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# Development of Mathematics Learning Tools Based on Realistic Mathematics Education (RME) to Improve Students' Mathematical Reasoning and Learning Independence

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***Abstrak***

*Penelitian ini menguji keabsahan, kepraktisan, dan keberhasilan perangkat pembelajaran berbasis Realistic Mathematics Education (RME) dalam meningkatkan Mathematical Reasoning dan Kemandirian Belajar siswa di SMP Free Methodist 2 Medan. Penelitian ini menggunakan metode penelitian dan pengembangan. Model pengembangan yang digunakan adalah ADDIE. Penelitian ini melibatkan siswa kelas VII SMP Medan. Hasil penelitian; Perangkat pembelajaran berbasis Realistic Mathematics Education (RME) dinyatakan telah valid dan dapat meningkatkan Mathematical Reasoning dan Kemandirian Belajar siswa di SMP Free Methodist 2 dengan rata-rata penilaian pada validasi untuk tiap perangkat yaitu 3,4. Perangkat pembelajaran berbasis Realistic Mathematics Education (RME) yang telah dikembangkan dinyatakan praktis untuk meningkatkan Mathematical Reasoning dan Kemandirian Belajar siswa di SMP Free Methodist 2 Medan dengan rata-rata skor yang diberikan observer tiap pertemuan yaitu 3,84 sehingga dinyatakan terlaksana dengan baik tanpa adanya hambatan. Perangkat pembelajaran berbasis Realistic Mathematics Education (RME) yang telah dikembangkan dinyatakan efektif untuk meningkatkan Mathematical Reasoning dan Kemandirian Belajar siswa di SMP Medan. Pembelajaran yang telah dilaksanakan dengan menggunakan perangkat pembelajaran yang dikembangkan diperoleh 23 siswa tuntas dalam test yang diberikan dengan persentase 76% dan hanya terdapat 7 siswa yang belum tuntas dengan persentase 23%.*

***Kata Kunci**: Pendidikan Matematika Realistis (RME), Penalaran Matematika dan Kemandirian Belajar.*

**Abstract**

This study tested the validity, practicality, and success of Realistic Mathematics Education (RME)-based learning devices in improving Mathematical Reasoning and Learning Independence of students at SMP Medan. This study used a research and development method. The development model used was ADDIE. This study involved grade VII students. The results of the study; Realistic Mathematics Education (RME)-based learning devices were declared valid and could improve Mathematical Reasoning and Learning Independence of students at with an average assessment of validation for each device of 3.4. The Realistic Mathematics Education (RME)-based learning devices that had been developed were declared practical to improve Mathematical Reasoning and Learning Independence of students at SMP Free Methodist 2 Medan with an average score given by observers for each meeting of 3.84 so that it was declared to be implemented well without any obstacles. The Realistic Mathematics Education

(RME)-based learning device that has been developed is declared effective in improving Mathematical Reasoning and Learning Independence of students at SMP Free Methodist 2 Medan. The learning that has been implemented using the developed learning device obtained 23 students who completed the test given with a percentage of 76% and there were only 7 students who had not completed it with a percentage of 23%.

**Keywords**: *Realistic Mathematics Education (RME), Mathematical Reasoning and Learning Independence.*

## A. Introduction

It is anticipated of educators that they will exercise caution while selecting the model that will be used, the medium that will be utilized, and the instructional contents that will be presented throughout the learning process (Muhammad, 2020). It is essential for educators to be innovative when developing instructional materials and critical when assessing the learning outcomes of their students at the conclusion of the learning process. Students might be handed student worksheets (LKPD) as part of the assessment process (Apertha, F. K. P., Zulkardi., 2018) . The purpose of these worksheets is to determine the level of comprehension that students have achieved in relation to the material that has been presented to them. In addition to facilitating alterations to the procedures, materials, and assessments that will be presented to students, LKPD is advantageous because it makes it easier to make improvements.

Additionally, LKPD is a technique that is used to ensure that students do not divert from the subject matter that is being studied. To put it another way, it simplifies students' views in the context of utilizing the knowledge that is required. Before engaging in learning activities, instructors are required to prepare a number of learning resources, one of which is the LKPD module. The Realistic Mathematics Education (RME) indicators will be connected to the learning technologies that are going to be created in the future (Hendrikson R Panjaitan, 2023).

The educational resources that are being generated will be modified to accommodate the circumstances and circumstances of the pupils. It is the purpose of this endeavour to develop students' knowledge, both cognitive and emotive, as well as to provide a solution that would make learning easier for students. Educators should finish the learning materials that have been produced by include LKPD, which is helpful as practice in addressing issues that are connected to real-world difficulties. The use of RME in the design of learning devices attempts to make learning more meaningful by allowing students to make use of their experiences, creating themselves via past experiences that are connected to daily life, and constructing themselves through those experiences (Habibi, A & Irawati, T, 2019).

Realistic Mathematics Education, often known as RME, is a method of teaching mathematics that prioritizes the use of real-world scenarios in order to make the learning process more significant. When it comes to RME, the most important notion is the meaningfulness of mathematical concepts. If the learning process is carried out in a context or

if students are learning using ideas that are practical, then the knowledge that they acquire will have significance for them (Laurens, T., Batlolona, F. A., Batlolona, J. R., dan Leasa, 2018).

The term "realistic" refers to more than just the content of ordinary life. On the other hand, an issue is considered to be considered realistic if it is able to be visualized by pupils or if it is seen as being real by them. Students are required to have the capacity to utilize reasoning on patterns and properties, execute mathematical manipulation in order to make generalizations, gather evidence, or explain mathematical concepts and claims, according to Sumartini, who was quoted in the Ministry (NCTM, 2020). The action of reasoning that is involved in the process of learning mathematics is referred to as mathematical reasoning. (Sumartini, 2016) says that the capacity to reason mathematically is a brain habit, similar to other habits that need to be formed continuously utilizing a variety of circumstances. Knowing that reasoning and proof are important components of mathematics is a prerequisite for developing this skill. Through the use of mathematical reasoning, students are able to form assumptions, then gather data, handle mathematical problems, and arrive at conclusions that are accurate and exact.

According to the National Council of instructors of Mathematics (NCTM, 2020), in order to successfully implement mathematics learning, instructors need to pay attention to five mathematical skills. These abilities include connections, reasoning, communication, problem solving, and representations. Consequently, instructors have a responsibility to cultivate mathematical reasoning skills in their pupils. This responsibility may be expressed in the form of learning techniques that are used, as well as in the form of assessments that include the creation of supporting questions. Independent living may be used in a variety of contexts, one of which being the process of acquiring independence. In mathematics education, it is expected of pupils that they would be able to learn independently via their activities. Independence, as defined by (Andara, B., Fadillah, S., & Jamilah, 2022), is the capacity that an individual has to carry out a specified activity and take responsibility for it. Students are required to have a number of crucial attitudes, one of which is the ability to learn independently.

According to (Zayyadi, M., Nusantara, T., Subanji, S., Hidayanto, E., & Sulandra, 2019), learning independence is a process that is both active and constructive. In this process, students set goals for their own learning and then attempt to monitor, regulate, and control their cognition, motivation, and behaviour. This process is guided and limited by the students' goals as well as contextual features in the environment. Learning independence, on the other hand, is defined by Tahar and Enceng (2016) as an activity that is carried out by an individual who is able to decide and control their own teaching materials, time, and location, as well as make use of the essential learning resources. Based on the researcher's experience as a teacher at one of the private junior high schools in Medan City, namely at SMP Free Methodist 2 Medan, it is possible to observe that the restricted learning devices produced by educators in learning are a result of the limited time that educators have available for developing.

(Surya, E., & Syahputra, 2017) found that student learning freedom improves results. Highly independent learners are more active, integrate their learning activities, and can choose the correct learning tactics. Learning independence supports students' schoolwork and helps them acquire job skills (Setiawan, R., Syahria, N., Andanty, F. D., & Nabhan, 2022). With modest criteria, (Aulia, N., Nurmawati, N., & Andhany, 2020) found an increase in learning independence with an n-gain value of 0.32 utilizing Edmodo. Thus, increasing mathematical thinking requires learning independence. Mia Yolanda's "Development of LKPD Based on Realistic Mathematics Education on the Material of Linear Equation Systems of Two Variables for Class VIII Students of SMPN 2 Batusangkar" found that educators' LKPD based on RME scored 92.2%. Erna Siti Nur'aini's "The Effect of the Realistic Mathematics Education (RME) Approach on Understanding Mathematical Concepts and Students' Self-Confidence in Fraction Driving Material" found that RME improved students' mathematical understanding in the experimental class. This 22.94% rise shows that the RME technique improved pupils' mathematical knowledge.

## B. Research Method

Development research (R&D) will be employed in this study to produce a new product or enhance current ones and may be accounted for. This research tries to create learning devices. Realistic Mathematics Education (RME) based Learning Devices are being developed to promote Mathematical Reasoning and Student Learning Independence. This study was conducted at SMP Free Methodist 2 Medan class VII. This 2023/2024 academic year study used quadrilaterals. This research included SMP Free Methodist 2 Medan Class VII students. Development of RME based learning devices is the goal of this study. To promote SMP Free Methodist 2 Medan students' mathematical reasoning and learning independence, learning gadgets will be assembled and connected to their daily lives. The research procedure based on the ADDIE model is designed as follows.

Analysis, Examination of student needs, student characteristics, curriculum, and learning objectives to identify relevant problems and solutions. Design, Based on the final results, design learning devices by assessing the preparation of materials, LKPD, and RPP. Development Conduct expert evaluation and changes after dismantling the mathematics learning device, then conduct expert validation and then make revisions if necessary.Implementation, Implement the product to test its efficacy and feasibility using data collection tools. Evaluation Assess learning technology based on analysis of data collection instruments.

## C. Result and Discussion

This research design was carried out through 5 main stages, namely analysis, design, development, implementation, and evaluation as described as follows:

***Analysis***

Based on the student characteristics analyzed above, Realistic Mathematics Education (RME) may be used in learning. Realistic Mathematics Education (RME) views math as an activity. Students solve issues, identify problems, and grasp the core topic here. RME solves arithmetic problems well because it provides stages to help pupils. Thus, this method focuses lessons on pupils. Researchers developed learning tools based on Realistic Mathematics Education (RME) to study quadrilaterals. These tools must meet valid, practical, and effective criteria to improve mathematical reasoning skills and student learning independence at SMP. Medan Free Methodist 2. This research uses quadrilaterals for grade VII odd semester after analyzing textbook content, student needs, and 2013 curricular relevancy. Square, rectangle, parallelogram, trapezoid, rhombus, kite are quadrilaterals. Learning gadgets are developed using indicators from the Basic Competencies (KD) assessed in the 2013 Ministry of National Education curriculum regulation. This idea analysis identifies, details, and organizes quadrilateral notions into a concept map for pupils. We adapt this idea map for Realistic Mathematics Education (RME) learning.

***Design***

In the design stage, the goal is to design a product that will be produced as well as the instruments that will be used to ensure the quality of the product. One of the most important aspects of designing a product is having a solid understanding of the product's intended use, the product that will be manufactured, as well as a description of the product's components and how they should be used. The objective of this stage is to develop learning devices in such a way that examples of devices that are used for Quadrilateral Building material can be produced via the implementation of the Realistic Mathematic Education (RME) methodology.

***Development***

Five sets of Student Activity Sheets (LKPD) are included for each of the five meetings. The LKPD serves both as a source of solutions and as a technique that is based on the difficulties that are presented in the LKPD. Adjustments have been made to the LKPD that was established in accordance with the concepts or methods of Realistic Mathematic Education (RME). The LKPD provides directions for work, a spot to put the group name, and answers to each question. In addition, work instructions are provided. Students enhance their mathematical reasoning skills as a result of the challenges presented in the LKPD, which allows them to simultaneously meet the learning objectives that they have set for themselves. For more information, a visual representation of one of the LKPDs that students utilize is shown in the form of Figure 1, which may be seen below.

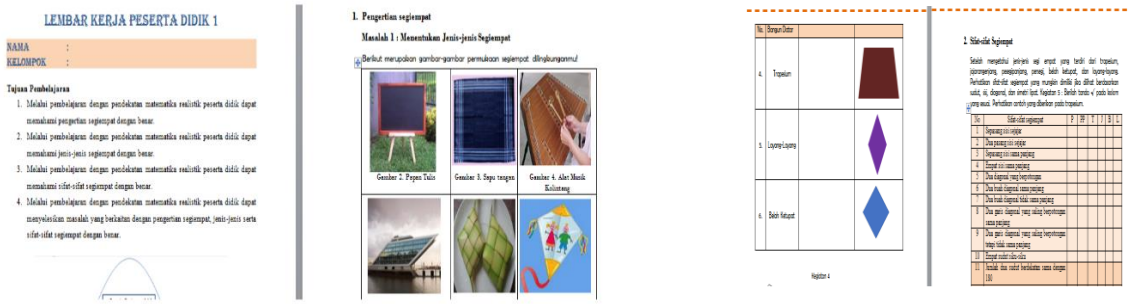


Figure 1. Student Activity Sheet (LKPD) Display

Table 1. Validation Results

| No | Aspect | Average | Category |
|---|---|---|---|
| 1 | Learning Tool Plan | 3,5 | Valid |
| 2 | Student Worksheets | 3,5 | Valid |
| 3 | Mathematical Reasoning Ability | 4,5 | Valid |
| 4 | Learning Independence | 4,5 | Valid |

Table 1 shows that the RPP, Student Worksheets have a total "valid" average of 3,95. The data in this study were analyzed using descriptive statistical analysis. According to Sheskin (2004), descriptive statistics as an analysis tool for the purpose of describing data without drawing conclusions and making predictions. Common procedures used in descriptive statistics are in the form of tables, graphs, diagrams and calculations on the size of the central and dispersion of data.

***Implementation***

After the learning is carried out, a final test is carried out to measure the extent to which the development of students' mathematical reasoning is studied with the development of the devices that have been developed. The following data were obtained

Table 2 Description of the Results of Mathematical Reasoning Ability in the Trial

| NO | Student Code | Score | Mark | Information |
|---|---|---|---|---|
| 1. | S1 | 11 | 91 | T |
| 2. | S2 | 9 | 75 | T |
| 3. | S3 | 8 | 67 | TT |
| 4. | S4 | 6 | 50 | TT |
| 5. | S5 | 10 | 83 | T |
| 6. | S6 | 12 | 100 | T |
| 7. | S7 | 12 | 100 | T |

| | | | | |
|---|---|---|---|---|
| 8. | S8 | 12 | 100 | T |
| 9. | S9 | 10 | 100 | T |
| 10. | S10 | 11 | 91 | T |
| 11. | S11 | 12 | 100 | T |
| 12. | S12 | 11 | 91 | T |
| 13. | S13 | 12 | 100 | T |
| 14. | S14 | 9 | 75 | T |
| 15. | S15 | 11 | 91 | T |
| 16. | S16 | 12 | 100 | T |
| 17. | S17 | 12 | 100 | T |
| 18. | S18 | 11 | 91 | T |
| 19. | S19 | 4 | 33 | TT |
| 20. | S20 | 10 | 83 | T |
| 21. | S21 | 4 | 33 | TT |
| 22. | S22 | 6 | 50 | TT |
| 23. | S23 | 12 | 100 | T |
| 24. | S24 | 12 | 100 | T |
| 25. | S25 | 12 | 100 | T |
| 26. | S26 | 12 | 100 | T |
| 27. | S27 | 10 | 83 | T |
| 28. | S28 | 12 | 100 | T |
| 29. | S29 | 8 | 67 | TT |
| 30. | S30 | 8 | 67 | TT |
| Amount | | 301 | 2.521 | |
| Averange | | 10,03 | 84,03 | |

Based on the test given to 30 students, 23 students completed the test and 7 students did not meet the completion criteria in the score given.

Final Test of Learning Independence

After the end of the meeting, a questionnaire was given to students to measure students' learning independence based on the encouragement given during learning activities. With the following data

Table 3. Final Test of Learning Independence

| NO | Student Code | Score | Mark | Information |
|---|---|---|---|---|
| 1. | S1 | 49 | 3,5 | Tall |
| 2. | S2 | 58 | 4,14 | Tall |
| 3. | S3 | 63 | 4,5 | Tall |
| 4. | S4 | 63 | 4,5 | Tall |
| 5. | S5 | 44 | 3,14 | Tall |
| 6. | S6 | 54 | 3,85 | Tall |

| | | | | |
|---|---|---|---|---|
| 7. | S7 | 52 | 3,71 | Tall |
| 8. | S8 | 62 | 4,42 | Tall |
| 9. | S9 | 47 | 3,35 | Tall |
| 10. | S10 | 39 | 2,78 | Tall |
| 11. | S11 | 39 | 2,78 | Tall |
| 12. | S12 | 41 | 2,92 | Tall |
| 13. | S13 | 44 | 3,14 | Tall |
| 14. | S14 | 27 | 1,92 | Tall |
| 15. | S15 | 52 | 3,71 | Tall |
| 16. | S16 | 55 | 3,92 | Tall |
| 17. | S17 | 53 | 3,78 | Tall |
| 18. | S18 | 55 | 3,92 | Tall |
| 19. | S19 | 42 | 3 | Tall |
| 20. | S20 | 57 | 4,07 | Tall |
| 21. | S21 | 61 | 4,35 | Tall |
| 22. | S22 | 49 | 3,5 | Tall |
| 23. | S23 | 57 | 4,07 | Tall |
| 24. | S24 | 58 | 4,14 | Tall |
| 25. | S25 | 50 | 3,57 | Tall |
| 26. | S26 | 62 | 4,42 | Tall |
| 27. | S27 | 51 | 3,64 | Tall |
| 28. | S28 | 47 | 3,35 | Tall |
| 29. | S29 | 37 | 2,64 | Tall |
| 30. | S30 | 49 | 3,5 | Tall |
| Amount | | 1.517 | 108,23 | |
| Averange | | 50,56 | 3,6 | |

Of the 30 students given a questionnaire to measure student learning independence, 30 students already had good learning independence.

Improvement of learning outcomes

In the research, data was obtained for improving learning outcomes with the following table.

Table 4. Improvement of learning outcomes

| NO | Initial value | Nilai akhir | Peningkatan (N-Gain) | Criteria |
|---|---|---|---|---|
| 1. | 45 | 91 | 0,8 | High |
| 2. | 58 | 75 | 0,4 | Medium |
| 3. | 55 | 67 | 0,2 | Low |
| 4. | 54 | 50 | 0,08 | Low |
| 5. | 44 | 83 | 0,6 | Medium |
| 6. | 41 | 100 | 1 | High |

| | | | | |
|---|---|---|---|---|
| 7. | 44 | 100 | 1 | High |
| 8. | 47 | 100 | 1 | High |
| 9. | 45 | 100 | 1 | High |
| 10. | 39 | 91 | 0,8 | High |
| 11. | 45 | 100 | 1 | High |
| 12. | 55 | 91 | 0,8 | High |
| 13. | 47 | 100 | 1 | High |
| 14. | 59 | 75 | 0,3 | High |
| 15. | 55 | 91 | 0,8 | High |
| 16. | 44 | 100 | 1 | Medium |
| 17. | 55 | 100 | 1 | High |
| 18. | 55 | 91 | 0,8 | High |
| 19. | 55 | 33 | -0,48 | High |
| 20. | 51 | 83 | 0,6 | High |
| 21. | 62 | 33 | 0,4 | High |
| 22. | 55 | 50 | -0,48 | High |
| 23. | 47 | 100 | 1 | High |
| 24. | 53 | 100 | 1 | Low |
| 25. | 54 | 100 | 1 | Medium |
| 26. | 38 | 100 | 1 | Medium |
| 27. | 56 | 83 | 0,6 | Low |
| 28. | 48 | 100 | 1 | Medium |
| 29. | 52 | 67 | 0,3 | High |
| 30. | 48 | 67 | 0,3 | High |

From the test given to 30 students, it turned out that 18 students had high learning outcomes, 8 students had medium learning outcomes and 4 students had low learning outcomes.

***Evaluation***

After media development, 5 validators—3 lecturers and 2 teachers—tested its validity. The five validators added captions to media and reasoning ability test images, expanded the LKPD answer space to allow students to express their thoughts, and directed the language on the learning independence questionnaire. The fifth validator suggested some changes, but the product.

**Discussion**

Based on the formulation of the problem and research statement presented in the previous section, and based on the data obtained from the research results, it will be known whether the formulation of the problem in the research has been answered or not. Based on the research conducted, it was obtained: (1) the learning device based on Realistic Mathematics Education (RME) was declared valid so that it could improve Mathematical Reasoning and Learning Independence of students at SMP Free Methodist 2 Medan; (2) The learning device based on Realistic Mathematics Education (RME) that has been developed is declared practical to improve Mathematical Reasoning and Learning Independence of students at SMP Free Methodist 2 Medan; (3) The learning device based on Realistic Mathematics Education (RME)

that has been developed is declared effective to improve Mathematical Reasoning and Learning Independence of students at SMP Free Methodist 2 Medan.

## D. Conclusion

The Realistic Mathematics Education (RME)-based learning device was validated and may improve SMP Free Methodist 2 students' mathematical reasoning and learning independence. Each gadget averaged 3.4 validation ratings. With an average score of 3.84 for each meeting, observers found the Realistic Mathematics Education (RME)-based learning device practical to increase SMP Free Methodist 2 Medan students' mathematical reasoning and learning independence. After that, it was declared successful and problem-free. A Realistic Mathematics Education (RME)-based learning gadget was found to improve SMP Free Methodist 2 Medan students' mathematical reasoning and learning independence. After using the learning gadget, 23 students passed the test, a 76% success rate. However, just 7 pupils (23%), failed the exam. One hundred percent of thirty pupils exhibited great learning freedom in participating in learning activities. Continues the emotive theme. During this time, 18 students had a 60% high increase in learning outcomes, 8 had a 26% moderate increase, and 4 had a 13% low increase. This was done using created learning techniques.

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