the ability to solve mathematical problems has a significant difference compared to learning with closed-ended problems. Students who learn using open-ended problems have higher problem-solving abilities compared to students who learn using closed-ended problems. The use of open-ended problems has a positive influence on students' mathematical problem-solving abilities. it is in line with the opinion of Shoimin (2014: 109) which states that learning with open-ended problems as learning presents problems with various ways of solving (flexibility) and the solutions can also vary (fluency). This happens because students are faced with problems that require the concepts' understanding, not just memorizing formulas and remembering the completion procedure.

A similar study was also conducted by Ruslan (2013) who showed a significant effect on increasing students' mathematical reasoning by using open-ended problems. The results of the study by Nada (2018) explain that the application of open-ended problems in learning can improve students' critical thinking skills because students can produce a variety of alternative answers to existing problems.

Based on these descriptions, this research aims to determine differences in mathematical problem-solving abilities between students who learn using open-ended problems and students who use closed-ended problems. The differences in students' mathematical problem abilities are expected to be known through research with the title of: “Implementation of Open-Ended Problems on Mathematical Problem Solving Skill of Elementary School Students”.

B. Research Methodology

This research is a quasi-experimental type of research using the Nonequivalent Control Group Design. This design uses an experimental group and a comparison or control group that begins with the provision of an initial test (pre-test). Furthermore, treatment is given to the experimental group, while the control group is given conventional learning. In the last stage, the two groups were given a final test (post-test). It is in line with Sugiyono's

statement (2010) that this design is the same as the pretest-posttest control group design except that the sample is not randomly selected.

The research was conducted at Gemiring Kidul Elementary School in the academic year of 2019/2020. The population of this research was grade 5 of 75 students consisting of three classes, namely 5A, 5B, and 5C. The 5A class as the control group and the 5B class as the experimental group.

The instruments used in this research were tests and non-tests. Problem-solving test instrument in the form of tests description of story questions. The number of questions is 5 items that fulfill the indicators of students' mathematical problem-solving ability. The question is firstly tested for validity by the experts (expert judgment). The researchers revise the test questions according to the input from the validators, then 5 questions are taken that have fulfilled the problem-solving indicators. Valid questions are used for the pre-test and post-test of the control group and the experimental group.

The data analysis techniques of this research are the normality test, homogeneity test, and hypothesis test. The results of the post-test mathematical problem-solving ability of the two groups will be analyzed to answer the hypothesis. The hypothesis test is done using t-test. If $t_{count} > t_{table}$ then H0 is rejected, whereas if $t_{count} < t_{table}$ then H0 is accepted. The test criterion is that H0 is rejected if $t_{count} \geq t_{table}$ by determining the level of significance (α) = 5%, chance (1-α) (Sudjana, 2006: 243).

C. Research Result and Discussion

The data in this research are the score of students' mathematical problem-solving ability as a result of the implementation of open-ended problems in the experimental group and conventional approaches in the control group. Based on the results of data analysis obtained calculation score of the ability to solve the problem as follows.

Table 1

Scores of Mathematical Problem-Solving Ability of Elementary Students

Group	N	Average Score of Mathematical Problem Solving Ability		Percentage of Increase
		Pre-test	Post-test	
Experimental	21	54,62	82,29	51%
Control	20	52,15	60,20	15%

The data in Table 1 shows that the average score of students' mathematical problem-solving ability pre-test for the control group is 52.15 and the experimental group is 54.62. Then the control group was given learning using a conventional approach obtained by the post-test results of 60.20 with a percentage increase of 15% from the pre-test. While the experimental group was given the learning treatment using the open-ended problem obtained by the post-test results of 82.29 with a percentage increase of 51% of the pre-test score. The data from the two groups revealed a difference in the percentage score of 36%. This shows that the use of open-ended problems gives a positive contribution to students' mathematical problem-solving abilities. To be clearer about the difference in the average score of pre-test and post-test mathematical problem-solving ability can be seen in the following diagram.

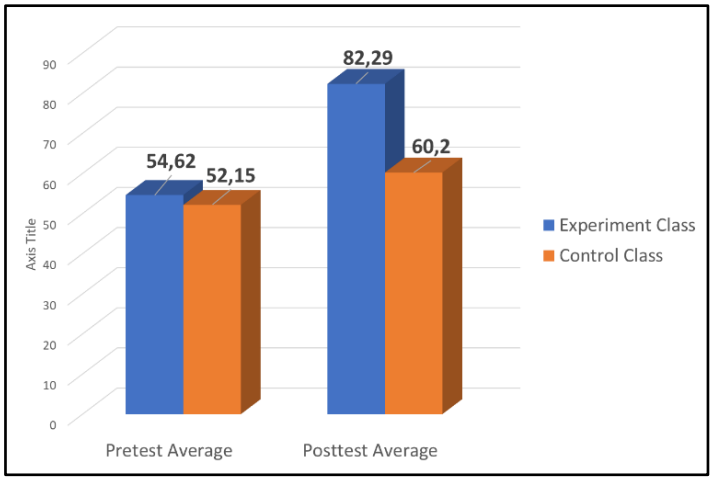

Figure 2. Diagram of *Pre-test* and *Post-test*

The diagram results show a significant increase score of 27.67 from pre-test to post-test in the experimental group. Learning in the experimental group uses open-ended problems, whereas the control group uses conventional learning which only increases the average score of 8.05. This is due to the influence of open-ended problems use on students' mathematical problem-solving ability. In line with research conducted by Husniah (2017) that the use of open-ended problems has a positive effect on mathematical problem-solving ability and students' learning motivation. Increased of mathematical problem-solving ability is categorized as medium.

The average results on the pre-test between the experimental group and the control group can be interpreted to be the same mean. But on the average post-test, both groups are still far adrift. All of that was caused by the treatment of the experimental group using open-ended problems. When learning using open-ended problems, students have the opportunity to answer in their own way according to the creativity and way of thinking of students to solve problems that have many answers. This has similarities with the research conducted by Setiawan (2014) that the application of an open-ended approach in mathematics learning is effective in aspects of students' mathematical problem-solving abilities.

This research is to test data normality using chi-square. The normality test results of the pre-test and post-test problem-solving ability can be seen in Table 2 below.

Table 2
Results of Normality Test
Calculations Mathematical Problem Solving Ability

Group	Data	N	X^2_{count}	X^2_{table} $\alpha = 0,05$	Conclusion
Experimental	Pre-test	21	5,940	9,488	Normal
	Post-test	20	8,775	9,488	Normal
Control	Pre-test	21	7,828	9,488	Normal
	Post-test	20	6,898	9,488	Normal

The data from the normality test results in Table 2 shows that the experimental group and the control group had $X^2_{count} \leq X^2_{table}$ ie X^2_{table} = 9,488. So it can be concluded that both groups have normal distribution data.

Homogeneity test results in mathematical problem-solving ability through the largest variance and the smallest variance between the experimental group and the control group. The homogeneity test results of the problem-solving ability can be seen in Table 3 below.

Table 3
Homogeneity Test Calculation Results

Group	N	Variance (s^2)	F_{count}	F_{table} $\alpha = 0,05$	Condition	Conclusion
Pre-test						
Experimental	21	156,25	1,268	2,112	$F_{count} < F_{table}$	Homogeneous
Control	20	123,19				
Post-test						
Experimental	21	59,91	1,342	2,112	$F_{count} < F_{table}$	Homogeneous
Control	20	80,38				

The homogeneity test table is known that the F_{count} is 1.268 at the pre-test and 1.342 post-test. Whereas the F_{table} with a significance level of 5% or α 0.05 was 2.112. So it can be concluded that the data variance of the pre-test and post-test results in the experimental and control groups is homogeneous.

Based on the prerequisite test data analysis, it was found that the post-test data results from the experimental and control groups were normal and homogeneous. Furthermore, hypothesis test is done using *t*-test. If $t_{count} > t_{table}$ then H_0 is rejected and if t $t_{count} < t_{table}$ then H_0 is accepted. The *t*-test calculation results of students' mathematical problem-solving ability in the experimental and control groups are presented in table 4 below.

Table 4
T-Test Calculation Results

Group	N	Mean	Variance (s^2)	T_{count}	t_{table} $\alpha = 0,05$	Conclusion
Experimental	21	82,29	59,91	8,456	1,677	Reject H_0
Control	20	60,20	80,38			

The results of t-test calculations of the table above, obtained T_{count} of 8.456 and T_{table} with a significance level of 0.05 and α = (n1 + n2) -2 is 1.677. This can be interpreted that $t_{count} > t_{table}$, so H0 is rejected. It can be interpreted that there are significant differences in the students' ability to solve mathematical problems who participate in learning with open-ended problems and students who attend learning with conventional approaches. Basically the use of open-ended problems with conventional approaches gives a different impact on students' mathematical problem solving. The application of open-ended problems has a positive impact on students. Students think creatively, more active, can find the concepts learned, brave to express opinions, can solve problems with the concepts found. This is reinforced by the Agustian's opinion (2015) that an open-ended approach is a learning approach that can provide opportunities for students to think freely in a problem in their own way. Learning with open-ended problems will make student-centered learning (student-oriented). Contrast to the use of closed-ended problems that still do not stimulate students to explore mathematical ideas, so they are less effective in developing the problem-solving ability.

The percentage of students' mathematical problem-solving ability on each indicator is as follows.

Table 5
Percentage of Students' Mathematical Problem-Solving Ability

No.	Indicator	Percentage	
		Experimental	Control
1	Understanding the problem	89%	65%
2	Planning the solution	83%	61%
3	Solving the problem according to plan	77%	57%
4	Re-checking all the steps that have been done	74%	56%

The percentage data of students' mathematical problem-solving ability on each indicator shows a difference between the experimental group and the control group. In the experimental group the level of understanding the problem reached 89%, planning the solution is 83%, solving the problem according to the plan is 77%, and re-checking for all the steps that had been

done 74%. While in the control group the percentage of each indicator was under the experimental group percentage. The percentage of each indicators of problem-solving ability in the control group are: understand the problem reaches 65%, planning the solution 61% resolution, solving the problem 57%, and re-checking all the steps that have been done 56%.

Based on the percentage of mathematical problem-solving ability, the level of understanding the problem is at the highest percentage. This can occur because of the influence of open-ended problems that have the characteristics of students to be free making some strategies with all the possibilities that are considered most appropriate for solving a mathematical problem. In open-ended, questions are directed to lead to the growth of understanding the problems raised by teachers (Kurnia, 2016).

The fourth indicator is the lowest percentage, which is 55%. This is because students do not yet understand and are accustomed to using problem-solving steps, especially in the fourth stage which is to re-check all the steps that have been done. Students feel they have finished working on answering questions when the third stage has been completed. So the fourth stage is often forgotten. This statement is reinforced by research conducted by Febriyanti (2020) that the average score of students' problem-solving ability is 12.28. This is because students are not accustomed to using the stages of problem-solving, especially in the fourth stage which is often not done by students because students are still confused until they finish solving the problem.

D. Conclusion

Based on the research that has been done can conclude a significant problem between the students' problem-solving ability who use open-ended problems and students who learn conventional problems or closed-ended problems. Students who learn by using open-ended problems have higher mathematical problem solving than those who learn by using closed-ended problems. It can

be seen from the average pre-test score of the experimental group students at 54.62, after learning to use the open-ended problem obtained 82.29. While the control group averaged pre-test scores of 52.15 to 60.20 after the post-test.

Based on the conclusions that have been approved, then some suggestions can be requested to make improvements in the future. This suggestion is the use of open-ended problems which are very effective in mathematics learning, one of which is in solving mathematical problems so teachers can consider using open-ended problems. This will be able to make students be more active and challenges in participating in learning and be able to construct their own knowledge through problem-solving experience.

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