Effectiveness of the Realistic Mathematics Education Approach in Mathematics Learning

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Abstract. Realistic Mathematics Education (RME) is an approach to mathematics education that has been developed in the Netherlands since 1970 and was adapted in Indonesia to become Realistic Mathematics Education (PMR). RME is a mathematics learning model that provides realistic explanations, where mathematics learning is oriented towards the application of mathematics in everyday life, so that students can easily digest the learning delivered by educators. This research aims to conduct a literature review related to the effectiveness of Realistic Mathematics Education (RME) in mathematics learning. The research method chosen in this research is the Systematic Literature Review (SLR) method. Data collection was carried out by documenting and reviewing all articles related to mathematics education in the period 2015 - 2023. The articles used in this research were 25 nationally and internationally accredited journal articles obtained from Google Scholar, Research Gate, SINTA, DOAJ, and Scopus . The results of this research show that Realistic Mathematics Education (RME) can improve many students' mathematical abilities. Starting from the abilities: mathematical understanding, mathematical problem solving, mathematical reasoning, mathematical connections, and students' mathematical communication.

Keywords: Realistic Mathematics Education, Mathematics Learning, Systematic literature review

1 Introduction

Education is essentially an effort to pass on values, which will become guidelines and direction in carrying out daily life practices. The essence of values education in general education aims to develop students' activities and creativity, as well as prepare them to face challenges in everyday life. So it can be said that the progress and decline and the good and bad of a nation's civilization are largely determined by the educational process implemented in a nation. In the field of education, mathematics is one of the subjects that plays an important role to study. Because mathematics is said to be the mother of science, this means that mathematics is a source of other sciences [1]. There are many sciences that depend on mathematics, including knowledge, discovery and development [2]

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Mathematics learning is one of the important subjects in improving students' intellectual abilities [3]. Apart from that, learning mathematics has an important role in developing students' abilities [4]. By learning mathematics, students can think critically and be skilled at calculating and have the ability to apply basic mathematical concepts to other subjects as well as to mathematics itself and in everyday life [5].

Objects in mathematics are abstract. Because of its abstract nature, it is not uncommon for teachers and students to experience several obstacles in the learning process. In fact, the mathematics learning that has been carried out so far is by explaining mathematical objects, giving examples of the mathematical objects that have been explained, then students are given questions and asked to solve them where the questions are similar to the examples, and giving students practice questions. The practice questions given are usually quite varied. Starting from questions similar to examples to the application of mathematical objects in everyday life.

Mathematics learning like that tends to make students passive, feel bored, not interested. Apart from that, the learning model used is still conventional, learning only takes place in one direction, teachers do not involve students in learning, they are less creative, their abilities are less developed, and the The saddest thing is that mathematics learning achievement to date has not been satisfactory [6]. Even though these students are not weak students, they have been busy memorizing mathematical objects presented by their teacher. These objects can be facts, concepts, principles or operations. Because they have to memorize too much, as a result students are unable to think critically and are less prepared to face problems.

Reform efforts to improve mathematics learning have long been carried out with various means and aims. These renewal efforts take the form of changes to the curriculum along with clarified objectives, there are also updates through the learning process in class. In Indonesia, the curriculum has repeatedly undergone changes according to developments over time. Starting from the 1947 Curriculum which was the first curriculum since Indonesia's independence. 1952 Curriculum, 1964 Curriculum, 1968 Curriculum, 1975 Curriculum, 1984 Curriculum, 1994 Curriculum, 2004 Curriculum, 2006 Curriculum (KTSP), 2013 Curriculum, and until now Indonesia's Independent Curriculum.

The curriculum changes are in line with the goals to be achieved. Apart from curriculum changes, efforts to improve learning in Indonesia are through learning models. The learning model introduced refers to the constructivist aspect. With the introduction of various models in learning, the existing learning models are still used in maximum combination.

Along with this reform, specifically for mathematics lessons, a special lesson known as Realistic Mathematics Education (RME) was introduced. Realistic Mathematics Education (RME) is an approach to mathematics education that has developed in the Netherlands since 1970 and was adapted in Indonesia to become Realistic Mathematics Education (PMR) [7]. The RME approach starts from something real so that students can be involved in the learning process meaningfully. According to Gravemeijer (1994) quoted in [8], there are three main principles in realistic mathematics education, namely guided reinvention and progressive mathematization (guided discovery and progressive

mathematics), didactical phenomenology (didactive phenomena), and self-development (development of one's own model).

The main idea of realistic mathematics learning according to Gravemeijer (1994) quoted in [4] is that students must be given the opportunity to reinvent mathematical concepts and principles under the guidance of adults. Students are given the opportunity to discover mathematical ideas or concepts based on children's experiences in interacting with their environment. The environment in question can be a school environment, family or community environment that is truly known to students.

The realistic mathematics learning process uses contextual problems as a starting point in learning mathematics. Students are given the opportunity to organize the problem and try to identify the mathematical aspects of the problem. Based on the description above, this research aims to determine the effectiveness of RME in mathematics learning.

2 Methods

This scientific article was prepared using the Systematic Literature Review (SLR) method. In Indonesian, a systematic literature review is a literature review method that identifies, examines, evaluates and interprets all available research. With this method, the researcher reviewed and identified journals in a structured manner, each process following predetermined steps [9]. To complete this research, the researcher collected journal articles from Google Scholar, Research Gate, SINTA, DOAJ, and Scopus. Key words are Realistic Mathematics Education Approach, and Mathematics Learning. The articles collected were only articles published in the period 2015 to 2023. From various articles, researchers selected 25 articles that were closely related to the keywords used. The next step, researchers grouped articles related to the application of realistic mathematics education.

3 Result and Discussion

The Realistic Mathematics Education (RME) approach is an approach to learning mathematics that emphasizes the application of mathematics in real life contexts. RME is one answer in implementing an active and effective teaching and learning process through real situations, especially mathematics learning. With this approach, students are expected to be able to easily understand the lessons delivered by educators, because students can understand mathematical concepts in depth and are able to relate them to the situations around them. This can improve students' mathematical abilities such as mathematical understanding, mathematical problem solving, mathematical reasoning, mathematical connections and mathematical communication.

The research data included in this article is an analysis and summary of documented articles related to Realistic Mathematics Education

Table 1. Research Results related to the Effectiveness of the RME Approach in Mathematics Learning

Researcher	Journal	Research result
(Sutisna et al, 2016)	Scientific Pen Journal	The thematic approach with RME is better at improving mathematical understanding abilities than the thematic approach in low grade multiplication material.
(Hidayat, et al, 2020)	Primary School Scientific Journal	Increasing the ability to understand mathematical concepts of students who use the Realistic Mathematics Education approach in the experimental class is better than students who use the contextual approach in the control class.
(Sari & Yuniati, 2018)	Scholar's Journal: Journal of Mathematics Education	The Realistic Mathematics Education (RME) approach can have a positive influence on students' ability to understand mathematical concepts.
(Mashuri et al, 2020)	AKSIOMA: Journal of the Mathematics Education Study Program	The STAD type cooperative learning model with the RME approach is more effective compared to conventional learning in improving the mathematical understanding abilities of class VIII students at MTs Nurul Yaqin Dawi-dawi
(Nurfadilah, 2020)	TIRTAMATH: Journal of Mathematics Research and Teaching	The mathematical understanding abilities of students who use the RME approach are better than students who use the scientific approach.
(Yanti et al, 2022)	Educative: Journal of Educational Sciences	LKPD based on Realistic Mathematics Education (RME) to improve the mathematical reasoning abilities of Class .
(Harahap, 2018)	MathEdu Journal (Mathematic Education Journal)	There is significant effectiveness between the use of the RME (Realistic Mathematic Education) approach on the mathematical reasoning abilities of students in class XI SMA Negeri 7 Padangsidimpuan.
(Gusnarsi, et al, 2017)	JPMI (Indonesian Journal of Mathematics Education)	The Realistic Mathematics Education (RME) learning model can be one of the alternatives in mathematics learning to improve students' mathematical reasoning abilities.
(Saputri, 2018)	Journal of Mathematical Pedagogic	There is an influence of the Realistic Mathematics Education (RME) approach on students' mathematical reasoning abilities in class XI trigonometry material at SMK S Agriculture Pembangunan Putra Jaya Stabat. This is becausecan improve activity and creative thinking of students.

Researcher	Journal	Research result
(Ardiniawan et al, 2022)	SNHRP	There is an increase in the RME method for developing the mathematical reasoning abilities of elementary school students in Pacitan sub-district
(Hidayat & Irawan, 2017)	Scholar's Journal: Journal of Mathematics Education	Student Worksheets (LKS) based on Realistic Mathematics Education (RME) to facilitate the mathematical problem solving abilities of class III students at State Elementary School 012 KP
(Widana, 2021)	Element journal	The application of the RME learning model can improve students' mathematical problem solving abilities with a moderate influence category and no publication bias.
(Harahap, 2018)	Journal of Education and Development	The use of RME-based geometry teaching materials can improve students' problem solving abilities.
(Rosyada et al, 2019)	Scientific Journal of Basic Education	There is an influence of the Realistic Mathematics Education (RME) learning model on the mathematical problem solving abilities of class V students at Prampelan State Elementary School. The class whose learning uses the RME model has a better average score than the control class whose learning uses the conventional model.
(Susanti & Nurfitriyanti 2018)	KPM (Journal of Mathematics Education Studies)	The mathematical problem solving abilities of students who receive learning using the Realistic Mathematic Education (RME) model are more improved than the problem solving abilities of students who using expository learning.
(Latipah & Afriansyah 2018)	Mathematics: Journal of Theoretical and Applied Mathematics	The CTL approach and the RME approach are equally good in improving students' mathematical connection abilities
(Flowers & Julia, 2016)	Scientific Pen Journal	The difference in increasing mathematical connection abilities in the experimental class and the control class shows that mathematics learning using the RME approach is better than conventional mathematics learning in improving students' mathematical connection abilities
(Mufidah & Machromah 2023).	Scholar's Journal: Journal of Mathematics Education	The RME approach can be an effective alternative in improving students' mathematical connection skills.
(Isroaty et al, 2023)	AKSIOMA: Journal of the	The CORE model learning tool with the RME approach that has been developed meets the criteria

Researcher	Journal	Research result
	Mathematics Education Study Program	of being valid, practical and effective and has an effect on increasing students' mathematical connection abilities.
(Firdaus et al, 2022)	JMIE: Journal of Madrasah Ibtidaiyah Education	The Realistic Mathematics Education (RME) learning model has a significant effect on students' mathematical connection abilities in the material of pyramid shapes
(Ramadhani et al, 2021)	AXIOM: Journal of Education and Mathematics	Based on student involvement and mathematical communication skills during learning using the RME approach, it can be said that students who have active involvement during learning also have good mathematical communication skills.
(Matondang et al, 2020)	Edumaspul: Education Journal	The ICT-assisted RME learning model can improve students' mathematical communication and critical thinking skills
(Hidayat et al, 2021)	Rafflesia Journal of Mathematics Education	RME-based mathematics learning media which is equipped with lesson plans on Equations and Inequalities of Linear Absolute Value of One Variable which is valid and practical so that it can improve the mathematical communication skills of students in class X SMA
(Kusumawati, 2017)	Delta: Scientific journal of mathematics education	There is an influence of communication skills and problem solving abilities in Realistic Mathematic Education (RME) mathematics learning on student learning outcomes in the main material of fractions with the magnitude of the influence being 0.028 or 2.8%
(Syamsudin, 2018)	JPMI (Journal of Innovative Mathematics Learning)	The mathematical communication skills of System of Linear Equations in Two Variables (SPLDV) material in class VIII students at SMP N 2 Cariu can be improved through the Realistic Mathematic Education (RME) approach.

Based on the research results in the table above, it shows that the use of Realistic Mathematics Education (RME) can improve students' mathematical understanding abilities in low grade multiplication material [10]. Increasing the ability to understand mathematical concepts of students who use the Realistic Mathematics Education approach in the experimental class is better than students who use the contextual approach in the control class [11]. The Realistic Mathematics Education (RME) approach can also have a positive influence on students' ability to understand mathematical concepts [12]. The mathematical understanding abilities of students who use the RME approach are better than students who use the scientific approach [13]. Apart from that, the STAD type cooperative learning model with the RME approach can improve the mathematical understanding abilities of class VIII students [14].

LKPD based on Realistic Mathematics Education (RME) to improve the mathematical reasoning abilities of Class [15]. The Realistic Mathematics Education (RME) learning model can be one of the alternatives in mathematics learning to improve students' mathematical reasoning abilities [16]. There is an increase in the RME method for developing the mathematical reasoning abilities of elementary school students in Pacitan sub-district [17]. Not only does it improve mathematical reasoning abilities, the use of RME also influences the effectiveness of students' mathematical reasoning abilities [18]. Apart from that, there is an influence of the Realistic Mathematics Education (RME) approach on students' mathematical reasoning abilities in class XI trigonometry material at SMK S Agriculture Pembangunan Putra Jaya Stabat. This is because RME can increase students' activity and creative thinking [19].

The use of Student Worksheets (LKS) based on Realistic Mathematics Education (RME) to facilitate the mathematical problem solving abilities of class III students at State Elementary School 012 KP [20]. RME-based Geometry Teaching Materials can improve students' problem solving abilities [21]. Meanwhile, the influence of the Realistic Mathematics Education (RME) learning model on the mathematical problem solving abilities of fifth grade students at Prampelan State Elementary School, the class whose learning uses the RME model, has a better average score than the control class whose learning uses the conventional model [22]. The mathematical problem solving abilities of students who receive learning using the Realistic Mathematic Education (RME) model are more improved than the problem solving abilities of students who use expository learning [23]. Thus, the application of the RME learning model can improve students' mathematical problem solving abilities [24].

The CTL approach and the RME approach are equally good in improving students' mathematical connection abilities [25]. The CORE model learning tool with the RME approach that has been developed meets the criteria of being valid, practical and effective and has an effect on increasing students' mathematical connection abilities [26]. The difference in increasing mathematical connection abilities in the experimental class and the control class shows that mathematics learning using the RME approach is better than conventional mathematics learning in improving students' mathematical connection abilities [27]. Apart from that, the Realistic Mathematics Education (RME) learning model has a significant effect on students' mathematical connection abilities in pyramid building material [28]. So, using the RME approach can be an effective alternative in improving students' mathematical connection skills [29].

There is an influence of communication and problem solving skills in Realistic Mathematic Education (RME) mathematics learning on student learning outcomes in the main material of fractions with the magnitude of the influence being 0.028 [30]. Where, the ICT-assisted RME learning model can improve students' mathematical communication and critical thinking skills [31]. RME-based mathematics learning media which is equipped with lesson plans on Equations and Inequalities of Linear Absolute Value of One Variable which is valid and practical so that it can improve the mathematical communication skills of students in class X SMA [32]. Mathematical communication skills regarding System of Linear Equations in Two Variables (SPLDV) in class VIII students at SMP N 2 Cariu can be improved through the Realistic Mathematic Education (RME) approach, the more students actively interact with fellow students or teachers, and are better at changing information in story problems or problems becomes a mathematical model or mathematical expression [33]. Therefore, based on student

involvement and mathematical communication skills during learning using the RME approach, it can be said that students who have active involvement during learning also have good mathematical communication skills [34].

4 CONCLUSIONS

Based on the results and discussion that have been presented, it can be concluded that the Realistic Mathematics Education (RME) approach is an approach to learning mathematics. This approach can be applied in school and college environments. The Realistic Mathematics Education (RME) approach is an approach to learning mathematics that focuses on realistic concepts, where students are able to understand the material by using examples and questions related to their daily lives. The use of the RME approach in mathematics learning is very effective and will have a positive impact, namely being able to improve many students' mathematical abilities. Starting from the abilities: mathematical understanding, mathematical problem solving, mathematical reasoning, mathematical connections, and students' mathematical communication.

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