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Exploring the implementation of realistic mathematics education in mathematics learning for mathematics education students

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Abstract: This study aims to investigate the Realistic Mathematics Education (RME) approach in greater detail so that students can apply it in their teaching and learning activities as prospective teachers. The study employs a quantitative approach with a descriptive method and was conducted at Sunan Kalijaga State Islamic University with 12 mathematics education students as research subjects. The results show that several factors such as instructors, curriculum, classmates, textbooks, and worksheets may influence how well students learn. Teacher-related factors identified include a lack of understanding of mathematical concepts by the teacher, limited variety in teaching techniques and methods, evaluation that is restricted to simple or straightforward answers, a teaching approach that emphasizes concepts in a way that encourages rote memorization and leads to less effective learning, the use of purely mechanical explanations that hinder student comprehension, and the infrequent use of media, which is important to help students develop formal mathematical skills. Based on the research findings, RME can help students perceive mathematics as more relevant and meaningful by presenting mathematical concepts in real-world contexts. Furthermore, RME supports the development of critical thinking, problem-solving, and teamwork skills, all of which are highly important in today's era.
Keywords: Exploration, Realistic Mathematics Education (RME), Mathematics Education

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Introduction

Mathematics learning is highly important in everyday life because it is directly related to problem-solving processes (Al Ayyubi et al., 2018; Simanjuntak et al., 2019; Sukmawarti et al., 2022; Utami, 2019; Widyastuti & Airlanda, 2021). Therefore, it is crucial for students to learn mathematics from an early age, and the content they study will hold greater significance as the intended learning outcomes can be documented through meaningful instructional mechanisms. Learning to think mathematically is essential for children because it helps them reason in real-world situations (Alfalah Riski, 2023; Fadli, 2019; Lestari & Masyithoh, 2023; Partono et al., 2021; Sulistiani, 2020). Students' learning outcomes should improve as a result of mathematical thinking, making information and learning experiences more meaningful. Understanding mathematical thinking techniques such as making connections, explaining, problem-solving, and creative thinking is one of the core components of mathematical competence. Mathematics also provides fundamental skills in logical reasoning and problem-solving. A person with mathematical skills can describe various things in detail and find original solutions to problems, making the role of teachers crucial in nurturing the development of students' mathematical abilities (Anditiasari et al., 2021).

Various studies have shown that students' learning outcomes are below standard (Chityadewi, 2019; Fitriah et al., 2024; Nurrawi et al., 2023; Rahmawati et al., 2021; Somayana, 2020). The findings of these studies indicate that several factors—such as instructors, curriculum, classmates,

textbooks, and worksheets—may influence how well students learn. Teacher-related factors include the following: (1) mathematical concepts are still not well understood by teachers; (2) teaching techniques and methods are insufficiently varied; (3) evaluation is limited to providing simple or straightforward answers; (4) students are often influenced by teaching styles that emphasize concepts heavily, making the learning less meaningful for them; (5) instructors generally use mechanical explanations to convey mathematical concepts, making it difficult for students to comprehend; and (6) although media is crucial for developing students' formal mathematical skills, its application in education remains infrequent. Students tend to memorize concepts and struggle to apply them, particularly in real-world situations related to those concepts, when teachers deliver lessons in a one-way, transmission-based manner (Noor et al., 2023; Prasetyo & Dasari, 2023; Wulandari & Machromah, 2024).

Teachers play a crucial role in helping students become more proficient mathematicians (Al Ayyubi et al., 2018; Al Ayyubi, Bukhori, et al., 2024; Al Ayyubi, Hayati, et al., 2024; Al Ayyubi, Rohaendi, et al., 2024). In addition, they are expected to support the development of students' higher-order thinking skills. The primary goal of the Realistic Mathematics Education (RME) method is to enhance students' mathematical abilities to better prepare them for life after graduation. Significant improvements are also needed in instructional techniques to support or address these challenges. It is recommended that teacher-centered strategies be replaced with student-centered approaches (Roberts & Roberts, 2023; Suntoro et al., 2021; Tijsma et al., 2020). Students' creativity, reasoning, and critical thinking should be actively encouraged throughout the learning process. The Realistic Mathematics Education approach is a teaching strategy that can foster the development of critical thinking, reasoning, and creative skills (Maulidina, 2023; Nurjamaludin et al., 2021; Prayetno et al., 2024).

Given the issues outlined above, the purpose of this study is to investigate the Realistic Mathematics Education (RME) approach in greater detail so that students who are studying mathematics as prospective teachers can apply it in their teaching and learning activities. This is because RME is a teaching method that integrates and connects the learning environment, incorporates students' real-world experiences, and positions mathematics as an active process for students. Rather than transporting students into the real world, the Realistic Mathematics Education approach helps them connect to real-world problems that already exist in their minds. Therefore, students are encouraged to consider solutions to problems that they may or may not encounter in their daily lives.

Method

This study employs a quantitative approach with a descriptive method to generate data that illustrate the research findings (Sugiyono, 2021). After completing mathematical problem-solving tasks, the study aims to investigate the perspectives of prospective mathematics teachers. It seeks to closely examine how students aspiring to become mathematics teachers perceive the problem-solving process during teaching and learning activities on campus. The subjects in this study were 12 mathematics education students at Sunan Kalijaga State Islamic University. The research procedure involved distributing a questionnaire to the students via Google Forms to gather their responses regarding the extent of their perceptions of the implementation of the Realistic Mathematics Education approach. The collected data were then analyzed using descriptive statistics to provide a clear overview of the research findings.

The syntax of Realistic Mathematics Education (RME) in mathematics learning is as follows.

Table 1. Syntax of Realistic Mathematics Education Learning

Stage	Teacher's Activity	Student's Activity
Introduction	• The teacher greets and prays • The teacher takes attendance • The teacher reviews the previous	• Students greet and pray. • Students say "present" when their names are called.

Stage	Teacher's Activity	Student's Activity
	lesson. • The teacher informs the learning objectives.	• Students recall previous information. • Students pay attention to the learning objectives.
Providing Contextual Problems	• The teacher uses images or teaching aids to present contextual problems related to everyday life.	• Students examine the problem given by the teacher individually or in small groups.
Solving Problems in Their Own Way	• Students' responses are met with positive feedback from the teacher. Students are then given the opportunity to observe and consider the best approach to solving the problem.	• In order to solve the problem, students work on it using the best technique.
Encouraging Interaction	• The teacher guides the class in problem-solving and encourages them to do it independently. • The teacher circulates the classroom and offers help if there are students struggling to understand.	• Students discuss and tackle challenges, both individually and in groups. • Students ask the teacher if they have questions or difficulties in understanding.
Comparing and Discussing Answers	• The teacher asks students to compare and discuss their responses with their seatmates or group members. • The teacher asks one student to share their response in front of the class, while other students listen and compare their responses.	• Students engage in group or class discussions to talk about the problem topic. • A representative from a group shares their response, and other students listen and compare.
Summarizing Discussion Results	• The teacher instructs students to summarize the lesson discussed that day.	• Students summarize the lesson that was discussed that day.
Closing	• The teacher informs the next topic to be discussed so that students can study in advance. • The teacher prays and says goodbye.	• Students listen to the next topic to study in advance. • Students pray and answer the goodbye.

Based on the above, the advantages of Realistic Mathematics Education (RME) are: (1) Students are less likely to forget information because they construct it themselves; (2) This learning approach is based on real-world situations, creating an enjoyable learning environment that prevents students from losing interest in mathematics too quickly; (3) Students feel valued and become more open; (4) It encourages group collaboration; (5) It encourages students to be bold because they must justify their responses; (6) It teaches students how to think and express their thoughts; and (7) It fosters character education, such as respecting peers who speak and promoting cooperation among classmates. Meanwhile, the disadvantages of Realistic Mathematics Education are: (1) Students still struggle to find solutions on their own because they are accustomed to receiving knowledge first; (2) It requires a long time, especially for students who are struggling; (3) Advanced students may find it difficult to wait for their peers to finish; (4) It requires learning resources that are suitable for the current learning environment.

Results and Discussion

The results of this study are based on the questionnaire given to 12 mathematics education students. The results of the questionnaire obtained from the mathematics education students are as follows:

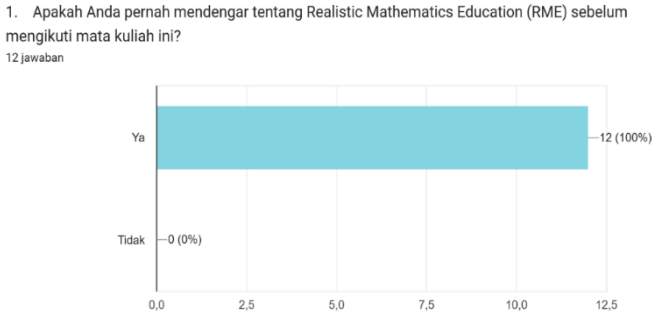

Figure 1. Students' Response to the Introduction of RME

Based on Figure 1 above, it can be observed that:

1. Awareness and Knowledge: All respondents had prior knowledge of RME, which suggests that they might have already understood the concepts and principles of RME before learning more about the course.
2. Readiness to Learn: Since all respondents were familiar with RME, they might be more prepared to study materials and teaching methods that utilize the RME approach.
3. Effectiveness of Teaching by the Lecturer: All respondents had a basic understanding of RME.

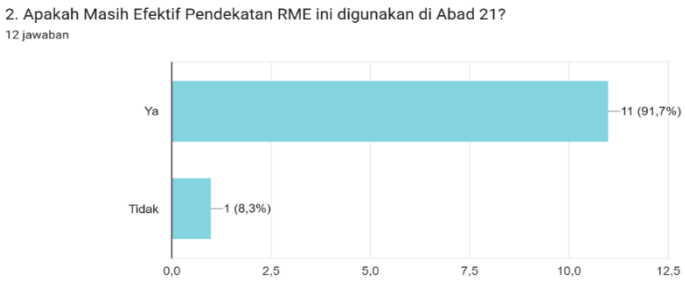

Figure 2. Effectiveness of RME in the 21st Century

Based on Figure 2 above, it can be observed that:

1. Contextualization of Learning: The RME approach remains effective to this day because it uses real-world contexts and relevant situations, making mathematics learning more meaningful for students. This is crucial in today's era to engage students and help them connect theory with practice.
2. Development of 21st Century Skills: RME enhances mathematical understanding and critical skills such as critical thinking, problem-solving, and collaboration. These skills are essential in the increasingly complex and technology-driven world of the 21st century.
3. Compatibility of RME: The RME approach can be adapted to the technology and digital tools available today, such as educational apps and e-learning platforms. This ensures that the method remains relevant and effective in various modern learning settings.
4. Respondents' Comments: The survey results show that 91.7% of respondents still consider RME effective, indicating that both students and education practitioners may have experienced the real benefits of implementing RME in enhancing mathematical understanding and learning outcomes.

The effectiveness of RME in the 21st century is supported by the method's ability to present real-world contexts in learning, develop essential skills needed in the modern world, and its adaptability with current educational technologies (Tambunan & Tambunan, 2023). The positive response from the majority of participants indicates that RME can still be used effectively in today's mathematics education.

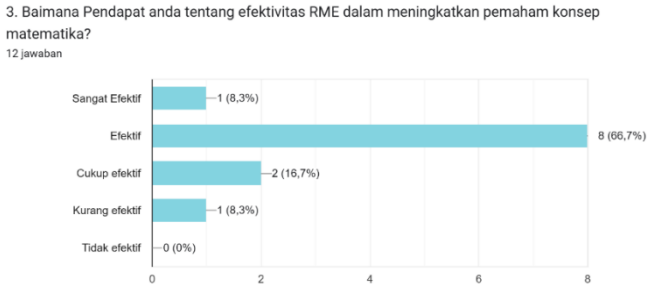

Figure 3. Effectiveness of RME in Improving Mathematical Concept Understanding

Based on Figure 3 above, it can be observed that:

1. Majority of Respondents: The majority of respondents (66.7%) consider RME effective in enhancing their understanding of mathematical concepts. This suggests that the RME method is perceived as successful in helping students understand mathematical concepts in a realistic and relevant context.
2. Very Effective and Effective: Although only one respondent (8.3%) considered RME very effective, the combination of the "Very Effective" and "Effective" categories covers 75% of the total respondents. This indicates that most respondents have a positive view of RME's effectiveness.
3. Quite Effective: Two respondents (16.7%) considered RME quite effective. This shows that while they see benefits from RME, there may be some aspects that could be improved to achieve higher effectiveness.
4. Ineffective or Less Effective: None of the respondents chose "Less Effective," but one respondent (8.3%) considered RME ineffective, suggesting that a small portion of the population may find this method unsuitable or not yielding the expected results.
5. Contextual Relevance: Based on the research findings, RME can help students find mathematics more relevant and meaningful by teaching them in real-world situations. This method works well in helping students understand and retain mathematical ideas.
6. 21st Century Skill Development: Important skills such as teamwork, problem-solving, and critical thinking are also fostered by RME. These skills are crucial in the 21st century.

RME is considered an effective method by the majority of respondents in helping them better understand mathematical concepts. However, most respondents expressed dissatisfaction and stated that further adaptation or improvements are still possible. (Fitri et al., 2020).

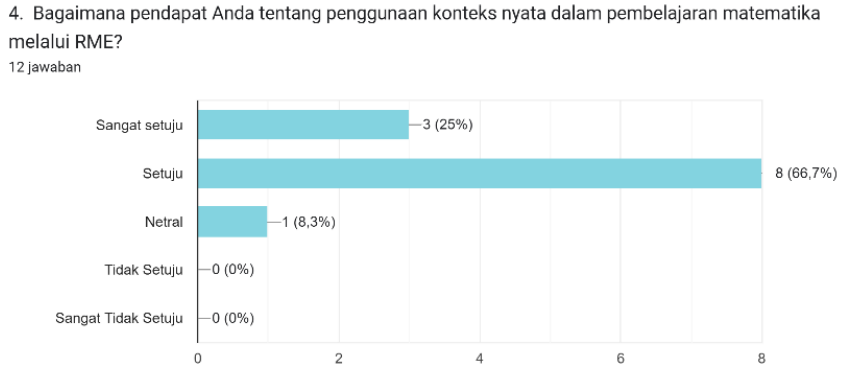

Figure 4. Use of Real-World Context in RME Learning

Based on Figure 4 above, it can be observed that:

1. Majority of Respondents Agree: The majority of respondents (66.7%) agree that the use of real-world context in mathematics learning through RME is effective. This suggests that they see the benefits of this approach in making learning more relevant and meaningful.
2. Strongly Agree: Most respondents strongly agree with the use of real-world context in RME. This indicates strong support for this approach, possibly due to their positive experiences in understanding mathematical concepts through real-world contexts.
3. Neutral: This may indicate that they haven't had sufficient experience or are not fully confident in the RME method, so they couldn't give a more definitive judgment.
4. No One Disagrees: It is likely that the majority of respondents accept this approach well, as no one selected "Disagree" or "Strongly Disagree," indicating there is no rejection of using real-world context in mathematics learning with RME.

The survey results show that the majority of respondents support the use of RME in mathematics learning with real-world context. This approach is considered effective in making learning more relevant and helping students understand mathematical concepts better (Fitra, 2019). The strong support from respondents suggests that RME can be a valuable method for teaching mathematics.

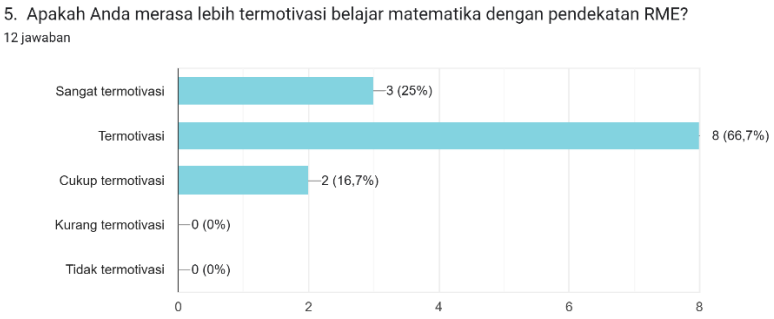

Figure 5. Learning Motivation with RME Learning

Based on Figure 5 above, it can be seen that:

1. Majority of Respondents are Motivated: The majority (66.7%) of respondents feel motivated by the RME approach in mathematics learning, indicating that this approach successfully enhances student learning motivation.
2. Very Motivated: As many as 25% of respondents feel very motivated by the RME approach, showing that this approach is not only effective but also highly motivating for most students.

3. Somewhat Motivated: Two respondents (16.7%) feel somewhat motivated by this approach, indicating that while they see benefits in RME, there are aspects that could be improved to further increase their motivation.
4. No One is Less Motivated or Unmotivated: No respondents chose "Less Motivated" or "Unmotivated," indicating there is no rejection of the RME approach in terms of learning motivation. This suggests that the approach is generally well-received by the majority of respondents.

The survey results show that the majority of participants feel motivated or very motivated to use the RME approach in mathematics learning. This approach is considered effective in increasing students' motivation to learn (Zuschaiya et al., 2021), which is a critical component of successful learning. The strong support from respondents indicates that RME can be a valuable method in mathematics education.

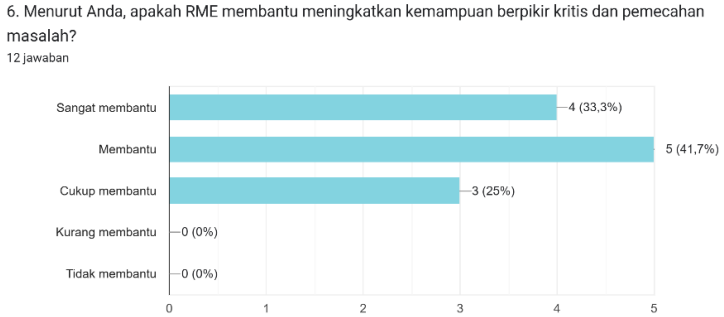

Figure 6. Enhancing Critical Thinking and Problem-Solving Skills

Based on Figure 6 above, it can be seen that:

1. Majority of Respondents Consider RME Beneficial: The majority of respondents (41.7%) believe that RME enhances their critical thinking and problem-solving skills. This indicates that the RME method is considered effective in improving these important skills.
2. Very Beneficial: A significant portion of respondents, 33.3%, stated that RME is highly effective in enhancing their critical thinking and problem-solving abilities. This opinion strongly supports the method, likely due to positive experiences with RME usage.
3. Somewhat Helpful: Three respondents (25%) feel that RME is somewhat helpful. This indicates that while they acknowledge the benefits of RME, there are certain aspects that could be improved to achieve higher effectiveness.
4. No One Felt it Was Insufficient: No respondents selected "Less Helpful" or "Not Helpful," indicating that there was no rejection of the RME approach in terms of enhancing critical thinking and problem-solving abilities. This can be interpreted as the approach being well-accepted by the majority of respondents.

The survey results indicate that the majority of respondents feel that RME improves their critical thinking and problem-solving skills. The approach is considered effective in developing important skills needed in both mathematics learning and everyday life (Agustyaningrum & Pradanti, 2022). The strong support from respondents shows that RME can be a valuable method in mathematics education.

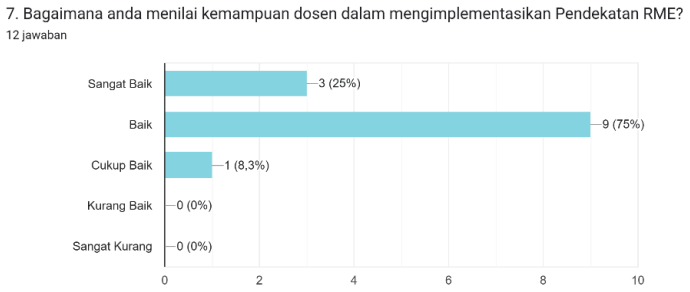

Figure 7. Educator's Ability to Implement RME Teaching

Based on Figure 7 above, it can be observed that:

1. Very Good: 25% of respondents rated the educator's ability as "Very Good." This suggests that some respondents were highly satisfied with how the educator applied the RME approach, likely due to positive experiences in the classroom.
2. Most Respondents Rated "Good": 75% of respondents rated the educator's ability to apply the RME approach as "Good." This indicates that the educator is generally perceived to have adequate skills in implementing the RME method in mathematics teaching.
3. No Negative Evaluations: There was no significant dissatisfaction regarding the educator's ability to implement the RME approach, as no respondents rated the educator's ability as "Fair," "Poor," or "Very Poor."

The survey results indicate that the majority of respondents hold positive views on the educator's ability to implement the RME approach. The positive ratings of "Good" and "Very Good" suggest that the educator is successfully applying the method, providing a positive learning experience for the students (Hakim, 2019).

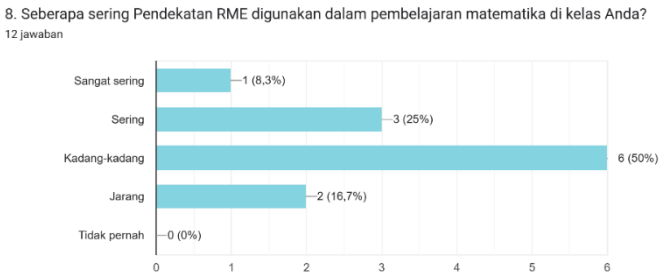

Figure 8. Evaluation of RME Implementation in the Classroom

Based on Figure 8, it can be seen that:

1. The Majority of Respondents (50%) stated that the RME approach is used "Occasionally" in their mathematics classes. This indicates that although the method has been implemented, its use may not yet be consistent or routine.
2. Frequent and Very Frequent Use: A total of 33.3% of respondents (8.3% "Very Frequently" and 25% "Frequently") reported that the RME approach is used quite regularly. This suggests that some classes might implement the method more consistently compared to others.
3. Rare Use: About 16.7% of respondents indicated that the RME approach is used "Rarely". This shows that there are some classes where the method has not yet been optimally or consistently applied.

4. No One Chose "Never": None of the respondents indicated that the RME approach is "Never" used. This suggests that the method has at least been introduced in all classes, even though the frequency of its use varies.

The survey results show that the RME approach has been used to teach mathematics in classrooms, but the frequency of its application varies. The majority of respondents indicated that the method is used occasionally, and some reported more frequent use. The fact that no respondent stated they never used RME shows that the method is already recognized and beginning to be implemented (Nur, 2020).

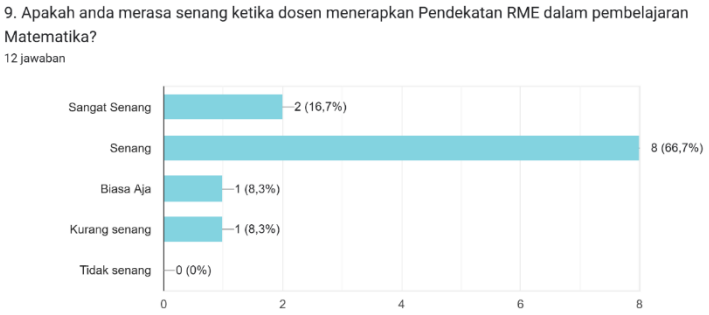

Figure 9. Enjoyable Learning Using the RME Approach

Based on Figure 9, it can be seen that:

1. The Majority of Respondents Enjoyed It: Most respondents (66.7%) stated that they enjoyed when lecturers used the RME approach in teaching mathematics. This indicates that the method is well-received and provides many students with a positive learning experience.
2. Very Enjoyable: As shown by the survey results, 16.7% of respondents reported that they greatly enjoyed the implementation of RME. This suggests that a significant number of students find this method very effective and motivating for continuing to learn mathematics.
3. Neutral: Two respondents (16.7%) stated that they felt neutral. This indicates that they did not mind the use of RME, although they were not particularly impressed by it.
4. No One Felt Less Enjoyable or Not Enjoyable: There is no evidence of significant dissatisfaction with the implementation of the RME approach in mathematics learning, as no respondents selected "Less Enjoyable" or "Not Enjoyable".

The questionnaire results show that most respondents were happy or very happy with the application of the RME approach in mathematics learning. This approach is perceived to provide a positive learning experience and motivate students. No respondents expressed dissatisfaction, indicating that the majority of students accepted this approach well (Widayat & Darmawan, 2024).

Based on the research findings presented above, it can be said that Basic knowledge of RME: All respondents have a basic understanding of RME, indicating their readiness to learn materials and teaching methods that use the RME approach. Effectiveness of RME in the 21st century: The RME approach remains effective because it uses real contexts and relevant situations, which makes mathematics learning more meaningful for students. RME also enhances 21st-century skills such as critical thinking, problem-solving, and collaboration. Understanding of mathematical concepts: Most respondents consider RME effective in improving their understanding of mathematical concepts. The combination of the "Very Effective" and "Effective" categories covers the majority of respondents. Use of real contexts: Most respondents agree that the use of real contexts in mathematics learning through RME is effective. Learning motivation: Most respondents feel motivated by the RME approach in mathematics learning. Critical thinking and problem-solving skills: Most respondents believe that RME improves their critical thinking and problem-solving abilities. Lecturer's ability: Most respondents rate the lecturer's ability to implement the RME approach as "Good" or "Very

Good". Frequency of RME use: Most respondents stated that the RME approach is used "Sometimes" in their mathematics classes. Satisfaction with RME: The majority of respondents stated that they are happy when lecturers use the RME approach in teaching mathematics.

Conclusion

The implementation of the Realistic Mathematics Education approach consists of three stages. Introduction phase: The teacher presents realistic mathematical problems to help students understand the problem. Exploration phase: Students model the problem scenario, exchange ideas, and form hypotheses in small groups or individually. Summary phase: After students show progress in solving the problem, the instructor initiates follow-up work. Students negotiate, speculate, seek different approaches to the problem, and create plans. All respondents have basic knowledge of RME and are ready to learn this method. RME is effective in the 21st century because it uses real-world contexts, enhances critical thinking, problem-solving, and collaboration skills.

Most respondents feel RME improves understanding of mathematical concepts, learning motivation, as well as critical thinking and problem-solving abilities. The lecturers' ability to implement RME is rated as good, although RME is only used occasionally. The majority of respondents are happy with the use of RME in mathematics learning. The findings of this study indicate that RME can help students find mathematics more relevant and meaningful by teaching them in real-world situations. In addition, RME encourages the development of critical thinking, problem-solving, and teamwork, all of which are important in this century. The majority of respondents are inspired by this method and support the application of RME in mathematics learning.

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