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Empowering Minds: Unleashing Numerical Literacy through Realistic Mathematics Education and Collaborative Problem Solving (RME-COPS) Integration in Mathematics Learning

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Abstract

The purpose of this investigation is to improve students' numerical literacy skills in learning mathematics through the integration of Realistic Math Education and Collaborative Problem Solving (RME-CopS) models. The investigation used a quasi-experimental design with a pretest-posttest control group. The research population was 184 of 7th grade students, with a sample of 64 using the purposive technique. The investigation was carried out at SMP X. The data were taken through a numerical literacy test instrument, 10 test questions, and documentation. The data were analyzed descriptively and with different test means. This investigation concluded that: (1) there was no distinction between the average numerical literacy of students at the time of the pretest, and (2) there was a significant distinction in the students' numerical literacy ability at the time of post-test, so the use of integration of realistic math education and collaborative problem-solving models were used (RME-CopS) can improve numeric literacy skills in mathematics learning for grade 7 students at SMP X

Keywords*:Realistic Main Education, Collaborative problem solving, numeric literacy*

Introduction

As stated in Permendikbud Number 20 of 2016, Indonesian graduates of primary and secondary education must possess various competencies, including numerical literacy, creativity, independence, collaboration, communication, and the ability to apply a scientific approach to learning from school and other sources. This is necessary to address the challenges of 21st-century learning, which require individuals to have skills in technology and information management, innovation, career development, global awareness, and the ability to fulfill the high demand for science and technology-based products in the market[1].

Real problems in RME can be solved with the results of mathematical representations by students. However, the majority of students feel less confident to represent their ideas and ideas. Interaction or cooperation in groups can increase the positive self-assessment of students [2]. Students can be actively involved in interacting, arguing, and working together, and can explore their creative ideas. Therefore, there is a need for a collaborative-based approach that can strengthen RME, namely Collaborative Problem Solving (COPS). The use of Realistic Math Education (RME) and Collaborative Problem Solving (COPS) Integration Models in mathematics learning aims to increase students' numerical literacy.

RME is an approach to learning mathematics that focuses on understanding and applying mathematics in real contexts. This approach emphasizes the importance of relating mathematical concepts to situations or problems in everyday life[3]. Through RME, students are invited to understand mathematical concepts in more depth because they see how these concepts are relevant and useful in real life.

COPS involves cooperation between students in problem solving. This approach allows students to interact, discuss, and support each other in understanding and solving mathematical problems[4]. Collaboration helps students see different approaches to solving problems and expands their understanding[5].

The integration of RME and COPS can have a positive impact on students' numerical literacy in learning mathematics:

The RME integration ensures that mathematics is presented in a real context, so students can see the usefulness and relevance of the concepts. This helps dispel the perception that math is just a bunch of meaningless formulas[6].

Through COPS, students not only receive information from the teacher, but they are actively involved in the learning process[7]. They collaborate in formulating and solving problems, which encourages critical thinking and deeper understanding[8]. Collaboration requires communication between students. In explaining their thoughts to classmates, students must formulate mathematical concepts more clearly and concisely, which in turn reinforces their own understanding[9].

RME and COPS help students feel more confident in dealing with real-life math problems. They learn that they have the tools to solve complex math challenges[10]. This combination of approaches can allow students to understand math concepts in greater depth as they see how the concepts operate in concrete situations and through different approaches[11].

Overall, the integration between Realistic Math Education and Collaborative Problem Solving can create a dynamic, contextual and interactive learning environment. This has the potential to build a strong foundation for increasing students' numerical literacy in learning mathematics.

The integration of RME-COPS in mathematics learning in Indonesia is currently still little developed. Based on this, it is necessary to have a study that can be used as a theoretical basis for developing an applicative approach. Therefore, this paper focuses on developing the integration of RME and COPS approaches to understand the characteristics, relationships, and applications in learning mathematics. A nation can be said to be advanced if it has quality human resources, both in terms of religion, intelligence and skills. Learning mathematics is one of the solutions in the field of education that can be done to achieve these goals[12]. One indicator of the success of learning mathematics is seen from the learning outcomes achieved. High or low learning outcomes achieved by a person can describe the effectiveness of learning[13]. Factors that cause learning outcomes can be due to a dense curriculum, inappropriate media, strategies, and methods, lack of motivation, or conventional approaches so that student involvement in learning is lacking. In line with research [14], states that developing strategies, media, and learning models that adapt to the material or context faced by students is a mandatory thing for teachers to do.

The demand for abilities that must be possessed through learning mathematics must be balanced with the approach given by the teacher in learning, especially mathematics. Problem-solving ability is one of the most important abilities to have in learning mathematics. It is not only a goal in learning mathematics but also the main point to work systematically [15]. This ability is a means to sharpen reasoning to be more accurate, logical, critical, creative, and also analytical. So that it will be needed by students to determine effective problem-solving in the profession and career success in the future(16).

Realistic Math Education (RME) or Realistic Mathematics Education is an approach to learning mathematics that emphasizes the use of real contexts and situations in the learning process[17]. This approach aims to help students understand and apply mathematical concepts in ways that are more meaningful and relevant in everyday life. The definition of RME can be explained as follows:

Realistic Math Education (RME) is an approach to learning mathematics that focuses on using real-world

situations, contexts or problems as a basis for teaching mathematical concepts[18]. This approach emphasizes that mathematical concepts should be taught in contexts that are meaningful and relevant to students, so that they can develop a deeper understanding and be able to apply mathematics in various life situations. In RME, students are invited to formulate and solve mathematical problems from real life, which helps them see the importance of mathematics in solving everyday problems and reduces the perception that mathematics only focuses on isolated formulas and theories[19].

RME emphasizes the importance of relating mathematical concepts to a wider context, such as social, economic, scientific or technological problems[14]. In this way, students can feel the connection between mathematics and real life, which in turn can motivate them to study better and understand concepts in greater depth[20].

Collaborative Problem Solving (COPS) is an approach in which students work together in groups to identify, analyze, and solve problems together[5]. The main objective of this approach is to develop collaboration skills, problem solving, and deeper understanding of concepts through interaction and discussion between students[21]. The definition of COPS can be explained as follows:

Collaborative Problem Solving (COPS) is a learning approach in which students work in groups to solve complex problems or assignments[5]. In this collaboration, students share their understanding, ideas, and approaches to solving problems, give each other feedback, and achieve deeper understanding through joint discussion and reflection. The main goal of COPS is to develop students' communication skills, teamwork, social skills, and problem solving abilities[22]. This approach encourages students to look at problems from multiple perspectives, formulate creative problem-solving strategies, and build a deeper understanding of the concepts involved in the problem[23]. In COPS, students not only receive instructions from their teachers, but they also learn from their classmates[24]. They collaborate on solving problems, discussing ideas, designing action plans, and creating an environment in which different approaches and solutions can be explored[25]. This approach creates an interactive learning environment, supporting the development of social and collaborative skills that are important in real life.

Collaborative Problem Solving can help students internalize mathematical concepts better because they have to talk and discuss about these concepts with classmates. It also helps overcome the tendency to rely on shallow understanding and encourages students to think more critically about the problems at hand.

Numerical Literacy is the ability of individuals to understand, interpret, and use numerical information in various contexts of everyday life. Numerical literacy involves understanding basic mathematical concepts, the ability to perform simple calculations, and the ability to apply mathematical knowledge in making decisions involving data and numbers[26]. The definition of Numerical Literacy can be explained as follows:

Numerical Literacy is an individual's ability to understand, process, and communicate numerical information in everyday life situations[27]. It involves understanding basic math concepts such as arithmetic operations (addition, subtraction, multiplication, division), comparison, proportion, percentage and an understanding of numbers, graphics and statistical data. Numerical literacy also includes the ability to identify, formulate and solve problems involving numbers and the ability to apply mathematical knowledge in making decisions involving measurement, estimation and interpretation of data[28]. Numerical literacy enables individuals to actively participate in a society that is increasingly dependent on numerical information[29], such as in contexts such as personal finance, health, employment and other everyday situations.

Numerical literacy is not just about the ability to count, it is also about the ability to understand the meaning of numbers, recognize how data is presented in various formats, and apply this knowledge in real-life contexts[30]. Good numerical literacy skills are important in making decisions where information is based on numerical data, such as shopping, managing a budget, understanding risk in decision making, or evaluating statistical claims in the news[31].

The definition of the issue in this think about : (1) Is there a distinction in students' numerical literacy in learning mathematics before using the RME-COPS approach? (2) Is there a distinction in students' numerical literacy in learning mathematics after using the RME-CopS approach in grade 7 at SMP X?

Promoting equity in math education: RME-COPS models can also promote equity in math education by providing all students with an equal opportunity to engage in problem-solving activities and collaborate with their peers. This can help reduce achievement gaps and ensure that all students have access to high-quality math education. The implications of this research are: promoting equity in math education: RME-COPS models can also promote equity in math education by providing all students with an equal opportunity to engage in problem-solving activities and collaborate with their peers. This can help reduce achievement gaps and ensure that all students have access to high-quality math education

Method

Research Design

The research employed the Pretest-Posttest Control Group Design to assess changes in students' numerical literacy. The RME-COPS approach was applied to the experimental group, while the control group utilized the PBL model.

Investigation Setting and Duration

The study took place at SMP X, with a duration of 2 months spanning from July to August 2022.

Research Alignment with Curriculum

The research was synchronized with the 7th-grade mathematics curriculum at SMP X.

Population and Sample Selection

The study encompassed all 7th-grade students (184 students in 8 groups) at SMP X. A purposive sampling technique yielded a selected group of 64 students, divided equally between the experimental and control groups.

Data Collection

Data was collected through tests and documentation methods.

Validity and Reliability Assessment

The validity and reliability of instruments were determined using the biserial correlation test and the KR-20 test.

Data Analysis

Collected data underwent descriptive analysis and inferential statistics, including the utilization of the average difference test.

Result and Discussion

Implementation of Learning

Research using the RME-COPS approach in improving students' numerical literacy has been carried out at SMP Xon August 24, 2021. The results of observations of the implementation of the RME-CopS approach carried out by teachers can be seen in Table 1 below:

Table 1. Implementation of the RME-COPS Approach by Teachers

Learning Phase	**RME-COPS Phase**	**Implementation (%)**
Initial Activity	Determination of basic questions (*Start with essential question*)	100
	Designing a lesson plan that accommodates aspects of RME-COPS	100
Core Activity	Monitoring students and learning progress that accommodates aspects of RME-COPS	100

Closing Activity)	*Assess the Outcome* in aspect RME-COPS	100
	Evaluate the Experience which accommodates aspects of RME-COPS	100

From the investigation of the implementation of the learning model by the instructor, it can be seen that the teacher can use the RME-COPS approach well because all the steps can be implemented.

Description of Pre-test and Post-test Scores

Table 2. Description of Pretest Numerical Literacy Test Results

Descriptive Statistic	Experiment Group	Control Group
Mean	73.33	69,38
Standard Deviation	2.159	10.76
Max	80	90
Min	70	50

Table 2 exhibits that the average value of the experimental numerical literacy ability pretest results is 73.33; the standard deviation is 2.159; the highest score is 80; the lowest score was 70. While the average value of the numerical literacy pretest results for the control group was 69.38; with a standard deviation of 10.76, a max value of 90, and the min value of 50.

Table 3. Description of Post-test Numerical Literacy Test Results

Descriptive Statistic	Experiment Group	Control Group
Mean	78.12	71.56
Standard Deviation	21.17	10.19
Max	100	80
Min	30	50

Table 3 shows that the average value of the post-test results of numerical literacy abilities in the experimental group is 78.12; the standard deviation is 21.17; the highest score was 100, and the lowest score was 30. Meanwhile, the average score of the final test of numerical literacy ability in the control group was 71.56; with a standard deviation of 10.19, the highest value of 80, and the lowest value of 50.

The increase in numeric literacy skills in 7th-grade students of SMP X in mathematics learning after the RME-COPS approach is applied can be determined by the normalized mean value of gain (<g>) obtained from the results of the pretest and posttest of numerical literacy skills.

The presentation of the results of the normalized average gain on students' numerical literacy abilities in the experimental and control groups in mathematics learning can be seen in Table 4 below:

Table 4.Numerical Literacy Gain Index in Experiment and Control Group

Group	**Pretest Mean**	**Post-test Mean**	**<g>**	**Criteria**
Experiment	73.33	78.13	0,170	Low
Control	69.06	71.56	0.152	Low

Table 4 shows the difference in the increase in numerical literacy ability in the experimental group and control

group, although the numerical literacy average was initially lower at the pretest, the experimental group experienced an increase in the average value from the pretest value of 73.33 to 78.13; with a normalized gain value of 0.170 which has low criteria. Meanwhile, the control group only achieved an average value of 71.56 in the post-test average, with a normalized gain value of 0.152, which is a low criterion. The average value of the post-test results for the experimental group has exceeded the minimum completeness criteria (KKM), while the control group has met the minimum criteria of 70.

Hypothesis Statistical Testing

To assess whether the difference in the average numerical literacy skills between the experimental and control groups is significant, it is essential to conduct a two-sample t-test after performing a prerequisite normality test. The final test results of numerical literacy skills were compared between the experimental and control groups using SPSS 19 for windows, and inferential statistical tests were conducted to test the hypothesis, preceded by testing the data's normality assumption.

Table 5. Normality Test Results of Pretest Numerical Literacy Data

Group	Sig.	Criteria
Pre-test experiment	0.004	Data is not normally distributed
Pre-test Control	0.117	Data normal

After conducting statistical calculations, it was found that the pre-test numerical literacy test data for the experimental group did not follow a normal distribution as its significant value was 0.004 < 0.05, whereas the control group's normality assumption test showed a significant value of 0.117 > 0.05, indicating that its data was normally distributed.

To test the hypothesis concerning the difference in the average numerical literacy skills of students between the experimental group, which was taught using the RME-COPS approach, and the control group, which did not receive this treatment or used the PBL model, the Wilcoxon test was conducted using SPSS for windows. The results of the average pretest data of numerical literacy ability between the experimental and control groups are presented in Table 6.

Table 6.Pretest Numerical Literacy Test Results

	Pre-C - Pre-E
Z	-1.819[a]
Probability (p-value)	.069

a. Based on positive ranks.

b. Wilcoxon Signed Ranks Test

Table 6 exhibits that there is no distinction in the average numerical literacy ability of the pretest data between the experimental group and the control group. This is evidenced by a significant value (p-value) of 0.069 which is greater than 0.05. The results of the statistical test using the Wilcoxon test exhibit that there was no significant distinction between the numerical literacy ability of the experimental group and the numerical literacy ability of the control group at the pre-test.

Table 7. Normality Test Results of Posttest Numerical Literacy Data

Group	Sig.	Criteria
Postest Experiment	0.111	Data normal

PostestControl	0.007	Data is not normally distributed

Based on measurable calculations, the post-test numerical education test information for the exploratory bunch and the control bunch appeared that the critical esteem of the exploratory bunch was 0.111 >0.05, so the informationwas ordinarilyconveyed, whereas thecontrol bunchhad irregular dissemination since the noteworthy esteem was 0.007 < 0.05.

To examine whether there was a difference in the average numerical literacy skills of students between the experimental group, which received instruction using the RME-COPS approach, and the control group, which did not receive this treatment or used the PBL model, the Wilcoxon test was conducted. Table 8 presents the results of the difference in average pretest numerical literacy ability between the experimental and control groups.

Table 8. Posttest Numerical Literacy Test Results

Test Statistics[b]

	Post-C - Post-E
Z	-2.020[a]
Probability (p-value)	.043

a. Based on positive ranks.

b. Wilcoxon Signed Ranks Test

Table 8 illustrates that there exists a disparity in the average score of post-test data for numerical literacy skills between the experimental group and the control group. This is backed up by a significant value (p-value) of 0.043, which is less than 0.05. The outcomes of the statistical test using the Wilcoxon test demonstrated a significant difference between the numerical literacy skills of the experimental group and the control group during the post-test.

Discussion

The improvement in numerical literacy skills can be observed by analyzing the gain between the initial test and the final test, which consisted of ten multiple-choice questions with three indicators: interpretation, analysis, and evaluation. The experimental group's superior numerical literacy skills, compared to the control group, are attributed to their use of the RME-COPS approach during the learning process, which involves completing tasks and questions that encourage analytical and interpretive thinking. The outcome of the study indicate that the RME-COPS approach is effective in improving numerical literacy skills since it includes several stages that facilitate learning. The learning process begins with addressing essential questions about issues relevant to the student's environment to stimulate problem-solving skills and enable the identification of learning objectives. Next, students create a learning implementation plan that involves identifying themes, objectives, relevant information, necessary tools, experimental procedures, and task division within groups. The final stage involves carrying out the assignment, testing the results, and evaluating the outcomes. The RME-COPS-based learning approach enhances students' numerical literacy skills

The results of the research on numerical literacy skills in the experimental group exhibited an increase in ability after learning mathematics through the RME-COPS approach. This can be explained because by carrying out real assignments following students' lives, students are more able to observe details on a thing or object on the task they are doing by outlining their constituent components or arranging these components for further study so that problems can be solved from the given task, according to the RME-COPS aspect.

The RME learning approach has various advantages. One of which is that it is based on real-life situations, which can motivate students to study harder as they perceive mathematics to be useful (Widana et al., 2021;

Nurfadilah et al., 2021). Additionally, (Saprizal, 2018) suggested that students find abstract mathematical concepts easier to comprehend when they are taught using learning media in their environment. The RME approach focuses mainly on numbers and operations, followed by geometry, which are the fundamental concepts taught in elementary school mathematics. Thus, RME research is primarily conducted in primary schools, and then in secondary schools (Prahmana et al., 2020; Zulkardi et al., 2020). The findings of this study are consistent with (Nahdi, 2019) research, which proved that the implementation of the Collaborative Problem Solving learning model can enhance students' mathematical representation skills because they engage in five types of behavior during collaborative problem-solving activities.(Karabulut-ilgu et al., 2018)incorporates issue investigation or understanding, working on personal issues, comparingperson work, connection with peers, and collaboration with instructors.

Significant differences in the average numerical literacy ability scores between the experimental group and the control group after learning mathematics with the RME-COPS approach in grade 7 students can be caused by several factors related to the way of learning and interaction in each group. The following are some of the factors that may have contributed to the difference:

Different Learning Approaches. The experimental group received learning using the RME-COPS approach, which emphasized understanding mathematics in real contexts and working together in problem solving[32]. This approach can further motivate students to actively learn and collaborate with classmates. On the other hand, the control group may use a traditional learning approach or a different model, which may not be as effective as RME-COPS in encouraging deep understanding and collaborative problem solving.

Social Interaction and Discussion. The RME-COPS approach involves active social interaction and group discussions. This interaction allows students to share ideas, discuss mathematical concepts, and help one another in problem solving[33]. In the control group, the lack of such interaction may not provide equal opportunities for students to discuss and deepen their understanding.

Applying the Concept in a Real Context. The RME-COPS approach encourages students to relate mathematical concepts to real-world situations[10]. This can help students understand the usefulness of the concept and how to apply it in various situations. If the control group does not focus on real contexts, students may have difficulty seeing the relevance of mathematical concepts in everyday life.

Improved Problem Solving Skills. The RME-COPS approach emphasizes collaborative problem solving. This can help students develop better problem-solving skills as they have to formulate strategies together to tackle complex math challenges[34][35].

Use of Various Learning Approaches. The RME-COPS approach can encourage students to see concepts from various points of view and formulate different ways to solve problems[36]. This can broaden their understanding. In the control group, less varied learning approaches may not provide similar opportunities.

In combination, these factors may contribute to significant differences in mean numerical literacy ability scores between the experimental and control groups after learning mathematics with the RME-COPS approach in grade 7 students.

Conclusion

Based on the results of research and discussion, it can be concluded that:

Based on the comes about of investigation and dialog, it can be concluded as takes after: (1) There's no distinction within the average value of numerical literacy abilities between the exploratory group and the control group sometime recently learning mathematics before utilizing the RME-COPS approach in Grade 7 SMP Xas prove by the probability value (p) 0.069 > 0.05; (2) There's a significant distinction within the average value of numerical literacy abilities between the experimental group and the control group after learning mathematics using the RME-COPS approach in Grade 7 SMP Xas evidenced by the probability value (p) 0.043 < 0.05. The enhanced numerical literacy abilities of the experimental group, in contrast to the control group, stem from their adoption of the RME-COPS methodology while learning. This methodology entails solving assignments and addressing queries that stimulate analytical

and interpretive cognition.

The findings of this study offer several recommendations for both professional academics and industry practitioners:

Implementation of Pedagogical Approaches: Academics and practitioners should consider adopting the combined approach of Realistic Mathematics Education (RME) and Collaborative Problem Solving (COPS) in mathematics education. The study's conclusion of a significant difference in numerical literacy skills suggests that this approach could yield positive results.

Curriculum Design: Academic professionals should revise curriculum designs to incorporate elements of RME and COPS. Integrating these approaches can potentially enhance students' analytical thinking, interpretation skills, and collaborative abilities, leading to improved numerical literacy outcomes.

Professional Development: Industry practitioners involved in education should engage in ongoing professional development to learn about and effectively implement the RME and COPS methodologies. This can enhance their teaching strategies and ultimately benefit students' numerical literacy development.

Collaborative Learning Environments: Both academics and industry practitioners should create and foster collaborative learning environments. The success of the experimental group's improved numerical literacy skills highlights the importance of group interactions and problem-solving discussions.

Assessment Strategies: Consider implementing assessment strategies that align with the analytical and interpretive skills emphasized in the RME and COPS approaches. This can help accurately measure and evaluate students' progress in numerical literacy.

Research and Innovation: Academics and industry practitioners should continue to explore innovative teaching methods and adapt them to different educational settings. This can contribute to ongoing improvements in students' numerical literacy and overall mathematical understanding.

Long-Term Impact: Recognize that the benefits of the RME and COPS approaches might have long-term effects on students' mathematical proficiency and problem-solving skills. Encourage continuous learning and application beyond immediate assessments.

Incorporating these recommendations can lead to more effective mathematics education, improved numerical literacy outcomes, and better-equipped students for both academic pursuits and real-world problem-solving in various industries.

Credit Statements

Theauthorconfirmssoleresponsibilityforthefollowing:studyconception and design, data collection, analysis and interpretation ofresults,andmanuscriptpreparation.

Declarationsofinterest

The author declared no potential conflicts of interest with respect totheresearch,authorship,and/orpublicationofthisarticle

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