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Jurnal Riset Pendidikan Matematika 12 (1), 2025, 74-85

The Effect of *Realistic Mathematics Education* Approach to Improve Students' Mathematics Learning Outcomes

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ARTICLE INFO

Article history
Received: 1 Aug 2024
Revised: 4 May 2025
Accepted: 7 May 2025

Keywords
Realistic Mathematics,
Students' worksheets,
Learning Outcome,
Learning Results

ABSTRACT

Learning outcomes are influenced by the process carried out during learning. The learning process is carried out by applying innovative learning models/approaches.This study aims to determine the effect of the Realistic Mathematics Education (RME) approach on the mathematics learning outcomes of grade VIII students at Siak Hulu Junior High School. Employing a development research design combined with a pseudo-experimental methodology, the research involved a population of six classes (VIII1 to VIII6). A purposive sampling technique was utilized, resulting in two selected classes: VIII3, comprising 32 students as the control group, and VIII4, also with 32 students, serving as the experimental group. The development phase produced a valid and practical student worksheet designed to facilitate the RME approach. The findings indicated that students who engaged with the RME approach demonstrated significantly better mathematics learning outcomes compared to those who experienced conventional teaching methods. Statistical analysis confirmed the effectiveness of the RME approach, suggesting that it not only enhances understanding but also improves overall performance in mathematics. This study concludes that the implementation of the RME approach positively influences the mathematics learning outcomes of grade VIII students in SMP 6 Kampar Regency, highlighting its potential as an effective pedagogical strategy in mathematics education. The research contributes to providing evidence for the adoption of realistic approaches in classroom settings to foster improved student engagement and achievement in mathematics. Recommendations for teachers to be encouraged to develop media and teaching materials that are contextualised and relevant to students' daily lives likes Trigonometry subject.

How to Cite: Zetriuslita, Andrian, D., Suripah, Maimunah, Hidayat, R., & Dacara, E. (2025). The effect of Realistic Mathematics Education approach to improve students' mathematics learning outcomes. *Jurnal Riset Pendidikan Matematika*, *12*(1), 74–85. https://doi.org/10.21831/jrpm.v12i1.76685

INTRODUCTION

Learning outcomes are a process of interaction between students and educators and learning resources in a learning environment (Suardi, 2018). In other words, learning is a process to help students learn well. Teachers play a role in facilitating the process that students do in learning (Prediger & Neugebauer, 2023; Tompong & Jailani, 2019). Teachers can guide students on how to learn and solve problems faced in learning (Arseven, 2015). Good learning will have interactions from various directions, namely teachers with students, students with other students, students with learning resources, and learning media and tools that can be used in learning (Weber et al., 2023). In learning, there are learning materials that must follow the needs of students, and materials must follow the real world (Gravemeijer et al., 2016). The material that corresponds to the real world (daily life) is mathematics subject matter.

Mathematics is one of the essential basic sciences that has an important role, both in everyday life and in the development of science and technology (Melisa, 2022). Mathematics is also said to be one of the subjects that is widely used in other subjects, so that mathematics cannot be separated from everyday life (Costa & Domingos, 2022). Many students need help to understand and even think that mathematics is a complex subject, so students cannot solve these problems because they need to understand mathematical concepts (Gijsbers et al., 2020). Finally, students become uninterested and discouraged in learning. Speaking of math learning outcomes, Indonesia still needs to meet international standards (Trinh Thi Phuong et al., 2022). The results obtained from the TIMSS (Trends in International Mathematics and Science Study) report in 2019 were that the mathematics assessment was carried out in grades four and eight. The grade VIII math assessment includes four areas, namely number (30%), algebra (30%), geometry (20%), and probability data (20%). The international score for math is 507 out of 550. TIMSS 2019 math achievement results for all 39 countries, but the 2019 TIMSS Indonesia survey results did not find Indonesian students participating (Karim, Ma'rufi, & Ilyas, 2021).

In line with these problems, the Program for International Student Assessment (PISA) report in 2018 stated that Indonesia was ranked 73 out of 79 countries surveyed with a score of 379 and an average international score of 489 in mathematics (OECD, 2018). On a smaller scale, based on the Ministry of Education and Culture's average math results report in 2020, the average junior high school math score was 62.063. Within the province, the average junior high school math score was 46.6, where Riau Province ranked 9th out of 35 regions in Indonesia. In the scope of junior high schools in Riau Province, Pekanbaru City, the average junior high school math score is 405. Based on the learning results obtained, it is hoped that teachers will further improve student learning outcomes, especially in mathematics subjects.

Based on interviews with math teachers, the average math test results of six junior high school students in Siak Hulu are 60.9. This is still relatively low so the researcher suspects that the problem of low student learning outcomes is influenced by the lack of mastery of the material taught by the teacher and the learning process used by the teacher. In the learning process, the teacher uses direct learning which centers on the teacher as the subject and students as the object. In this case students need help to understand mathematical concepts related to everyday life, especially in cube and beam material. This can be used as a lesson for teachers to make math a subject that students like and how to help students understand mathematical concepts. This condition requires teachers to improve the learning process, one of which is by using the right learning strategy so that it can affect learning outcomes. To improve learning outcomes, learning strategies, learning approaches, and visual aids in learning are needed. One learning approach that is oriented towards students' real life is the Realistic Mathematics Education (RME) approach.

RME is a learning approach that uses real problems in everyday life (Barnes, 2004a; Helstad et al., 2017). RME will make students participate in learning in accordance with their lives because the mathematical objects in RME are problems that exist in society (Chronaki, 2023). RME will make it easier for students to adapt to their environment because every mathematical material is connected to students' daily habits (Christiansen & Erixon, 2021). Realistic mathematics education is implemented through real events that are close to children's experiences and relevant to society so that students can imagine them (Isrok'atun & Rosmala, 2021). RME provides enjoyable learning for students because they can repeat everyday activities in mathematics materials (Igbo & Omeje, 2014; Tuen Veronica Leung et al., 2019). This approach will strengthen students in understanding mathematics material

ISSN 2356-2684 (print), ISSN 2477-1503 (online)

according to the targeted competencies of the government, especially the ministry of education.

The above explanation provides information that RME is very important for the development of learning in the classroom. RME must be an approach that is used regularly in the classroom in order to obtain maximum student learning outcomes. Therefore, this research is important to be applied in the process of learning mathematics whose mathematics learning outcomes are still very low. This research can provide new experiences and knowledge to students so that fun mathematics learning can be realized in the classroom. This research was conducted at SMP Negeri 6 with the hope that this research can improve student learning outcomes through the best experiences that students will get supported by SWS learning media.

METHODS

This research is an R&D research and quasi-experimental research. R&D research is conducted to develop SWS learning media that can be applied in experimental research. The research method used in this research is the ADDIE model research and development (R&D) method which consists of 5 stages, namely Analysis, Design, Development, Implementation, and Evaluation. The ADDIE model can be used as a research method to develop teaching materials and other educational products. The product will be created and produced in the form of learning media with a realistic mathematics approach and applied to flat geometry material, namely cubes, blocks, prisms, and pyramids. Selection of geometry material data can facilitate the teacher in explaining and giving examples related to geometry. Teachers do not need to bring props and other media because SWS has provided a complete picture of the spatial construction.

The quasi-experimental research in this study is a follow-up research to the development research. The development results have been valid and practical applied for one month in the learning process in the classroom. It is called a quasi-experiment because in this experimental research the variables cannot be controlled. Pseudo-experimental research determines the effect of the experiment on the characteristics of the subject that the researcher wants. The design used in this research is Nonequivalent Control Group Design (Zetriuslita et al., 2020). This design uses pre-test and post-test for control and experimental groups. The form of the research design is as follows:

Table 1. Research design

Class	Measurement (Pre-Test)	Treatment	[easurement (Post-test)
Experiment	O1	X	O2
Control	O3	-	O4

Information:
O1 : Pre-test applied to experimental class
O3 : Pre-test conducted for control class
X :Treatment with Realistic Math
- :Treatment with conventional learning
O2 : Post-test conducted for the experiment
O4 : Posuji-t applied for control

This research was conducted at SMPN 6 Siak Hulu. The population in this study were all VIII grade students of SMPN 6 Siak Hulu, totaling 192 people, consisting of 6 classes, namely classes VIII1 - VIII6. Sampling in this study using side purposive technique. The sample is part of the entire population studied. The sample in this study consisted of two classes, namely class VIII3 which numbered 32 people as a control class, and class VIII4 which numbered 32 people as an experimental class.

The data collection technique used in this research is the test technique. The test technique was designed in the form of descriptive questions (description questions), carried out as a pretest and posttest. The pretest instrument is to measure the initial ability of students' math learning outcomes before being given treatment. While the posttest instrument is given to measure math learning outcomes after treatment. Testing was carried out in two classes, one of which was an experimental class with realistic mathematics education and a control class with conventional learning.

ISSN 2356-2684 (print), ISSN 2477-1503 (online)

The data analysis techniques used in this research are descriptive statistics and inferential statistics. Descriptive statistics calculated is the average learning outcomes of control and experimental classes, then calculated the standard deviation. While inferential statistics by calculating the normality test of data, variance homogeneity test, and comparison test of the average student math learning outcomes (t-test). Normality test is not required for samples with the same number or more than 30. This is based on the explanation (Wahyuni, 2019) that samples above 30 or more than 30 tend to be normal and do not need to be tested for normality. Thus, researchers did not conduct a normality test because the research sample amounted to 32 in the experimental and control classes. So in processing the data of the research results, the homogeneity of variance test and t test are directly carried out.

RESULTS AND DISCUSSION

1. Development Phase

At this stage, the development of learning media in the form of math-based SWS (student worksheets) was developed to be used in classroom experiments. The learning media developed consists of 4 meetings with material on number patterns, cartesian coordinates, functional relationships, and broken line equations. The four materials will be the focus of this research and will be tested in classes VIII3 and VIII4. The developed SWS is then evaluated or validated by experts and teachers. The purpose of validation is to check whether the SWS developed is in accordance with the standards and curriculum that runs at school. The validation results can be seen at the evaluation stage.

2. Evaluation Phase

The evaluation stage is the stage of assessing the results of the development that has been carried out. This is the stage of developing SWS media based on realistic mathematics. The results of the analysis of the media expert assessment show that SWS learning media based on realistic mathematics can be used in learning mathematics. The results of the analysis can be seen in Table 2.

Table 2: Media Expert Validation Results

Assessment Components	Assessment Score (%)	Criteria	Conclusion
Material	87,5	Legal	can be used with minor revisions.
Illustration	75	Legal	can be used with minor revisions
Media Quality and Display	87,5	Legal	can be used with minor revisions
Attractiveness	72,2	Legal	can be used with minor revisions
Average	80,6	Legal	Can be used with minor revisions

Learning media experts assessed the material, illustrations, quality, and appearance of the media. From this assessment, the expert explained that SWS learning media can be used with a validity level of 80.6% in the valid category. These results indicate that the validity test from experts for media from each component is valid and can be used RME learning.

Furthermore, it can be seen the results of the validity of the material aspect which consists of the components of content feasibility, language feasibility, and presentation feasibility of the developed SWS. Table 3 shows the results of material feasibility.

Table 3. Material aspect expert validation results

Assessment Component	Total Assessment Score (%)	Criteria	Conclusion
Decent Content	80,5	Legal	usable with minor revisions
Language	80, 5	Legal	usable with minor revisions
Presentation	87,5	Legal	usable with minor revisions
Average	82,83	Legal	usable with minor revisions

The results of the validity test in terms of material aspects resulted in a validity index of 82.83%,

ISSN 2356-2684 (print), ISSN 2477-1503 (online)

including in the valid category. According to experts, this media contains core or basic competencies that are taught or tested. These results indicate that the validity test from experts for material aspects from each component is valid and can be used RME learning.

Furthermore, the results of the practicality of the SWS media developed can be seen. Table 4 presents the results of the practitioner's assessment in assessing the level of practicality of the developed media.

Table 4. Teacher Response to Practical Learning Media

Validator	Average (%)	Criteria
Validator 1	83,5	Practical
Validator 2	87,4	Practical
Validator 3	80,3	Practical
Average	83,73	Practical

Table 4 illustrates the results of practitioners' responses to the level of practicality of the developed SWS. The analysis results obtained an average score of 83.73 in the practical category. These results conclude that the media can optimistically transfer mathematical knowledge or material in accordance with the targeted core or basic competencies. These results indicate that teacher response to practical learning media from each experts practical and can be used in RME learning

Furthermore, practitioners have assessed the aspects of media display, content, and media attractiveness in detail. Table 5 illustrates the results of the three practitioners' assessment of the developed SWS.

Table 5. Teacher Assessment of SWS Media

Validator	Assessment Indicator	Score (%)	Criteria
Validator 1	Media Display	75	Practical
	Media content	75	Practical
	Attractiveness	83,3	Practical
Validator 2	Media Display	83,3	Practical
	Media content	75	Practical
	Attractiveness	83,3	Practical
Validator 3	Media Display	75	Practical
	Media content	75	Practical
	Attractiveness	83,3	Practical

The first to third validators gave a minimum score of 75 and a maximum score of 83.3. From the results of the three practitioners, an average score of 78.69 was obtained in the practical category. The three practices assessed the appearance, content, and attractiveness of SWS media to attract students to learn mathematics in accordance with the targeted core or essential competencies. According to the experts, this media will be even more interesting if it is integrated with technology that can be played on Android or computer. These results indicate that teacher response to practical SWS media from each experts practical and can be used in RME learning.

Based on the results above, that the development of learning media in the form of math-based SWS (student worksheets) meets the valid and practical criteria, then we can use it in learning using RME to improve math learning outcomes.

3. Experiment Results

Based on the results of post-test data analysis, the experimental class average was 75.47 and the control class average was 51.69. The difference is due to the treatment in learning. In the experimental group applied with a realistic mathematics approach, and in the control class applied with conventional learning.

Based on the analysis of variance homogeneity test, it was found that . This means that the post-test results of the two groups, namely the experimental class and the control class, are homogeneous.

ISSN 2356-2684 (print), ISSN 2477-1503 (online)

This can be seen from the following variance homogeneity test table 6.$F_{Count} < F_{table} = 1{,}04 < 1{,}82$

Table 6. Homogeneity Test of Experimental and Control Classes

Validity Percentage (%)			verage Validity (%)	Validity Level
V1	V2	V3		
100	100	100	100	Very Valid
Average Number (%)			100	Very Valid

In the experimental and control class groups with normal and homogeneous distribution, hypothesis testing was carried out using the comparative test, and the average learning outcomes with the t test. These results indicate that teacher response to homogeneity test of experimental and control Classes from each experts was very valid and can be used in RME learning.

Table 7. Comparison of Experimental and Control Class Learning Outcomes

Class	Average	Variants	t_{Count}	t_{table}	Information	Conclusion
Experiment	75,47	240,06	6,08	2,04	$t_{Count} > t_{table}$	H0 rejected

Based on the mean and variance of the experimental class and control class obtained and for a sample of 32 obtained. From the calculation results it is explained that, then H0 is rejected and H1 is accepted. This means that the mathematics learning outcomes of students who use the PMR approach are better than conventional learning. So there is a difference between the average math learning outcomes of the experimental class and the average math learning outcomes of the control class.$t_{hitung} = 6{,}08 t_{tabel} = 2{,}04\ t_{hitung} = 6{,}08 > t_{tabel} = 2{,}04$. Thus, it can be concluded that there is an effect of the RME approach on the mathematics learning outcomes of class VIII students at Siak Hulu Junior High School.

4. Discussion

The learning media has been assessed by experts and practitioners with valid and practical categories. SWS learning media developed according to the correct procedure will provide students with the best experience in understanding mathematics material (Nofriyandi & Andrian, 2022; Rezeki et al., 2021). Experts argue that SWS learning media will contribute to building students' knowledge of mathematical materials (Andrian & Wahyuni, 2020; Maclinton & Andrian, 2022). Learning media developed with strict procedures and supported by several experts will provide significant results in assisting teachers in the classroom (Andrian et al., 2022; Setiawan et al., 2019). Students will be interested in learning math materials because they feel happy learning with new media (Amir et al., 2021; MZ et al., 2021). The learning media will consistently transfer complex math materials because some students feel bored learning math (Bektaş et al., 2020; Liu & Hallinger, 2018). New learning media is the best idea to develop the classroom in the best condition. It is very important to continue developing learning media because students only sometimes have good feelings towards learning math.

Realistic mathematics can enhance or improve mathematics learning. Realistic mathematics is the best step to develop students' skills in mathematics (Heuvel-panhuizen & Drijvers, 2014; Stemn, 2017a). Some of the reasons mathematics can improve the learning process towards learning outcomes are; realistic mathematics has several things that make the learning process run optimally, namely; 1) Understanding contextual problems, namely observing real objects in everyday life such as cardboard boxes and dice, so that students know the real objects in cubes and blocks; 2) Solving contextual problems by observing real objects; students find it easier to solve problems in everyday life and are given the freedom to think actively according to their ideas and ideas in finding and understanding a concept and building their knowledge; 3) Comparing and discussing answers, namely from the results of problem solving, students can compare the results of their solutions with other friends so as to create

ISSN 2356-2684 (print), ISSN 2477-1503 (online)

an active classroom atmosphere. Conditions like this will foster student self-confidence; 4) Concluding, which is from the results of learning students can conclude what they get during learning so that learning is more meaningful. This causes the learning outcomes of mathematics applied with a realistic mathematics approach to be higher than the learning outcomes applied with conventional learning.

Significant results of classroom experiments show that the realistic mathematics approach can have the best effect on learning outcomes. The realistic mathematics approach has advantages that can support success in learning, such as a) Meaningful learning, b) Fun atmosphere, c) Students are more open because they feel appreciated for answers that are different from their friends, d) Foster cooperation between groups, e) Train students to dare to convey their work in class, and f) Character education such as cooperation and respect for speakers during discussions (Makonye, 2014a; Sitorus & Masrayati, 2016a, Sitorus & Masrayati, 2016b; Webb et al., 2011). However, success in learning certainly has drawbacks, namely at first students still need clarification about problem solving in SWS, so it takes a long time for them to adjust to their groups and the realistic mathematics approach that researchers apply (Arsaythamby & Zubainur, 2014; Saleh et al., 2018). With the realistic mathematics approach that the researchers applied, students did not feel bored; although the classroom atmosphere needs to be more conducive, it can be managed (Sumirattana et al., 2017). The classroom atmosphere during learning is a little noisy because students are still actively involved in the learning process and work together with their group members to solve problems (Franklin & Harrington, 2019; McMillen et al., 2019).

The learning process becomes interesting learning because this learning brings students closer to students' lives at home or in their environment. Realistic mathematics education stimulates students to think mathematically in easy conditions so that students must bring daily activities at home into the learning process (Revina & Leung, 2021; Zakaria & Syamaun, 2017). The increase in mathematics learning outcomes occurs because students feel that learning mathematics in the classroom is like at home so that students do not feel difficulties in learning mathematics (Klein et al., 1998; Stemn, 2017b). Improved mathematics skills can be achieved through realistic mathematics education when teachers and students can collaborate (Barnes, 2004b; Makonye, 2014b). Teachers and students need to apply realistic mathematics education because this approach will provide an excellent experience (Athar, 2012; Laurens et al., 2018). Every activity in learning becomes free without difficulty when realistic mathematics education is applied in the classroom (Chao et al., 2016; Schukajlow et al., 2017). Every school in the world needs to plan the learning process with realistic mathematics education.

CONCLUSION

Based on the research results, the development of this learning media is categorised as valid and practical. This means that this media will make a significant contribution to improving the quality of education in the classroom. These results indicate that the validity test from experts for media SWS from each component is valid and can be used RME learning. From the experimental research, the results obtained that the Realistic Mathematics Approach can improve student learning outcomes from the experiments conducted. This means that the experiment or treatment given has a significant effect on students. Recommendations for teachers to be encouraged to develop media and teaching materials that are contextualised and relevant to students' daily lives dan for applying the RME approach not only in grade VIII, but also in other lower (grade VII) or higher (grade IX) grade levels to make learning mathematics more interesting and meaningful. Broader Implementation: Consider applying this approach in other subjects or curricula to assess its effectiveness across different areas of learning. Encourage further research to explore long-term impacts of the RME and the learning media on diverse student populations or conduct further research with a wider scope, such as in different schools, different materials, or by considering other factors (such as learning motivation, student learning styles, or critical thinking skills) to enrich the evidence of the effectiveness of the RME approach.

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ISSN 2356-2684 (print), ISSN 2477-1503 (online)

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ISSN 2356-2684 (print), ISSN 2477-1503 (online)