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IMPROVING MATHEMATICAL LITERACY SKILLS OF SMP OR MTs STUDENTS THROUGH THE REALISTIC MATHEMATICS EDUCATION (RME) LEARNING MODEL

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ABSTRACT
This study aims to improve students' mathematical literacy skills through the Realistic Mathematics Education (RME) learning model. The underlying issue of this research is the low level of students' mathematical literacy, particularly in the aspects of mathematical modeling, concept application, and result interpretation. This research is an action research conducted over two cycles. The subjects of this study were students of class VIII/3 of SMP Negeri 1 Banda Aceh. To collect research data, an instrument in the form of a self-evaluation test on mathematical literacy was used. Data analysis to measure the improvement of students' mathematical literacy skills was carried out using the N-Gain Score test. The results of the N-Gain analysis showed a significant increase in students' mathematical literacy skills, from a very low category (per-cycle) to a moderate category in cycle I, with a consistent increase in each cycle, reaching a high category in cycle II. These findings indicate that RME is effective in enhancing students' mathematical literacy skills, aligning with the goals of mathematics education that focus on real-life applications.
Keywords: action research; mathematical literacy; realistic mathematics education.

ABSTRAK
Penelitian ini bertujuan untuk meningkatkan kemampuan literasi matematika siswa melalui model pembelajaran Realistic Mathematics Education (RME). Permasalahan yang mendasari penelitian ini adalah rendahnya kemampuan literasi matematika siswa, khususnya dalam aspek pemodelan matematika, penerapan konsep, dan interpretasi hasil. Penelitian ini merupakan penelitian tindakan yang dilaksanakan selama dua siklus. Adapun yang menjadi subjek penelitian ini adalah siswa kelas VIII/3 SMP Negeri 1 Banda Aceh. Untuk mendapatkan data hasil penelitian, digunakan instrumen berupa tes evaluasi mandiri literasi matematika. Pengelolaan data peningkatan kemampuan literasi matematika siswa menggunakan uji N-Gain Score. Hasil analisis N-gain menunjukkan peningkatan yang signifikan pada kemampuan literasi matematika siswa dari kategori sangat rendah (prasiklus) menjadi kategori sedang pada siklus I, peningkatan terjadi dengan konsisten pada setiap siklus, sehingga mencapai kategori tinggi pada siklus II. Hal ini mengidentifikasi bahwa RME efektif dalam meningkatkan kemampuan literasi matematika siswa, sehingga selaras dengan tujuan pembelajaran matematika yang berorientasi pada kehidupan nyata.
***Kata kunci**: literasi matematika; penelitian tindakan; realistic mathematics education.*

Introduction

Mathematics, as a universal discipline, plays an essential role in various aspects of life. Beyond mere numbers and calculations, mathematics serves as a

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fundamental tool for logical and analytical thinking, enabling individuals to solve problems systematically and make informed decisions. Its diverse applications in everyday problem-solving makes it a crucial subject at every level of education (Kemendikbudristek, 2022). Mathematics learning is not only about calculations but also emphasizes the ability to apply mathematical concepts in real life (Putra & Purnomo, 2023; Wulandari, 2020; Febriana, Jazim & Vahlia, 2022; Sari, ES & Vahlia, 2021).

Understanding mathematical concepts is essential for problem-solving and stimulates abstract thinking, creativity, and innovation. The mathematics curriculum in SMP/MTs aims to develop students' mathematical thinking skills (Kementerian Pendidikan dan Kebudayaan Republik Indonesia, 2018). Many students do not understand its application in real life and according to most students, the learning from teachers is very abstract so it is difficult to understand (Qoiriah, Vahlia & Agustina, 2021) .

Mathematical literacy refers to an individual's ability to apply mathematics in everyday life. This ability involves critical reasoning and supports individuals in problem-solving and decision-making. Therefore, mathematics learning should be designed to be engaging and effective to achieve learning objectives. Through mathematical literacy, individuals can actively participate in society and utilize mathematics in real life (OECD, 2023b).

Mathematical literacy consists of three key indicators: (1) Formulating real-world problems into mathematical models (Formulate), (2) Applying mathematical concepts in problem-solving (Employ), and (3) Interpreting mathematical solutions within the problem context (Interpret). However, despite Indonesia's improved ranking in the PISA survey, students' conceptual understanding and application of mathematics remain weak. In 2022, Indonesia ranked 69th out of 81 countries, lagging behind Malaysia (55th) and Thailand (58th). The average mathematics score also declined from 379 in 2018 to 366 in 2022, falling below the global average of 376. This disparity indicates that improvements in mathematical literacy have not been accompanied by a stronger conceptual understanding. Therefore, a contextual learning approach that emphasizes real-world experiences is essential to help students better understand and apply mathematical concepts (OECD, 2023a).

Students' low mathematical literacy skills remain a serious issue, particularly in the aspects of mathematization, reasoning, and argumentation. Additionally, students are not accustomed to solving applied problems and have not yet mastered mathematical concepts adequately. This indicates that students still struggle to translate real-world problems into mathematical models and solve them logically (Sapsuha, Fatimah, & Moniy, 2024; Vebrian, Putra, Saraswati, & Wijaya, 2021; Indriyani, ES & Vahlia, 2021).

Furthermore, field observations conducted in May 2024 indicate that the implementation of the planned learning activities is often not optimal. In these observations, the researcher monitored the learning process without direct involvement and recorded various challenges in implementing the instructional model. The findings revealed that teachers had not yet fully create a learning environment that allows students to maximize their mathematical literacy skills. The limited use of contextual problems and the lack of teacher training in developing various mathematical literacy indicators have become major obstacles in this regard

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(Ramadhani, Johar, & Irianto Ansari, 2021). This condition makes it difficult for students to connect abstract mathematical concepts with real-life situations. As a result, they lack meaningful learning experiences and struggle to understand mathematical material in depth. Student interviews confirmed these findings, with many stating that the mathematics problems given at school rarely relate to everyday life. This, of course, hinders the development of students' mathematical literacy skills.

Currently, various learning models attempt to connect mathematics with real-life situations, one of which is the Realistic Mathematics Education (RME) model. Recognized as a pioneer in reality-oriented mathematics learning approaches, RME encourages students to construct mathematical understanding through real-world experiences. By linking mathematical concepts to everyday situations, RME not only makes learning more engaging but also helps students recognize the relevance of mathematics in their lives. (Apriyanti, Asrin, & Fauzi, 2023; Nur Rozalia, Haniik, & Ika Nuzula, 2024).

The RME learning model is based on several learning theories relevant to the development of mathematical literacy, namely: constructivism (Ausubel, Piaget), cognitive (Bruner), and sociocultural (Vygotsky). These theories emphasize the importance of real-world experiences, student engagement, concept formation, and social interaction in the mathematics learning process (Nuriati & Amidi, 2022; Sohilait, 2021). Esing problems related to students' daily lives or experiences, namely using the Realistic Mathematics Education (RME) approach so that students can easily understand the material and use language and sentences that are easy for students to understand (Noviarni, Vahlia & Agustina, 2020).

The RME learning model emphasizes the relevance of mathematics in everyday life, enabling students to develop critical thinking, problem-solving, and mathematical literacy skills. RME not only equips students with mathematical concepts but also trains them to apply these concepts in various contexts (Maulyda & Mudrikah, 2023). Model with a contextual problem-based approach relevant to students' daily lives. Referring to Hobri, the steps in RME include: (1) Mathematical Environment Orientation (context problem), (2) Material Model (model of), (3) Foundation Building (model for), and (4) Formal Mathematics (formal mathematics)(Mira, Nuhamara, Bima, Taunu, & Ndakularak, 2024).

Previous studies have demonstrated the effectiveness of RME in enhancing students' mathematical literacy (Ayunis & Belia, 2021; Irham, 2020; Istiana, Satianingsih, & Yustitia, 2020; Maulyda & Mudrikah, 2023). However, most research has focused on the general effectiveness of the model rather than its role in improving mathematical literacy in classroom learning. This study introduces a novel approach using Action Research to explore how RME strategies gradually enhance students' mathematical literacy through continuous reflection and improvement. Mathematical literacy remains a challenge in education, particularly in applying concepts to real-world situations (Jannah & Hayati, 2024). Therefore, this study aims to optimize RME based learning to help students better understand and apply mathematical concepts meaningfully.

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Research Methods

This study is a qualitative research employing an action research approach. This method is used to improve the learning process in the classroom through reflective and collaborative practices. The research was conducted over two cycles, as illustrated in Figure 1, with each cycle consisting of four stages: action planning, action implementation, observation, and reflection (Mira et al., 2024) shows in Figure 1.

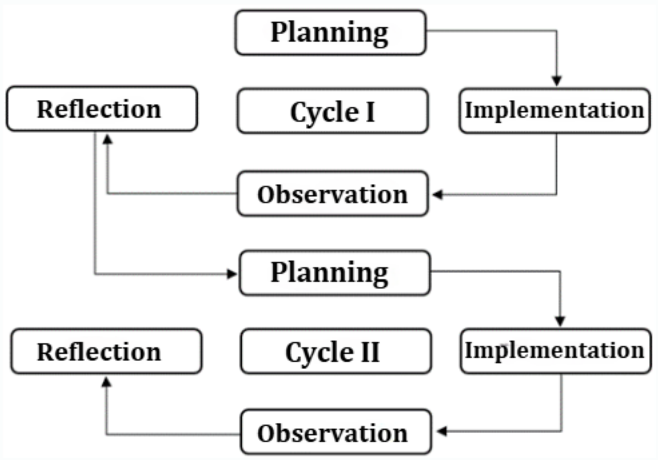

Figure 1. The action research cycle flowchart (Mira et al., 2024)

The subjects of this study were 32 students from class VIII-3 of SMP 1 Banda Aceh in the 2024/2025 academic year. The research focused on enhancing student' mathematical literacy skills through the implementation of the Realistic Mathematics Education (RME) learning model. The research procedure consisted of the following stages as illustrated in Figure 1:

a) Planning: Developing learning materials, including RME-based teaching modules, Student Worksheets (LKPD), and mathematical literacy tests.
b) Action Implementation: Applying the RME learning model in classroom instruction, where students engage in discussions and solve mathematical literacy problems based on real-life contexts.
c) Observation: Monitoring students' participation in discussions, problem-solving strategies, and challenges encountered during the learning process.
d) Reflection: Analyzing learning outcomes and evaluations to determine necessary improvements for the next cycle.

The research instrument used was a mathematical literacy test in the form of descriptive questions. The test included a pretest conducted before the intervention and a self-evaluation (post-test) at the end of each cycle. The pretest consisted of three questions, while the self-evaluation consisted of one question. Before implementation, the test items underwent content and structural validation by experts, including lecturers from the Mathematics Education Department at UIN Ar-Raniry Banda Aceh and mathematics teachers of class VIII-3 at SMP 1 Banda Aceh. The validation process categorized the test items into two classifications: appropriate and inappropriate, with additional feedback and suggestions for revision.

The data on students' mathematical literacy skills were analyzed using the N-Gain test based on the mathematical literacy scoring rubric, which was initially in

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ordinal scale data format. The data were then analyzed based on mathematical literacy indicators. The students' test scores were first converted into interval scale data using the Method of Successive Intervals (MSI) and then transformed into a percentage scale, where the ideal maximum score for the mathematical literacy test was 100, and the ideal minimum score was 25.63. The students' scores were then classified based on the N-Gain score criteria. The following presents the N-Gain test formula and the criteria table used:

$$N - Gain = \frac{posttest\ score - pretest\ score}{ideal\ score - pretest\ score} \qquad (1)$$

The effectiveness of the RME learning model in improving students' mathematical literacy skills was analyzed using the N-gain score (Siregar & Panjaitan, 2024). The categorization of the N-gain score is presented in Table 1.

Table 1. N-gain score criteria

N-gain score	Categori
$g \geq 0.7$	High
$0.3 \leq g > 0.7$	Medium
$g < 0.3$	Low

Based on Table 1, the N-gain score is categorized into three levels: high, medium, and low. These categories are used to assess the extent of improvement in students' mathematical literacy after implementing the RME learning model. Each evaluation result will be reflected upon to determine the next steps and improvements needed to achieve the research objectives. The implementation of the RME learning model is considered successful in enhancing students' mathematical literacy skills if there is a consistent improvement in their mathematical literacy abilities in each cycle.

Results and Discussion

This study implemented the RME learning model in conducting learning activities. The research was carried out in two cycles. The material used in cycle I involved modeling problems into mathematical forms and solving systems of linear equations with two variables using the substitution method, while the material for cycle II focused on solving systems of linear equations with two variables using the elimination method.

The research findings on the mathematical literacy skills of class VIII-3 students at SMP 1 Banda Aceh were obtained through a written literacy test in the form of descriptive questions. The scores obtained were then converted from ordinal scale data to interval scale data using the Method of Successive Intervals (MSI) and subsequently transformed into a percentage scale.

Pre-Cycle

Before proceeding to the action phase using the RME learning model, the researchers conducted an initial written test. This test lasted for two lesson hours and was conducted in an orderly manner. The initial test served as a baseline for

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assessing students' prior knowledge of the SPLDV (Simultaneous Linear Equations in Two Variables) material and as a reference for designing a differentiated instructional module.

Initial observations indicated that students experienced significant difficulties in developing their mathematical literacy skills. They often struggled to understand word problems, create appropriate mathematical models, and interpret calculation results. Additionally, students demonstrated limited ability to review their answers and identify relationships between mathematical concepts. These findings highlight the need for more meaningful and contextualized learning.

The RME learning model, which emphasizes the use of real-life contexts and problem-solving, was identified as a suitable solution to address these issues. In line with constructivist theory, RME provides students with opportunities to construct their knowledge through active experiences. Additionally, by applying the principles of the Zone of Proximal Development (Vygotsky), RME helps students achieve a deeper understanding through collaboration and teacher guidance. Furthermore, based on the theory of meaningful learning (Ausubel), RME enables students to connect mathematical concepts with real-life experiences, making learning more relevant and impactful. Thus, RME aligns with relevant learning theories while offering a practical solution to overcome students' difficulties.

The pre-cycle test results, which serve as the baseline for evaluating students' mathematical literacy skills before implementing the RME learning model, are presented in Table 2.

Table 2. Pre-cycle result

Number of students	Score
13	30,3211
4	40,2797
7	42,0442
2	47,7408
1	52,0028
1	53,7673
4	59,4639
Average	**40,2722**

The results of the initial test, as shown in Table 2, indicated that the average mathematical literacy score of the students was still in the very low category, with a score of 40.2722 out of a maximum score of 100. This suggests that students required significant improvements in their mathematical literacy skills.

Cycle I

The first cycle was conducted over two meetings. This section presents the data collected during the implementation of Cycle I, which includes:

a) Planning

The planning stage involved preparing instructional materials such as learning modules, student worksheets (LKPD), and self-evaluation tests to be used in the learning process. The lessons were designed by integrating the RME model

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into the learning modules, with a focus on enhancing students' mathematical literacy skills.

b) Implementation of Actions

The learning process was carried out according to the lesson plan developed during the planning stage, using the RME learning model. In general, the steps implemented in the learning process included: (1) Mathematical Environment Orientation (context problem), (2) Material Model (model of), (3) Foundation Building (model for), and (4) Formal Mathematics (formal mathematics).

c) Observation

Observations were conducted to assess students' engagement during the learning process, their participation in group discussions, and their ability to implement the RME model steps in the LKPD. At the end of the lesson, students were given a self-evaluation test to measure their understanding of the material taught.

d) Reflection

Reflection was conducted based on the observations and results of the self-evaluation test to identify several issues that needed improvement, including:

1. Ineffective strategies – Students still struggled with the "model of" step.
2. Lack of active participation – Many students were passive, not actively engaged in the learning process, and there was minimal communication among group members.
3. Weak conceptual understanding – Students had difficulty grasping the concepts.
4. Limited time – The duration of each session was insufficient, leading to an incomplete delivery of lessons.
5. Lack of prerequisite knowledge – Many students had not yet mastered the prerequisite concepts of SPLDV, creating obstacles in completing the given tasks.

The results of the students' self-evaluation test in Cycle I, which reflect their progress after the initial intervention with the RME learning model, are presented in Table 3.

Table 3. The result of cycle I

Number of students	Score
2	25,6274
9	69,7053
11	75,1653
10	92,6729
Average	**76,0047**

The results of the Cycle I test, as shown in Table 3, showed that the average mathematical literacy score of students improved to 76.0047 out of a maximum score of 100. Students' understanding of SPLDV material had increased through the implementation of the RME learning model, although this improvement was not yet highly significant, and some students had not reached the expected level set by the researchers.

Cycle II

Cycle II was conducted over one meeting, following the same learning process as in Cycle I.

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a) Planning

Planning was carried out based on the reflection from Cycle I, with several improvements made to create a more conducive learning environment and eliminate obstacles in the learning process. These improvements aimed to further enhance students' mathematical literacy skills. The modifications included:

1. Enhancing conceptual understanding by modifying the “Model Of” step, simplifying concepts, and providing additional individual exercises related to real-world problems.
2. Increasing student engagement by restructuring group discussions with fewer members per group.
3. Providing additional individual exercises that were simpler and more contextualized.
4. Dividing the material into smaller subtopics and improving time management strategies for each step of the learning process.
5. Incorporating additional explanations as reminders of prerequisite material.

b) Implementation

The implementation followed the revised planning. The learning activities in Cycle II were a continuation of the reflection conducted in Cycle I, aiming to refine the process and ensure a better learning experience. The improvements made allowed the learning process in Cycle II to run more effectively, providing students with a deeper understanding of relevant theories and methods.

c) Observation

Observations were conducted again in Cycle II, focusing on students' engagement during the learning process, their participation in group discussions, and their ability to apply the steps of the RME model in the LKPD. At the end of the lesson, students were given a self-evaluation test to assess their understanding of the material taught.

d) Reflection

Based on the observations and results of the self-evaluation test, reflections were made on the learning process and outcomes in Cycle II. The observations showed that during the learning activities:

1. Students' ability to perform each step in the LKPD improved.
2. All students appeared more enthusiastic, motivated, and actively engaged.
3. Students' conceptual understanding of the material showed significant improvement.

The results of the students' self-evaluation test in Cycle II, which assess their progress after further refinement of the RME learning model, are presented in Table 4.

Table 4. The result of cycle II

Number of students	**Score**
2	76,1622
5	82,6983
25	100
Average	**95,8067**

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The results of the Cycle II test showed a significant improvement in students' mathematical literacy skills, with an average literacy score of 95.8067. As shown in Table 4, out of 32 students, 25 achieved the maximum score, indicating that the majority of students had attained a high level of mathematical literacy. Below are the average mathematical literacy scores of students in the pre-cycle, Cycle I, and Cycle II.

The following figure presents a comparison of students' average mathematical literacy scores in the pre-cycle, Cycle I, and Cycle II after the implementation of the RME learning model in each cycle shows in Figure 2.

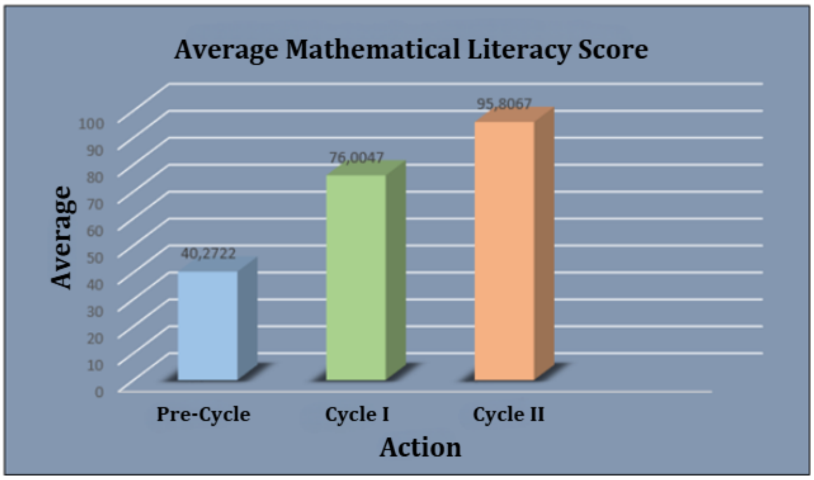

Figure 2. Average score of students' mathematical literacy skills

Based on the obtained data, as illustrated in the figure, the average mathematical literacy skills of students improved in each cycle. The pre-cycle implementation showed an initial average mathematical literacy score of 40.2722. After Cycle I, the average score increased to 76.0047. This indicates an improvement of 35.7325 points, categorized as moderate according to the N-Gain Score test. In Cycle II, the average mathematical literacy score further increased to 95.8067, classified as high according to the N-Gain Score test, with an improvement of 19.802 points from Cycle I. Below are the N-Gain Score results for the pre-cycle, Cycle I, and Cycle II.

The following figure illustrates the N-Gain scores of students' mathematical literacy in each cycle, showing the improvement in mathematical literacy skills throughout the research process shows in Figure 2.

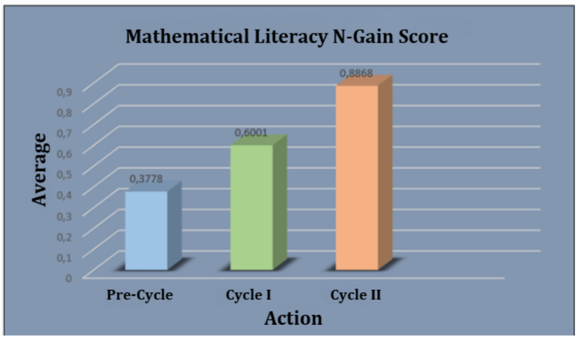

Figure 3. N-gain score of students' mathematical literacy skills

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As shown in the figure, the N-Gain score in the pre-cycle was 0.3778, categorized as low. After Cycle I, the score increased to 0.6001, classified as moderate. In Cycle II, the N-Gain score reached 0.8868, which falls into the high category. These results indicate that the implementation of the RME learning model significantly enhanced students' mathematical literacy skills in a structured and iterative manner. The primary basis for developing this research was the low initial mathematical literacy skills of the students. This study employed action research with a continuous reflection cycle aimed at improving the quality of mathematics learning. The research provided a comprehensive overview of the iterative process of planning, implementation, observation, and reflection to refine teaching practices and ultimately enhance students' mathematical literacy skills (Yaumi & Damopolii, 2016).

This study adopts the RME learning model by emphasizing several key principles. First, phenomenological exploration, which encourages students to begin learning mathematics through real-life experiences. Through observation and inquiry, students construct an initial understanding before progressing to abstract concepts (Johar, Morina Zubainur, Khairunnisak, & Zubaidah, 2021). Second, the progressive use of models and symbols allows students to visualize and understand mathematical concepts gradually before transitioning to more formal symbolic representations. Third, the principle of student construction and product positions students as active agents in learning, where they develop their understanding through exploration and problem-solving. Finally, interactivity and conceptual integration are key aspects of RME. Students are encouraged to interact with peers, teachers, and learning materials while connecting various mathematical concepts in meaningful contexts (Septiana, 2023).

In the implementation of Cycle I, students were given a self-evaluation test consisting of mathematical literacy-based questions on the SPLDV material. The results showed that two students were unable to answer the test, while 20 students experienced confusion or uncertainty in responding. After reflecting on Cycle I, several underlying factors were identified. This required corrective actions aimed at creating a more conducive learning environment and eliminating obstacles during the learning process.

Based on these findings, improvements were made by considering several relevant learning principles. First, constructive theory emphasizes the importance of students constructing their own knowledge through active learning experiences. This approach aims to create a learning environment that allows students to actively engage in the learning process and develop their own understanding (Septiana, 2023). Second, Vygotsky's theory highlights the significance of social interaction in learning, aiming to enhance student-student and student-teacher interactions to facilitate the learning process (Sohilait, 2021). Third, the RME principle focuses on meaningful, contextual, and problem-solving-oriented learning, enabling students to connect mathematical concepts more easily with real-life situations (Samron & Safarudin, 2022). Fourth, Ausubel's theory stresses the importance of providing contextual problems relevant to students' daily lives. This approach helps facilitate the active construction of mathematical knowledge, allowing students to relate abstract mathematical concepts to real-world experiences (Sohilait, 2021; Dayani, Vahlia & Agustina, 2021; Yuhasriati et al., 2022).

In Cycle II, students showed improvement in learning through the RME model. This cycle was implemented based on reflections and refinements from Cycle I, with the expectation that students' literacy skills would improve and that learning would proceed without the obstacles encountered in the first cycle. These findings align with numerous studies demonstrating that the RME model enhances students' mathematical literacy skills. For example, research by (Maulyda & Mudrikah, 2023) concluded that the RME approach positively impacts mathematical literacy development. Similarly, (Lusiana, Turmuzi, & Nurmawanti, 2024) found that the RME model is highly effective in improving students' mathematical literacy. Moreover, research by (Komala & Erma Monariska, 2023) supports the findings of this study, showing that students taught using the RME approach exhibited greater improvements in mathematical literacy than those taught using conventional (scientific) learning methods.

RME was also identified as an effective model for enhancing mathematical literacy skills. Additionally, (Lailatul Mubarokah, Khuzaini, & Suhartati, 2024) reported a significant improvement in students' numeracy literacy through the RME model. Their study further highlighted the positive impact of RME on students' mathematical literacy skills.

The findings of this study indicate that the gradual implementation of the Realistic Mathematics Education (RME) model within a classroom action research cycle has successfully enhanced students' mathematical literacy skills significantly. Unlike experimental studies that typically compare experimental and control groups, this study allowed for an in-depth observation of classroom learning processes and the identification of specific factors contributing to students' mathematical literacy development.

Based on observations and test results, students demonstrated improvements in comprehending mathematical concepts deeply, applying their knowledge in relevant contexts, and effectively communicating mathematical ideas. These findings are consistent with previous studies that have demonstrated the effectiveness of RME in enhancing conceptual understanding and problem-solving skills (Ayunis & Belia, 2021; Istiana et al., 2020). However, this study provides further contributions by showing that a reflection-based cyclical approach and continuous improvement enable students to develop mathematical literacy more comprehensively than experimental approaches that measure impact only at the end of an intervention.

Although the findings indicate a significant improvement, several challenges in implementing RME remain, such as limited instructional time and teachers' readiness to adopt a problem-based approach. These constraints highlight the need for further teacher training to ensure the effective implementation of RME in classroom settings.

Overall, this study contributes to the development of RME based instructional strategies, particularly in the context of classroom action research. The findings provide valuable insights for educators and policymakers in designing more contextualized learning experiences, enabling students to not only understand mathematical concepts but also apply them effectively in real-world situations.

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Conclusion and Suggestion

Through the Realistic Mathematics Education (RME) learning model, this study successfully improved the mathematical literacy skills of students at SMP Negeri 1 Banda Aceh significantly. The N-Gain analysis indicated a notable increase in each cycle. In Cycle I, the N-Gain score was 0.6001, categorized as moderate, while in Cycle II, the score increased to 0.8868, classified as high. This demonstrates that RME enables students to develop a better conceptual understanding, enhance problem-solving skills, and communicate mathematical ideas more effectively. The improvement in students' mathematical literacy aligns with the goals of mathematics education, which emphasize conceptual understanding and its application in real-life contexts. Based on the research findings, it is recommended to broaden the implementation of the RME learning model in mathematics education at schools. This is expected to further enhance students' mathematical literacy skills and achieve the educational objective of emphasizing conceptual understanding and its real-world applications.

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