

Realistic Mathematics Education (RME): Implementation of Learning Models for Improving HOTS-Oriented Mathematics Problem-Solving Ability

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ABSTRAK

The results of students' still-inadequate capacity to solve mathematical problems with a focus on HOTS encouraged this study. The Realistic Mathematics Education (RME) learning model is one strategy for enhancing competence in this area. This research aims to determine whether or not eighth-graders at a State Junior High School in the Boyolali district of Central Java, Indonesia, can improve their problem-solving skills in mathematics by using the RME learning paradigm. Action research in the classroom is what we call it. Data is gathered through testing, observing, taking field notes, and documenting. Additionally, triangulation methods will be used to verify the accuracy of the data. Data was collected through both direct observation and standardised testing. Problem-solving indicator values, observation sheets, and recommendations for data interpretation are among the devices employed. The data analysis shows that teaching with the RME learning model improves students' capacity to solve mathematical problems. This is evidenced by the fact that all problem-solving indications have been met: There are four stages to any problem-solving process: 1) analysis, 2) planning, 3) execution, and 4) reflection (checking and interpreting).

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1. INTRODUCTION

Problem-solving ability is the ability of students to find solutions to the problems presented (Indarwati, Wahyudi, & Ratu, 2014). Problem-solving can be a way or strategy to realize expectations through reasonable and correct procedures (Febriyanti & Irawan, 2017). Based on some of the opinions above, students must have problem-solving skills to train to be accustomed to facing various problems, one of which is problems in mathematics (Efendi, 2012). This is in line with NCTM (2000), which states that problem-solving is an integral part of mathematics learning, so it should not be let go. Reality shows that most of our lives deal with problems (Sutarto Hadi & Radiyatul, 2014). Students' problem-solving ability can be measured through several aspects; below are the indicators of the stages expressed by Polya (1957), namely: 1) understanding the problem, 2) devising a plan, 3) carrying out the plan, and 4) look back (check and interpret). One problem that must be solved in solving mathematical problems is a problem based on High Order Thinking Skills (HOTS). However, HOTS-based math problems are a scourge of students because of difficult problems to solve.

Cognitive and learning taxonomy principles and approaches like problem-solving strategies, the Bloom taxonomy, and the taxonomy of learning, teaching, and evaluation were used to build High Order Thinking Skills (HOTS) (Saputra, 2016). Think about your problem-solving, imaginative, analytical, deliberative, and deciding skills and multiply these by ten (Sofyan, 2019). Students most often struggle with addressing HOTS-oriented problems due to a lack of mathematical process abilities. Formula, mathematical calculation, algebraic operation, and algebraic manipulation faults all point to this issue (Samsul Hadi, Retnawati, Munadi, Apino, & Wulandari, 2018). Syafryadin, Wardhana, Noermanzah, Rofi'i, & Awalludin (2021) list several benefits associated with HOTS, including the following: (1) students will be able to think independently, allowing them to make decisions; (2) will improve students' abilities or achievements or achievements because they will know how to deal with questions from teachers or lecturers in the teaching and learning process; (3) will encourage students to think creatively, critically, and innovatively because they will know how to analyse Higher Order Thinking Skills (HOTS) and Lower Order Thinking Skills (LOTS) are the two categories into which Bloom's updated Taxonomy categorises mental operations. Memory (C1), comprehension (C2), and application (C3) are examples of lower-order thinking skills, while synthesis analysis (C4), evaluation (C5), and creation (C6) are examples of higher-order thinking skills. According to the latest iteration of Bloom's Taxonomy, "high-level thinking" entails the capacity for analysis (C4), evaluation (C5), and creation or creativity (C6) (Anderson et al., 2001:68-88).

On the one hand, problem-solving learning is critical to do and get used to in mathematics learning, but on the other hand, it turns out that the ability of junior high school students to solve HOTS-based mathematics problems is still low. The results of preliminary observations were made with a VIII mathematics teacher at a state junior high school in Boyolali district, Central Java, Indonesia. Data on the ability to solve hots-based mathematics problems, a total of 13 students, are still relatively low. The low problem-solving ability can be seen from the indicators by the Polya step strategy, namely: 1) understanding the problem of 3 students with a percentage of 23.07%, 2) devise a problem-solving plan of 3 students with a percentage of 23.07%, 3) solve the problem of 2 students with a percentage of 15.38%, 4) decide the conclusion of the answer by two students with a percentage of 15.38%. One of the learning methods that students can use to solve high-level thinking mathematics (HOTS) problems is the RME approach.

According to Gravemeijer (1994), Realistic Mathematics Education (RME) is a method of teaching and learning mathematics that takes into account the world as it actually exists. Because it is not enough to know and memorise mathematics, but rather to be able to solve mathematical problems properly and correctly through real/real objects in everyday life, the RME learning model is ideally suited to be applied to mathematics education (Widyastuti & Pujiastuti, 2014). Ulfah, Yerizon, and Arnawa (2020) supported this claim. Students can use RME to tackle various challenges, particularly mathematical ones. The Realistic Mathematical Education (RME) learning model, as explained by Febriyanti, Bagaskorowati, & Makmuri (2019), is a method of instruction that encourages students to

collaborate, discuss, and debate in order to rediscover mathematical ideas and concepts through the investigation of authentic problems. Moreover, as stated by Wulandari, Rochmad, & Sugianto (2020), RME is a method of teaching mathematics that uses contextual problems to assist educators in fostering students' capacity for inquisitiveness, rationality, and originality in mathematical problem-solving. Successful problem-solving by students requires a combination of students' critical thinking abilities and psychological factors. Holisin (2007) outlines the fundamental actions involved in the educational process. There are five stages in realistic learning steps; stages of understanding contextual problems; Stages of explaining contextual problems; stages of solving contextual problems; stage of comparing and discussing answers; The stage concludes After the completion of the class discussion.

Students are more engaged in the learning process with Realistic Mathematics Education (RME), and the information they retain is more relevant to their lives since it is grounded in real-world examples (Rahmawati & Ranti, 2021). This is consistent with the findings of Juandi, Kusumah, and Tamur (2022), who found that using RME had a far more beneficial effect on students' mathematical abilities than more conventional instruction methods. When put into practice, the RME approach technique offers clear and practical knowledge and is complete, detailed, and functional. However, due to the method's weaknesses, it might be challenging to discover examples of each problem. So that students are not caught off guard by the problem-solving tasks assigned, teachers should use a consistent model, such as a realistic mathematical approach (Rahmat, Zubainur, & Marwan, 2020).

Regarding the problem of solving HOTS-oriented mathematics problems experienced by students, this study aims to improve the ability to solve HOTS-oriented mathematics problems through the Realistic Mathematics Education (RME) learning model.

2. METHODS

This type of research is Classroom Action Research (PTK) or Classroom Action Research (CAR). According to Sutama (2019:134), class action research is an effort to improve learning practices to be effective. Therefore, the researcher chose classroom action research on the grounds that the application of realistic mathematics learning strategies in the research cycle can ultimately achieve the planned goals. The subjects of this study were all class VIII C students at a state junior high school in Boyolali district, Central Java, Indonesia. The number of students in class VIII C is 13 students, consisting of 8 female students and 5 male students. This research was implemented in the even semester of the 2021/2022 academic year. The data collection techniques used are observation techniques, field notes, documentation, and test methods. Observation techniques are carried out for student activity actions in preparing, paying attention to, and responding to explanations from the teacher during the learning process. Field notes are used to record all activities carried out by students during learning, in the form of student interaction with teachers, teacher interaction with students, the process of improving learning outcomes, problem-solving processes, and applied learning models. Documentation is used as evidence during observation. The test method is used to measure the improvement of student problem-solving by presenting and summing up the results obtained and will be used to control whether there is an improvement in the student's problem-solving ability. Furthermore, a triangulation of the technique is carried out to find out the data's validity. Researchers used observations and test questions to obtain data from the same source.

The indicators of students' problem-solving ability can be measured through several aspects. The following is a breakdown of the stages revealed by Polya (1978), including 1) understanding the problem, 2) devise a problem-solving plan, 3) solving the problem, and 4) deciding the conclusion of the answer. Furthermore, data analysis includes data reduction techniques, data presentation, and conclusions (Pratiwi, Redjeki, & Masykuri, 2014). In PTK research, the targets or achievements teachers and researchers have set are presented. Here are the indicators of the achievement of solving mathematical problems in Table 2 as follows:

Table 1. Problem-Solving Achievement Indicators

No	Indicators	Before Action	Targets / Achievements
1.	Understanding the issue	23,07%	60%
2.	Devise a problem-solving plan	23,07%	60%
3.	Solve the problem	15,38%	50%
4.	Decide the conclusion of the answer	15,38%	50%

Data reduction is obtained from research data which is then reduced and summarized to get the main things or a sharper picture of the results of observing realistic mathematics learning models. The presentation of the data displays a description of the results of observations obtained from observations and interviews. In the next stage, the researcher concludes the data obtained. The steps of such research can be illustrated in the following cycle:

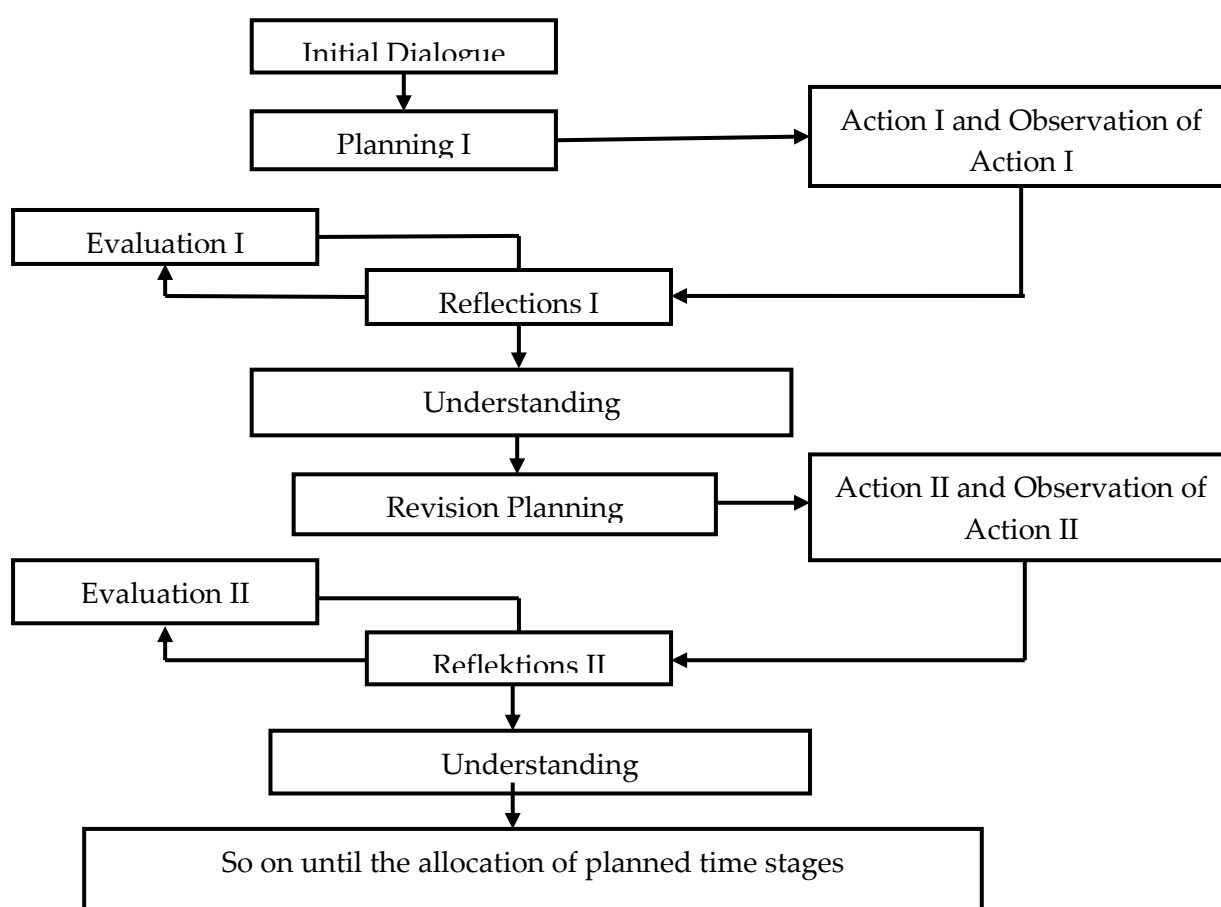


Figure 1. Research Implementation Cycle (Sutama, 2010: 96)

3. FINDINGS AND DISCUSSION

Classroom action research is carried out in two cycles. Cycle I is carried out in two meetings, and cycle II is carried out in one meeting. Which began with an initial dialogue with mathematics teachers and preliminary observations. The goal was to determine the initial conditions of the mathematics learning process and the ability to solve HOTS class VIII C-oriented mathematics problems at a State Junior High School in Boyolali district, Central Java, Indonesia.

The results of preliminary observations made with mathematics teacher VIII show that the ability to solve mathematical problems is still relatively low because the mathematics learning method carried

out is still teacher-centred and less than optimally cultivates problem-solving learning. A total of 13 students obtained data on the ability to solve mathematical problems. The indicators to be studied by Polya's step strategy, namely, the ability to solve mathematical problems. The following are the preliminary observations in Table 3 as follows:

Table 2. Preliminary observation data on mathematical problem-solving ability

Indicators	Initial Conditions	
	Percentage	Many Students
Understanding the problem	23,07%	3
Devise a problem-solving plan	23,07%	3
Solve the problem	15,38%	2
Decide the conclusion of the answer	15,38%	2

Based on the initial dialogue conducted by researchers and mathematics teachers of class VIII C at a state junior high school in Boyolali district, Central Java, Indonesia, obtained an agreement to carry out learning by applying the Realistic Mathematics Education (RME) learning model to improve students' mathematical problem-solving skills in SPLDV material.

In the actions of Cycle I and Cycle II, there are four stages: planning, implementation, observation, and reflection. Researchers act as perpetrators of actions or teachers, while students in class VIII C of State Junior High School in Boyolali as recipients of actions. Before taking action, researchers plan by carrying out various activities such as discussions by collaborating with mathematics teachers, observation sheets, research instruments, and Learning Implementation Plans (RPP).

In cycle I, researchers and class VIII mathematics teachers carry out the planning stage of class actions by compiling a HOTS-oriented RPP and Student Worksheet (LKS). The data collection techniques are observation guideline techniques, field notes, documentation, and test methods. The action was implemented by the design of researchers and teachers of class VIII at a state junior high school in Boyolali district, Central Java, Indonesia. The first cycle of a class action was held twice, namely the first meeting on February 8, 2022, and the second on February 9, 2022. The researcher acts as a teacher and carries out learning by the planned RPP, and the student acts as the recipient of the action. This research was assisted by fellow researchers. Fellow researchers are in charge of taking pictures or documentation during the learning. During the learning process in the first cycle, observations are carried out according to observation guidelines and record essential things on the field record sheet.

The first meeting in cycle I went well. However, at the stage of learning steps, RME was still not optimal, especially at the stage of understanding contextual problems, the stage of solving contextual problems, and the stage of comparing and discussing answers. This can be seen during the learning period, and many students have not been able to adapt to the RME learning model because this method is rarely used by teachers, so students are less enthusiastic about listening to learning. Researchers must pay more attention to students learning in the next cycle so that the RME learning model can run well.

In the second meeting of the cycle I, the class action is carried out the same as in the first meeting of the cycle I. Researchers remind of student deficiencies during the learning of the first meeting, and the researcher again explains the steps of RME learning to be used. Overall the second meeting went well according to the RME learning steps. It can be concluded that students are getting used to the application of the RME learning model. However, the learning steps of the stage of comparing and discussing students' answers have not been maximized, and it is seen that there are still some students who have not participated in the discussion in the group. The test results show that the ability to solve mathematical problems has improved even though it is not yet within the specified target; the improvement in cycle I of the first and second meetings can be seen in Table 4 as follows:

Table 3. Data on Improving The Problem-Solving Ability of Cycle Mathematics I

Indicators	Initial Conditions	Cycle I	
		Meeting I	Meeting II
Understanding the problem	23,07%	53,84%	76,92%
Devise a problem-solving plan	23,07%	46,15%	69,23%
Solve the problem	15,38%	38,46%	53,84%
Decide the conclusion of the answer	15,38%	30,76%	38,46%

Reflection is carried out between the researcher and the mathematics teacher to discuss the results of observations and field notes in cycle I. Reflections are carried out then notes are obtained for the improvement of the next cycle. Students improved their mathematical problem-solving ability using the Realistic Mathematics Education (RME) learning model. What needs to be improved in the next cycle is that researchers must be more able to master learning so that students can follow the learning well. With the evaluation, it is expected to be able to correct deficiencies in cycle I.

The implementation of class actions in cycle II carried out one meeting, namely with a time allocation of 3 x 40 minutes (3 class hours) on February 15, 2022, in this study, assisted by fellow researchers. Fellow researchers assist in taking pictures or documentation during learning. The action of class cycle II is carried out the same as in cycle I. Learning in cycle II goes according to the plan. The differences that appear in cycle II students are more accustomed to the RME learning steps applied by the researcher. This can be seen from the observations of cycle II that students show interest and enthusiasm in learning in all stages of RME learning in HOTS-oriented SPLDV material. Therefore, the ability to solve HOTS-oriented mathematical problems has been successfully achieved in cycle II.

Based on the analysis of data from the test questions given at the end of cycle I and II, it can be seen that the problem-solving ability of HOTS-oriented mathematics has increased. As for further clarifying the improvement of problem-solving ability before and after the implementation of learning with the RME model, the results of processing the results of the student's problem-solving ability evaluation test are presented in the form of Table 5 as follows:

Table 4. Data on Improving Mathematical Problem-Solving Ability

Indicators	Initial Conditions	Cycle I		Cycle II
		Meeting I	Meeting II	
Understanding the problem	23,07%	53,84%	76,92%	84,61%
Devise a problem-solving plan	23,07%	46,15%	69,23%	76,92%
Solve the problem	15,38%	38,46%	53,84%	69,23%
Decide the conclusion of the answer	15,38%	30,76%	38,46%	61,53%

The improvement of students' problem-solving ability from the initial conditions, cycle I to cycle II in class VIII C of Kemusu Boyolali State Junior High School 1 can also be seen in the graph.

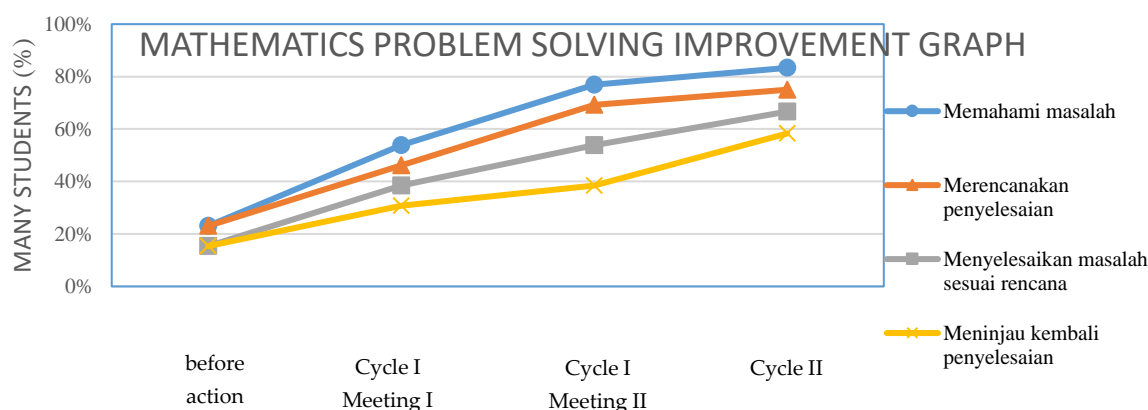


Figure 2. Graphs Improved Mathematical Problem Solving

This study discusses the results of the initial conditions, cycle I to cycle II, in class VIII C at a State Junior High School in Boyolali district, Central Java, Indonesia. In the initial conditions, it is obtained from data on student work results, and for the results of the cycle I to cycle II, it is obtained from the test results that researchers on students have tested. Based on observations, data analysis, and hypothesis actions towards improving mathematical problem-solving ability by applying the Realistic Mathematics Education (RME) learning model to the HOTS-oriented Two-Variable Linear Equation System (SPLDV) material.

Based on Table 5 data, it can be explained that there is an increase in mathematical problem-solving ability from pre-cycle, namely before applying the Realistic Mathematics Education (RME) learning model and after applying the RME learning model in cycle I and cycle II. This can be seen from the achievement of indicators of mathematical problem-solving ability, namely: 1) students' ability to understand problems increased (61.54%), 2) students' ability to plan problem-solving increased (53.85%), 3) students' ability to solve problems according to plan increased (53.85%), 4) students' ability to review solution results increased (46.15%). So, it can be concluded that students' mathematical problem-solving ability improves through the application of realistic mathematical learning models.

The presentation of improving the ability to solve mathematical problems by applying realistic mathematical learning models based on the indicators in the tables and graphs above was presented by the researcher as follows:

3.1 Students' ability to understand problems

This indicator identifies the known element, which is asked, and the necessary element's adequacy.

Diketahui : 30 soal - soal benar mendapat 5 point
- lulus apabila mendapat 70 poin. -Salah dikurangi 3 poin.
Ditanya : Berapakah maksimal jawaban yang salah untuk mendapat 70 poin?

Figure 3. Students' ability to understand problems

An example student response at the "understanding the problem" stage is presented in Figure 3. The level of students' problem-solving competence has increased. The amount of pupils who make a list of the problem's components is indicative of this. Students can easily locate relevant data, allowing them to thoroughly grasp the concepts at play in planning challenges. The researchers found a wide range of students' problem-solving abilities. There are individuals who can fully translate,

Handwritten text in Indonesian: "jadi maksimal jawaban salah untuk mendapatkan poin 70 adalah 10 soal". The text is written in black ink on a white background, enclosed in a rectangular box.

Figure 6. Students' ability to review completions.

Figure 6 is one of the students' answers to the indicators of students' ability to review completion. This can be seen from the students studying their completion by being able to answer their problems. Students mainly research the results of their activities carefully to reduce errors in answering. On this indicator, it was found that students' answers also vary. Some students have written down the conclusion completely, or incompletely, and only write the final result in the form of numbers.

The research was conducted by researchers with class VIII teachers at a state junior high school in Boyolali district, Central Java, Indonesia. This research aligns with Sintawati, Berliana, & Supriyanto (2020) concluded that applying the RME learning model can be used in mathematics learning to improve students' mathematical problem-solving skills and outcomes. In addition to improving the problem-solving ability of Mathematics, (Sholihah & Rejeki, 2020) research concluded that Indonesian realistic mathematics learning (PMRI) could improve students' critical thinking skills and learning outcomes.

(Hasniawati, Jais, & Herlawan, 2020) concluded that realistic mathematics learning has increased the ability to solve mathematical problems. This was also found by Febriyanti & Irawan (2017) in their research that realistic mathematics learning can improve problem-solving skills with three indicators that students must have, namely students' ability to understand problems, student's ability to find the right way and students can solve them appropriately. Rosneli, Fadhilaturrahmi, & Hidayat (2019) also explained that Mathematics learning with RME learning could improve the ability to solve mathematical problems in students. This is seen from the achievement of indicators of mathematical problem-solving ability.

Based on the description above, it can be concluded that this research is in line with research that previous researchers have carried out. Research conducted by researchers by applying the Realistic Mathematics Education (RME) learning model to mathematics learning class VIII C at a State Junior High School in Boyolali district, Central Java, Indonesia, can improve problem-solving skills in mathematics learning.

4. CONCLUSION

Based on the results of research and discussion, it can be concluded that the application of the Realistic Mathematics Education (RME) learning model can improve the ability to solve mathematical problems in the HOTS-oriented Two-Variable Linear Equation System (SPLDV) material in grade VIII students at a State Junior High School in Boyolali district, Central Java, Indonesia. The ability to solve problems by applying the Realistic Mathematics Education (RME) learning model has increased from before the action and meets the target of achieving indicators. Based on the conclusions presented, it implies that applying the Realistic Mathematics Education (RME) learning model can improve the problem-solving ability of HOTS-oriented mathematics students. The application of the RME learning model makes students more focused and enthusiastic in the learning process, more active in receiving material, and more interesting communication between researchers and students. It is hoped that teachers will be more optimal in applying the RME learning model in learning.

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