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Students' Mathematical Problem-Solving Ability at Realistic Mathematics Education (RME)

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Abstract

This study aims to determine the effectiveness of the Realistic Mathematics Education model on mathematics problem-solving ability of students and analyze the mathematical problem-solving ability of students based on Polya steps. The method used is the sequential explanatory mixed-method design. The sample in this study is the fourth-grade students of Public Elementary School Bintoro 8 and the fourth-grade students of Public Elementary School Bintoro 9. Quantitative data were analyzed using a t-test and N-gain test based on the value of mathematical problem-solving ability. Qualitative data were analyzed through five procedures: data collection, triangulation, reduction, data presentation, and verification. The results showed that the average difference of mathematical problem-solving ability of students experimental class is better than the control class, improvement of mathematics problem-solving ability of students in the experimental class is higher than the control class. In the high category, students can apply the measures to see, plan, d, and check it well. In the medium category students can apply the measures see, plan, do and check, but there is an error in the operation so that the results of any settlement, while in the low category of students has not concluded.

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INTRODUCTION

Towards the 21st century, a man should be able to develop quality in him to compete globally. Human resources are expected to have the ability to think critically, systematic, logical, creative, able to work well together, and can solve problems in life. Law Number 20 of 2003 explains that education is a conscious and deliberate effort to create an atmosphere of learning and the learning process so that learners are actively developing the potential for him to have the spiritual power of religion, self-control, personality, intelligence, noble character, and skills needed him, society, nation, and state. Education serves to improve the quality of human life, both as individuals and groups in society.

Mathematical problem-solving skills must be possessed by students so that they can create relevant mathematical problems with daily life. Mathematics education in the 21st century requires students have the ability known as 4C Skills, include: communication, collaboration, critical thinking, and problem-solving, and creativity and innovation. Mathematics is a scientific discipline that has an important role in developing human thinking. Also, mathematics has a role in solving problems in real life. Permendikbud Number 20 of 2016 explained that mathematics needs to be given to students from elementary schools to develop knowledge factual, conceptual, procedural, and metacognitive relating to the logical problem-solving skills, analytical, systematic and creative and work together.

Problem-solving skills are an important component of the curriculum of Mathematics and contain the essence of the activities of Mathematics, so the problem-solving abilities should be a concern in the learning process. According to Freitas (2008) with serious problem-solving skills, students can immerse yourself in the situation of others and fix it for the good of everyone.

Someone who wants to solve the problem should be good problem solvers. Polya (1973) explained that one could have good problem-solving skills when one can understand the problems encountered, can design a problem-solving plan, then implement plans troubleshooting, and recheck the solution of the problem. Problem-solving ability is very useful for students in solving mathematical problems.

Based on the results of the TIMSS (Trends in International Mathematics Science Study) in 2011 on student achievement in mathematics Indonesia ranks 38 of 42 countries with a score of 386, and in 2015 was ranked 45th of 50 countries with a score of 397. The data from the PISA (Program for International Student Assessment) in 2012 shows Indonesian student achievement in mathematics ranks 64 of 65 countries with a mean score of 375, while in 2015 the average math score was 385 Indonesian students with an average score of 494. The results of the OECD international studies show many students are still difficulties in understanding math.

One way to support the success of learning is to choose a learning model. The application of innovative learning model to explore and engage students actively and creatively needed to develop students' mathematical problem-solving ability. One model of learning that can develop students' mathematical problem-solving ability is Realistic Mathematics Education (RME). Piaget's theory of development looked at cognitive development as a process in which children actively construct systems of meaning and understanding reality through experience and their interactions. Cognitive development largely depends on how far the child actively manipulates and actively interact with their environment.

Hirza, Kusumah, Darhim, and Zulkardi (2014) showed a significant difference in the results of the average value of students' intuition abilities in the experimental class with the control class. The students' intuition ability in the RME Model is better than the conventional model. Based on the Hake category, the improvement of students' abilities is in the medium category. Results of Ichwatun study (2015) showed that the learning outcomes of students with learning-based method Scientific approach RME higher than the average student learning outcomes with

conventional learning. Saleh, Darhim, and Sabandar research results (2017) show that the RME model more effectively applied to the learning that emphasizes students' mathematical problem-solving ability. Karyadi, Suyitno, and Dwidayati (2018) concluded that the RME model was effectively applied to learning that emphasized students' mathematical literacy abilities. The results of student grades taught with the RME model as a whole are more than 75%.

Gravemeijer (1994) explained that with regard mathematics as an activity, then learning mathematics means working with mathematics, where solving problems of everyday life is an important part of learning. Sugesti, Budiyono, and Subanti (2014) explained that the Realistic Mathematics Education model is a learning model that is oriented on everyday experience and apply mathematics in everyday life. The Realistic Mathematic Education model encourages students to solve problems experienced in life-related to mathematics. Susanto (2016) states that the Realistic Mathematics Education model-oriented students.

The underlying principle or idea Realistic Mathematic Education is the situation when students are allowed to rediscover the ideas of mathematics. On realistic situations, students are encouraged to construct their problems realistically, because of the problems that have been constructed by the students would attract other students to solve. According to Dickinson, and Hough (2012) the Realistic Mathematics Education model requires students to develop an understanding of mathematics to the study of the use of contextual problems. Gravemeijer (1994) mentions three basic key in designing the Realistic Mathematics Education model, namely (1) guided reinvention and progressive mathematizing, (2) didactical phenomenology, and (3) self-developed models.

Sembiring, Hadi, and Dolk (2008) argue that the syntax of the Realistic Mathematics Education model consists of four steps: Opening, Students Working, Discussion, and Closing. Application of appropriate learning model will affect the student's understanding and ability to resolve existing problems.

The Mathematics Education Realistic model emphasizes mathematical process skills, discussing and collaborating, arguing with classmates so they can find out for themselves and finally solve problems both individually and in groups.

Based on the above, this study aims to determine the effectiveness of learning by using the Realistic Mathematics Education model on mathematics problem-solving ability of students and analyze the mathematical problem-solving ability of students based on Polya steps by using the Realistic Mathematics Education model.

METHODS

The method used in this study is a research method of combination (mixed method). Design combinations used are sequential explanatory design. Sugiyono (2015) explains that the sequential explanatory design is a combination of research methods that combine quantitative and qualitative research methods in series, wherein the first phase of research conducted by quantitative methods and followed by qualitative methods.

This research was conducted in Public Elementary School UPTD Demak, Central Java. The population in this study were all students of class IV, while the sample in this study is the fourth-grade students of Public Elementary School Bintoro 8 as experiment class and the fourth-grade students of Public Elementary School Bintoro 9 as a control class. Sampling in this study using simple random sampling technique.

The determining level of mathematical problem-solving ability of students performed on grade IV Public Elementary School Bintoro 8. The subject of the study conducted with the guidance test students' mathematical problem-solving ability. Level mathematics problem-solving ability of students includes high, medium, and low. This study took two students from each level of students' mathematical problem-solving ability.

The data source of this research is the result of mathematical problem-solving ability tests and

interviews with grade IV. The data collection technique consisted of tests, interviews, and documentation. Test the level of mathematical problem-solving ability to see the level of students' mathematical problem-solving ability. Interviews are used to determine the level of credibility of the data of mathematical problem-solving ability of students.

The data obtained were analyzed quantitatively and qualitatively. Quantitative data analysis in this study is a classical completeness test of result test mathematical problem-solving ability using the proportion test, comparison test to experiment class with control class using independent sample t-test and improvement test of mathematical problem-solving ability using N-Gain test.

Qualitative data analysis in this study is data collection, triangulation, reduction, data presentation, and verification.

RESULTS AND DISCUSSION

The results of this research are used to analyze the effectiveness of the Realistic Mathematics Education model to the students' problem-solving ability in learning mathematics.

Before performing a hypothesis test to determine the effectiveness of first tested the prerequisite that normality test and homogeneity test to determine the distribution of research data.

Normality test aims to determine the data post-test of the experimental class and control class normal distribution or not. Normality test results are presented in table 1.

Table 1. Results of Normality Test

Normality test	Significance	$\alpha = 0.05$	Criteria	Conclusion
Experiment	0.200	0.05	H_0 accepted	Normal
Control	0.169	0.05	H_0 accepted	Normal

Based on table 1 the value of normality test results experimental class and control class is overrated α (Sig. > 0.05) so that it can be concluded that the data were normally distributed.

Homogeneity test aims to determine the data post-test of the experimental class, and control class have the same variance or not. The value of the test results and the experimental class homogeneity control class is overrated α (Sig. > 0.05) so that it can be concluded that the data have the same variance or homogeneous.

The learning to use the Realistic Mathematics Education model completed math problem-solving ability by 24 students or 80% of the proportion of students who achieve mastery over a minimum of 75%. This means that 80% of students using the model Realistic Mathematic Education has achieved mastery in the classical style.

The results of the t-test analysis show $t_{value} = 2.825 > t_{table} = 1.671$ at 95% confidence level can be concluded that the average mathematics problem-solving ability of students in the experimental class is better than the control class.

N-Gain results of the analysis showed that the students' mathematical problem-solving abilities experimental class of 0.65 and included in the criteria for being. Comparison of the average increase in pre-test and post-test results of the mathematical problem-solving ability of students between experimental and control classes can be seen in figure 1.

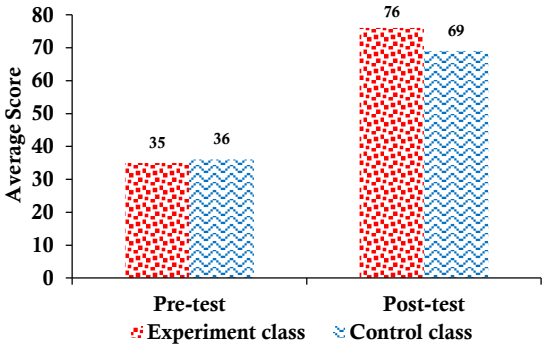

Figure 1. Results of Mathematics Problem Solving Scores

Based on figure 1, the increase in the mathematical problem-solving ability of students can be seen from the difference between pre-test and post-test. Also, it appears that the resulting increase in the experimental class is better than the result of an increase in the control class.

Saleh, Darhim, and Sabandar research results (2017) show that the Realistic Mathematics Education model more effectively applied to the learning that emphasizes students' mathematical problem-solving ability. The results of the average value of students 'problem-solving abilities by using Realistic Mathematics Education is 25.45, while the average value of students' problem-solving abilities by using conventional learning is 15.17.

Learning by using the Realistic Mathematics Education model places more emphasis on the use of objects or events originating from the environment of students' lives, so students can play an active role in gathering information to solve problems. Students can use the initial knowledge they have in the problem-solving process.

According to Krulik, and Rudnick (1995) things need to be done by the students in solving problems are: (1) reading and thinking, (2) selecting strategies, (3) searching for answers, and (4) look back if the answer is already answered questions. Polya (1973) explained that one could have good problem-solving skills when one can understand the problems encountered, can design a problem-solving plan, then implement plans troubleshooting, and recheck the solution of the problem.

Figure 2. Students in Solving Mathematical Problem

Based on figure 2 students in solving mathematical problems using objects such as ceramics and bicycle saddle. Students measure the sides of these objects to find out the size and width of the object. Students play an active role in solving problems given by the teacher. They are very happy during the learning process. Based on the analysis results of student work, interview, and field notes, the six subjects in this study have a level of mathematical problem-solving abilities different.

Students with serious mathematical problem-solving abilities are students who obtained the highest mathematics problem-solving ability test scores. Results of student work in this study can be seen in figure 3.

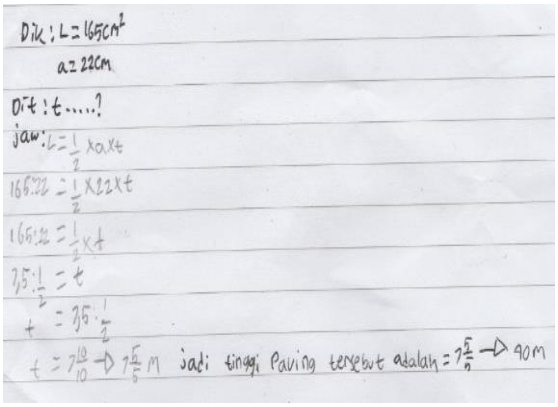

Figure 3. High Category of Mathematical Problem Solving Abilities

Based on figure 3 students in the high category can finish all the given problem. On the indicator to understand the problem (see), they have been able to understand the problem well.

This is evidenced by the existing answers on the student answer sheet. Also, they can explain verbally what is known and the problem in question. On indicators make troubleshooting plan (plan) it, they were able to understand the intent of the problem and can determine what steps (formulas) used. In planning performance indicators (do), they can implement the settlement plan, although there is one question that has not been the right answer. In indicator check (check) they provide conclusions answers they have completed.

Based on the statements of students in the interview explained that in completing the questions given, students read and understand the questions given first, then identify the elements that are known. Students can determine the formula used properly. They also have no difficulty in operating numbers when working on a given problem. They enter the numbers in the elements according to the formula found previously. They do it carefully. After finding the results, students also look back at the calculations that have been done to ensure the answers given.

Based on the results of the field notes show that students in the category of serious problem-solving abilities can solve the problems given using Polya steps very well.

Presentation of data related to the ability to solve mathematical problems with high categories can be seen in table 2.

Table 2. Description of High Category Mathematical Problem Solving Ability

Indicator	Description
See	Students can understand the problem in the problem correctly and can write down the elements that are known to solve the problem very well
Plan	Students can think of formulas that will be used to solve problems in the problem correctly
Do	Students can operate the numbers/elements that are well known in the formula so that the final results of the calculation are correct
Check	Students convince themselves by looking back at their work to the problem being solved carefully

Results of student work of medium category of mathematical problem-solving ability in this study can be seen in figure 4.

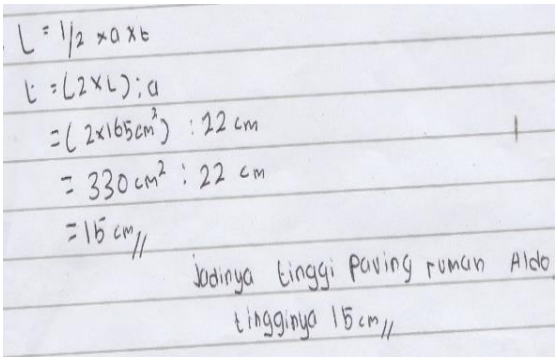

Figure 4. Medium Category of Mathematical Problem Solving Abilities

Based on figure 4 students in the medium category have not been able to complete the whole problem given. On the indicator to understand the problem (see), they've been able to understand the problem well. This is evidenced by the existing answers on the student answer sheet. Also, they can explain verbally what is known and the problem in question. On indicators make troubleshooting plan (plan) they were able to understand the intent of the problem and can determine what steps (formulas) used. In planning performance indicators (do) they can operate numbers to carry out the settlement plan, but not the right answer. In indicator check (check) there is still inconclusive answers.

Based on the statements of students in the interview explained that in completing the questions given, students read and understand the questions given first, then identify the elements that are known. However, students do not write down elements they already know. Students can determine the formula used properly. Students can solve problems in a problem although they have a little difficulty in operating numbers when working on a given problem. The calculation is not detailed. After finding the results, students also look back at the calculations that have been done to ensure the answers given.

Based on the results of the field notes show that students with moderate problem-solving abilities still have difficulty using Polya steps to solve problems.

Presentation of data related to the ability to solve mathematical problems with medium categories can be seen in table 3.

Table 3. Description of Medium Category Mathematical Problem Solving Ability

Indicator	Description
See	Students can understand the problem in the problem correctly and have not been able to write elements that are well known
Plan	Students can think of formulas that will be used to solve problems in the problem correctly
Do	Students still have difficulty operating the numbers/elements known in the formula, but the final results are correct. students are still confused with the symbols in the formulas used
Check	Students convince themselves by looking back at their work to the problem being solved carefully

Results of student work of a lower category of mathematical problem-solving ability in this study can be seen in figure 5.

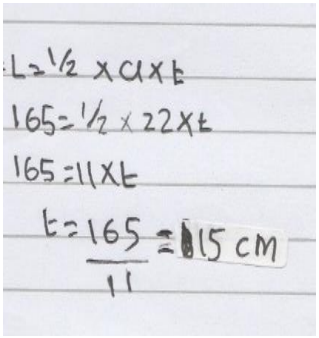

Figure 5. Lower Category of Mathematical Problem Solving Abilities

Based on figure 5 students in the lower categories have not been able to complete the whole problem given. On the indicator to understand the problem (see), they've been able to understand the problem well. On indicators make troubleshooting plan (plan), they were able to understand the intent of the question, but it can not determine what steps (formulas) used to solve problems related material flat wake. In planning performance indicators (do) they can operate numbers to carry out the settlement plan, but not the right answer. In indicator check (check), they are inconclusive answers that they have completed.

Based on the statements of students in the interview explained that in solving the questions given, students still have difficulty understanding the questions given first and identify the elements that are known. Students can determine the formula used properly. However, they cannot operate the calculations properly, so the results of the calculations are still in error. Students also cannot deduce the results of their work.

Based on the results of the field notes show that students in the category of problem-solving abilities were low; they did not understand Polya steps in solving problems in the problem properly.

Presentation of data related to the ability to solve mathematical problems with low categories can be seen in table 4.

Table 4. Description of Lower Category Mathematical Problem Solving Ability

Indicator	Description
See	Students can understand the problem in the problem correctly and have not been able to write elements that are well known
Plan	Students can determine the formula used properly
Do	Students do not fully understand the formula used to solve problems in the problem, and they can't operate the calculations properly, so the results of the calculations are still in error
Check	Students also cannot deduce the results of their work

CONCLUSION

Based on the results and discussion, it can be concluded that learning by using the Realistic Mathematics Education model is effective against students' mathematical problem-solving abilities. Also, each student has different levels of mathematical problem-solving abilities. This is evidenced by the application of students to Polya steps in solving the problems given.

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