Section A-Research paper
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THE EFFECTIVENESS OF REALISTIC MATHEMATICS EDUCATION (RME)-BASED MATHEMATICS LEARNING FLOW IN IMPROVING THE STUDENTS' ABILITY FOR MATHEMATICAL PROBLEM-SOLVING

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Abstract
The objective of this investigation was to assess the efficacy of realistic mathematics education (RME) as a pedagogical approach for enhancing mathematical problem-solving proficiencies of students. The study employed an experimental research design utilizing a pretest and posttest design group. Two distinct classes were included in the study, with each class receiving different treatments. Data collection involved the utilization of an interest-in-learning questionnaire and a question test. The results of the hypothesis test indicated that the experimental class data exhibited significantly higher scores than the control class data on both measures of learning interest and test questions, with a two-tailed significance level of 0.000, 0.025 and 0.014, 0.025, respectively. This suggests that the RME-based mathematics learning flow is an effective approach for enhancing students' mathematical problem-solving abilities in class VIII SMP Negeri 1 Bangkinang.

Keywords: RME-Based Mathematics Learning Flow, Effectiveness, Mathematical Problem-Solving Ability

Introduction

Mathematics is an all-encompassing science that underpins the evolution of contemporary technology [1]. Permendikbud number 59 of 2014 states that mathematics is a universal science that is beneficial to human existence, underpins the development of modern technology, plays a role in various sciences, and enhances human intelligence. Mathematics serves an essential function in resolving life's problems. Consequently, mathematics must be taught from elementary to tertiary levels, as it influences the development of reasoning and critical thinking [2].

The importance of learning mathematics in education will increase the ability to apply learning at a high level, but some students experience difficulties. One of the difficulties students face when solving math problems is not just counting but training students to think logically and overcome their child's mathematical difficulties [3]. According to Partayasa [4], it is imperative for students to acquire proficiency in mathematical problem-solving abilities. To achieve this, the process of learning mathematics should commence with the presentation of contextual problems, wherein students are gradually guided towards mastering mathematical concepts.

Based on the results interview, Which the researcher did with a mathematics teacher on the date 04 March 2022 Of SMPN 1 Bangkinang, it was found that in learning mathematics, problem general faced student when Study mathematics is student No capable of solving questions related to problem-solving. Many students still say that mathematics is difficult to understand even though the teacher has provided explanations and examples of questions in learning. Sometimes it is necessary to repeat explaining the material studied because it does not

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understand the previous mathematical concepts. Learning time *is normally* only for one hour of subjects with a duration of fifteen minutes, so the learning objectives achieved are less than optimal. The process of learning mathematics is still centered on the teacher, even though the 2013 curriculum has been directed *student Centered*.

Mathematical education in the twenty-first century necessitates active learning in which students draw knowledge from their thought processes and learning experiences in order to connect concepts (content). National Council of Teachers of Mathematics (NCTM)-mandated wrong-one competence in mathematics includes five components: 1) problem-solving ability (problem-solving), 2) communication skills (communication), 3) connection capability (connection), 4) reasoning ability (reasoning), and 5) representation ability (representation) [5]. Difficulty Mathematical problem-solving is routinely effective and influential, according to study. The difficulty stems from the student's incapacity to recognise and comprehend problems, so he or she cannot find a solution. In contrast, the ability to recognise and comprehend a problem represents an early step. Before the strategy is devised and applied to a solution, this must be completed. The ability to solve a problem is a skill that can be used to obtain the solution to a problem that requires a procedure or series of actions. There is no pattern in shape text, nonroutine puzzles, and real-world situations [6]. When students are provided questions that differ from the examples presented by the instructor, they are unable to determine what is known in the problems of these questions. In this instance, students have difficulty solving problems where student cannot solve one or more stages of the solution mathematics. According to Polya, there are four steps to solving a problem: understanding the problem, planning, implementing solutions, and evaluating the results. Understanding problems is a component of problem-solving because problems that arise when problems are understood can be readily resolved [7].

Students' conceptual comprehension is influenced by a teacher's capacity for lesson preparation. It demonstrates the close relationship between the structured learning process and learning design [8], [9]. So is required learning, which necessitates student participation in the learning process, beginning with problem-based contextualization, so that learning becomes more efficient. Realistic Mathematical Education (RME) is the foundation for process-based learning in Hypothetical Learning Trajectory learning flow (HLT) [10], [11]. The development of a hypothesised learning trajectory (HLT) comprised of learning objectives, learning activities, and learning processes as a prediction of how students' thinking and comprehension develops in the context of learning activities. Teaching mathematics, solving context problems, predicting student responses to context problems, and predicting theories to predict student responses are all components of the learning flow. The hypothetical learning trajectory (HLT) is the learning flow based on the learning trajectory [12]. According to research, HLT can help pupils enhance their conceptual comprehension and mathematical reasoning. In designing HLT to teach the subject of sequences and series, RME-based learning is also utilised. Herein, The RME is the learning of mathematics that begins with a statement or context, is contextualised around pupils, and is ultimately applied to solving real-world problems [13]. Applying RME as a theory of designing HLT because 1) students will learn mathematical concepts beginning with contextual problems related to their daily lives, and 2) learning activities in RME are sorted from horizontal and vertical mathematical processes, meaning students will have the opportunity to explore their knowledge under teacher guidance in order to reinvent the formula in the learning they are learning [14]. RME is a form of mathematics education that encourages students to apply the material to their daily activities. The teacher does not explicitly provide formulas or concepts to students when delivering lessons; rather, students are guided to construct their own concepts [15].

The learning process requires teachers to be able to actively involve students in conveying the understanding they get. Each student has the knowledge he found in the previous class or lesson. Before the learning process begins, the teacher should know the condition of student knowledge, and this is useful to make it easier for the teacher to start the learning stage

and make it very easy for the teacher and students. It follows the nature of mathematics, which is hierarchical. To understand or study mathematical material, one must first know or recognize that material. So, then the teacher can determine where to start the material to be delivered [16]. Learning is the activity of an educator or teacher who conveys the knowledge they have by organizing and creating a learning environment and using various methods according to the needs of students, which can increase student motivation to study even harder. It means that in learning, It will be seen the ability of a teacher to convey material to students in a learning environment with the hope that students can learn optimally according to the learning objectives set. The teacher carries out learning with the aim that students can learn from the surrounding environment to gain knowledge and develop their cognitive, affective, and psychomotor abilities [17]. The effectiveness of the RME-based learning flow is applied to learning when it produces something as expected. Learning effectiveness is the ability to carry out planned learning that allows students to learn easily to achieve learning goals [18].

Based on the explanation above, It needs to conduct research about "Effectiveness of RME-Based Mathematics Learning Flow in Improving Students' Ability for the Mathematical Problem Solving."

Materials And Methods

Research design

This research procedure is quasi-experimental by design, consisting of a pre and posttest, and control group. In this design, various remedies will be administered to the two classes [19]. The investigation is shown in the table below.

Table 1 Research design

Class	Pretest	Treatment	Posttest
Experiment	O_1	X	O_2
Control	O_3	-	O_4

Source: Sugiyono (2019)

Before getting treatment, the experimental group (O_1) and the control group (O_3) are given a test viz pretest to determine the condition of the two groups before receiving treatment. Then, the group experiment gets treatment learning mathematics-based RME(X), and the group control gets learning conventional with women lessons Which same Then, at the end of the discussion of learning material, group experiment (O2) and group control (O4) given a hand that *posttest* for find out after treatment.

Place and time of research

Study This done Of Junior High School 1 Bangkinang, Village island, Subdistrict bangkinang, Regency Kampar, Province Riau. Study This is held on semester odd year lessons 2022/2023, Which go on on moon July-August 2022.

Population and Sample

The investigation involved 89 students from class VIII at SMP Negeri 1 Bangkinang. The sample consisted of 60 students in two sections, with Class VIIIB as the experimental class and Class VIIC as the control class. Simple random sampling is used to determine the sample, if the population is homogeneous [20].

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Research Instruments

A learning interest questionnaire and test pages served as the research instruments. In the investigation, questionnaires were used to capture information regarding the efficacy of the RME-based mathematics learning flow. The test document is formatted as a description problem and is used to evaluate students' problem-solving skills in mathematics. The research instrument was derived from the research design for realistic mathematics.

Data Collection Techniques

An interest in education questionnaires, test booklets, and documentation was utilised to collect research data. Student interest in learning process activities in experimental and control classes is determined using interest in learning questionnaires. The test document is used to evaluate the level of mathematical problem-solving skills of the students. Simultaneously, documentation is used to acquire information or support research. The following table details the effective categories of the interest in learning questionnaire.

Table 2 Criteria for the Effectiveness of N-Gain

Interval (%)	Category
< 40	Ineffective
40 -55	Less effective
56 – 76	Effective enough
>76	Effective

Source: (Nasution & Oktaviani, 2020)

The criteria for knowing the students' level of problem-solving ability achieved by students in working on questions:

Table 3 Problem-Solving Ability Test Criteria

Interval Shoes	Criteria
0 – 54	Very Low Capability
55 – 64	Low Ability
65 – 79	Moderate Ability
80 – 89	High Ability
90 – 100	Very High Ability

Source: (Narmi et al., 2020)

Data analysis technique

Analysis data disclose How effective channel learning mathematics-based RME increases the problem-solving ability of mathematical students. Data analyzed is questionnaire interest Study and hand ability solving problem mathematical, results pretest (condition early) and posts (condition end) after treatment. Analysis data used in the study This uses the program SPSS 25. For test normality, used technique *Kolmogrov-Smirnov.* Test homogeneity using the technique of *Levene statistic*. At the same time, testing the hypothesis using the T-test or *independent sample t-test.*

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Result and Discussion

Results

Based on the data obtained from the pre- and post-tests administered in the control and experimental courses, the results of the research are presented. The following table displays the average results of the student learning interest questionnaire calculated in SPSS 25 using the N-Gain formula.

Table 4 Recapitulation of Student Learning Interest Values with the N-Gain Formula in SPSS 25.

Statistics	Class	
	Control	Experiment
N	30	30
Minimum	40,96	58,24
Maximum	79,55	89,13
Mean	56,76	80,56
Std.Deviation	10,33	6,93

The N-Gain value of the control class was calculated to be 56.76%, while the experimental class was 80.56 percent effective. The mathematical problem-solving test results are displayed in the table below.

Table 5 Value SummaryPretest and posttest Control Class Mathematical Problem-Solving Ability Test and Experiment Class

Statistics	Control Group		Experiment Group	
	Pretest	*Posttest*	*Pretest*	*Posttest*
N	30	30	30	30
Minimum	0	50	0	55
Maximum	63	100	75	100
Mean	29,43	73,00	31,07	81,90
Std.Deviation	12,143	13,170	20,265	13,942

The descriptive mean value of pretest students in the control and experimental groups was 29.43 and 31.07. The average posttest score for the mathematical problem-solving aptitude of the students in the control group was 73.00, while that of the experimental group was 81.00. This suggests that the average math problem-solving score of the experimental class increased significantly compared to the control group [21].

Data analysis

1. Normality test

Table 6 Normality test of the Student Learning Interest Questionnaire

Kolmogorov-Smirnov		
Class	Value Sig	Information
Control Class	0,200	Normal Distributed Data
Experiment Class	0,200	Normal Distributed Data

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The Kolmogorov-Smirnov significance value of 0.200 > 0.05 for interest in learning in both classes indicates that the data is normally distributed.

Table 7 Normality Test Results*Pretest* and *posttest* Student Mathematical Problem-Solving ability test

Kolmogorov-Smirnov		
Data	Value Sig	Information
Pretest Control	0,075	Normal Distributed Data
Pretest Experiment	0,104	Normal Distributed Data
Posttest Control	0,119	Normal Distributed Data
Posttest Experiment	0,160	Normal Distributed Data

The output normality test from the pre-test of student learning and problem-solving abilities yielded a significance value of 0.075 > 0.05 in the control class and 0.104 > 0.05 in the experiment class. At the posttest, a test of students' mathematical problem-solving abilities yielded a significance of 0.119 > 0.05 in the control class and 0.160 > 0.05 in the experimental class.

2. Homogeneity Test

Table 8 Recapitulation of Student Interest Homogeneity Test Results and Mathematical Problem-Solving Ability Tests

Instrument	Value Sig	Information
Interest in Learning	0,092	Homogeneous Distributed Data
Mathematical Problem-Solving Ability Test	0,292	Homogeneous Distributed Data

Based on Table 8, students' interest in learning obtained a significance value of 0.092 > 0.05, indicating that the interest in learning in control and experimental classes were homogeneous. Meanwhile, the significance of the students' mathematical problem-solving abilities test was 0.292 > 0.05, and the data was homogeneous.

3. Hypothesis testing

Table 9 Summary of Independent Sample T-Test Results on the Hypothesis

Instrument	Say. (2-tailed)	Information
Interest in Learning	0,000	H_0 rejected and H_1 accepted
Problem-Solving Ability Test	0,014	H_0 rejected and H_1 accepted

The Independent Samples T-Test for curiosity about learning showed that students' learning pursuits differ between the RME-based mathematics learning path and conventional learning. The problem-solving ability test showed that H0 was rejected and H1 was accepted, indicating that the RME-based mathematics learning flow is effective for increasing mathematical problem-solving skills.

Discussion

The findings of this study suggest that the RME-based mathematics learning flow is a more efficacious approach than conventional learning for enhancing students' mathematical problem-solving skills. The experimental group was subjected to a treatment based on the RME-based mathematics learning flow, while the control group was subjected to a treatment based on the traditional model. The results showed that the experimental group had an average test score of

81.90 in the high category, while the control group had an average test score of 73.00 in the medium
category and 81.90 in the high category. This suggests that the RME-based mathematics learning flow is a more efficacious approach than conventional learning for improving students' mathematical problem-solving abilities at SMP Negeri 1 Bangkinang. Herein, RME is a pedagogical approach in mathematics education that involves students learning mathematical concepts through their daily experiences with the guidance of their teacher. Students engage in active expression of their learning experiences and are asked to act as representatives and deliver presentations on the knowledge they have acquired.

The posttest t-test hypothesis results suggest that the utilization of Realistic Mathematics Education (RME) and conventional learning approaches have varying effects on students' level of interest in mathematics. Based on the results of a hypothesis test on the significance of problem-solving ability with a 2-tailed value of 0.014, it can be inferred that the null hypothesis (H0) is rejected and the alternative hypothesis (H1) is accepted. The findings of Gee's (2019) study indicate that the implementation of RME can improve mathematical problem-solving skills.

The RME-based learning flow is effective for mathematical problem-solving abilities because the steps in learning direct students to be able to find a solution to a problem between these steps, namely, 1) Giving contextual questions (problems) according to the first indicator, namely understanding the problem, 2) The teacher observing students' answers being able to plan and carry out problem-solving according to the second indicator understanding the problem 3) the teacher asks students as representatives to present the results of the task given the third indicator compares and discusses answers 4) after discussing answers, the teacher guides students to conclude a mathematical concept as well as conveying the difficulties and problems experienced for improvement at the next meeting according to the fourth indicator to conclude the answers. The following research conducted Yuanita [22] The effectiveness of Realistic Mathematics Education approach: The role of mathematical representation as mediator between mathematical belief and problem solving.

The research results obtained follow/supported by Vigotsky's theory [23], one of the streams of constructivism with the learning process being inseparable from the influence of the surrounding environment, the teacher's role in guiding and facilitators in the learning process assists in the form of examples, work instructions, charts flow and provide constructive questions that can help students rediscover the mathematical ideas/concepts they are learning. Vygotsky's theoretical framework is congruent with the fundamental tenets of Realistic Mathematics Education (RME), which advocates for the acquisition of mathematical knowledge through the incorporation of students' everyday experiences as a foundation for comprehending mathematical concepts. RME learning methodology employs contextualized problems, models, and active student participation, with the incorporation of questioning as a means to alleviate cognitive congestion or stagnation. The upcoming procedure prioritizes student engagement. To ensure that the learning process is not teacher-centric.

The findings of the study and subsequent analysis suggest that the implementation of RME-based mathematics learning flow yields favorable outcomes in terms of enhancing the mathematical interests and problem-solving abilities of eighth-grade students at Bangkinang 1 Public Middle School, as the employment’s compared of conventional learning in the control group. The implementation of a mathematics learning flow based on the RME approach has been found for having a positive impact on the eighth-grade students at SMP Negeri 1 Bangkinang’s mathematical problem-solving skills.

Conclusions And Recommendations

The study's findings indicate that students who participate in realistic mathematics learning-based learning have an average interest in learning mathematics that is 80.56 percent. It is higher than

those who take conventional learning. The average test results for mathematical students' problem-solving skills following the RME-based mathematics learning path fall into the high category with an average score of 81.90, while the average test score for conventional learning is 73.00. The RME-based mathematics learning flow increases the mathematical problem-solving abilities of Bangkinang 1 Public Middle School students effectively.

It is recommended to use RME-based learning mathematics flow in the implementation of mathematics learning as an alternative to increasing students' interest and mathematical problem-solving skills.

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