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Article

Systematic Literature Review: The Role of Realistic Mathematics Education Approach in Indonesia

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Abstract: The main goal of learning mathematics is that students have the full range of mathematical skills to pursue higher education and solve problems in everyday life. An approach that can be used is Realistic Mathematics Education (RME). RME is an approach in learning mathematics using situations that contain real experiences or problems. This research aims to define RME, describe the principles and characteristics of RME, and the roles of RME in Indonesia. The method used is Systematic Literature Review (SLR). The result of this study is that the researcher found that RME helps the students to connect mathematics in everyday life so they can improve their mathematical skills as well, and it can help 'slow learners' to understand mathematics' concepts. In addition, RME also can increase students' affective domain, such as learning independence, self-efficacy, and self-confidence.

Keywords: RME; SLR; mathematical skills

1. INTRODUCTION

The development of science and technology in the era of globalization requires every country to prepare generations to become quality human resources. According to Wikipedia, education is defined as a planned effort to establish a study environment and educational process so that the student may actively develop their own potential in religious and spiritual level, consciousness, personality, intelligence, behavior and creativity to themselves, other citizens and the nation. To achieve those educational goals, it is necessary to carry out the learning process in schools optimally, including mathematics.

Mathematics has an important role in promoting science, technology and communication growth (Utami et al., 2019). The main goal of learning mathematics is that students have the full range of mathematical skills to pursue higher education and solve problems in everyday life. These mathematical skills include problem-solving, reasoning, communicating, connecting, and representing mathematics, as well as high-level thinking skills, namely critical and creative thinking (Basuki and Wijaya, 2018). Unfortunately, many students think mathematics is too abstract and too complex because they do not understand its meaning or do not see its usefulness or who have negative biases with regard to the subject (Daniel, 2013).

Students who are passive learners often do not retain the information they are taught and have difficulty applying it to new situations so that the teacher-centered approach is still used in most schools. The teacher will give a procedural question, then the students will complete the problem with a formula without knowing the meaning of the formula used. Students who follow procedure correctly do not guarantee a good understanding of the concept. Sometimes students only focus on the final answer without understanding the process because they come to think that "learning math" means memorizing procedures, applying to the questions, and finding exact answers.

The students do not aware that mathematical problems are closely related to the context of problems that exist in everyday life. An approach that can be used to overcome this problem is Realistic Mathematics Education (RME) or Pendidikan Realistik Matematika Indonesia (PMRI) in Bahasa. RME was first developed in the Netherlands which "realistic" interpretation in Dutch means "Zichrealiseren" or "to imagine". Thus, realistic emphasizing everything that can be imagined by students' minds (Fauzana et al., 2020).

According to Freudenthal, mathematics must be related to reality, the problems posed to learners must be suitable to the life of society, the material must be conveyed are human activities (Da, 2022). Treffers (1987) stated that RME is an approach in learning mathematics using situations that contain real experiences or problems (Fadlila and Sagala, 2021; Putranto and Marsigit, 2018). This approach can make the atmosphere in the class more effective and comfortable. Bringing the prospective teacher to learn the abstract matter by imagining it in their daily life is the best way because they build their own knowledge so that students find it hard to forget (Ashari and Salwah, 2021). McCormic noted that students experience meaningful learning when they are actively involved in the learning process such as investigating and understanding important mathematical ideas (Sulasmi et al., 2020).

Based on the description above, this research aims to define RME, describe the principles and characteristics of RME, and the roles of RME in Indonesia.

2. METHOD

The Materials and Methods should be described with sufficient details to allow others to replicate and build on the published results. Please note that the publication of your manuscript implicates that you must make all materials, data, computer code, and protocols associated with the publication available to readers. Please disclose at the submission stage any restrictions on the availability of materials or information. New methods and protocols should be described in detail while well-established methods can be briefly The research method used is systematic literature review (SLR). SLR is a method to identify, evaluate and interpret all relevant research results related to certain research questions, certain topics, or phenomena of concern. The research method with the following procedures.

Develop Research Question

The research questions aim to help understand what will be done in this literature review. Research questions also help make data collection easier. The research questions are as follows.

1) What is realistic mathematics education?
2) What are the principles and characteristics of realistic mathematics education?
3) What are the roles of realistic mathematics education in Indonesia?

Selection Criteria

Research articles were selected based on inclusion and exclusion criteria. The selection criteria are shown in table 1.

Table 1. Selection Criteria

Criteria	
Inclusion	1) Articles are results of research in Indonesia journals, international journals, and proceedings. 2) Publication from 2015 to 2023. 3) Discussion of articles according to research topics.
Exclusion	1) Articles are not results of research in Indonesia journals, international journals, and proceedings. 2) Publication before 2015. 3) Discussion of articles outside the research topic.

Developing the Search Strategy

The strategy used in this research is to collect articles on the results of realistic mathematics education research in electronic databases, such as; ERIC, IOP Science, SINTA, and journals published by Springer and Google Scholar. The search string in this research is as follows.

1) Realistic mathematics education
2) Realistic mathematics education in Indonesia
3) Realistic mathematics education characteristics

The search string above is needed for more specific searches and to avoid filtering a large number of articles.

Appraising the Quality of Studies

Articles found will be evaluated based on the following quality assessment criteria questions.

1) Is the article the result of research?
2) Was the article published in the last 8 years?
3) Does the article write a research problem that is relevant to this research?

Each article will be given an answer value for each of the questions above with Y (Yes) or T (No).

3. Results and Discussion

The search results of research articles relating to the RME in Indonesia, detected as many as 51 articles detected through Springer and Google Scholar. Then the author made a selection according to the inclusion criteria and got 32 articles. The author then proceeded to assess the quality of the study results and determined as many as 25 research articles that

met the criteria. The search and discussion of the 25 articles was carried out to answer research questions.

Realistic Mathematics Education

Realistic Mathematics Education (RME) is a theory of teaching and learning mathematics that has been developed in the Netherlands since the early 1970s. This theory was influenced by Hans Freudenthal (1905–1990), a professor of pure and applied mathematics who became interested in mathematics education. RME is shaped based on Freudenthal's two main principles for mathematics teaching and learning. Freudenthal (1991) stated that mathematics is a human activity (Da, 2022; Hajizah et al., 2021; Rusdi et al., 2020; Van den Heuvel-Panhuizen and Drijvers, 2014) and an actual activity in doing mathematics (Fadlila and Sagala, 2021; Fauzana et al., 2020). RME has been applied in many countries around the world such as Great Britain, Germany, Denmark, South Africa, USA, Japan, and Malaysia, including Indonesia where RME is known as Pendidikan Matematika Realistik Indonesia (PMRI).

RME is applying "realistic" situations that are given a prominent position in the learning process. These situations serve as a source for initiating the development of mathematical concepts, tools, and procedures. The word "realistic" means students are offered problem situations which they can imagine. Therefore, in RME, problems presented to students can come from the real world but also from the fantasy world of fairy tales, or the formal world of mathematics, as long as the problems are experientially real in the student's mind (Van den Heuvel-Panhuizen and Drijvers, 2014).

The principle of RME in terms of activity aspects treats students as active participants in the learning process. RME is a teaching approach that starts from real things for students, emphasizes the skills of "the process of doing mathematics", discussing and collaborating, and also arguing with classmates to find its solution. Instead, rather than being receivers of ready-made mathematics, students should be active participants in the educational process, developing mathematical tools, and insights by themselves (Van den Heuvel-Panhuizen and Drijvers, 2014). In RME, the teacher's role is as a facilitator, moderator or evaluator while students think and communicate ideas or opinions to train democratic nuances by respecting the opinions of others (Paroqi et al., 2020), so that RME can emphasize the meaningfulness of science based on the philosophy of mathematics as an activity. In addition, it is important to identify every student's level and prior knowledge of the topic area that will help them to cope with quantitative situations in the world around them.

De Lang (1987) stated that the learning process using RME can be done through four activities, they are real situations, mathematization and reflection, abstract and formalization, and mathematization in application (Putranto and Marsigit, 2018). According to Treffers and Freudenthal, the process of rediscovering mathematical concepts is related to the search for patterns and relationships starting with realistic problems, trying to describe with language and symbols created by students, modeling, symbolizing, schematization, and defining which also starts with realistic problems and goes on (Natalia, 2017). Students' formal thinking integrates

their previous and new knowledge to find the solutions (Pratiwi and Widjajanti, 2020). If students already understand the concept, then they can find a way to solve similar problems without resorting to the help of realistic problems. It can be said that RME helps students to construct and improve their mathematics skills.

Treffers (1987) stated that mathematization is distinguished between 'horizontal' and 'vertical' dimensions. In horizontal mathematization, the students define a problem and solve it using their own strategies, while in vertical mathematization, the students solve their problem using mathematical language (Bayrak and Aslanci, 2022; Van den Heuvel-Panhuizen and Drijvers, 2014).

Based on the definition that has been presented, it can be concluded that RME is a learning activity with the idea that mathematics should be connected to the imaginable context of students' daily lives, so it will help students to construct their mathematical thinking and be able to find the exact answer.

The Principles and Characteristics of Realistic Mathematics Education

Gravemeijer (1994) considered that mathematics learning using RME approach has three main principles: (1) the principle of guided reinvention mathematics, which is the teacher should create learning opportunities for their students to acquire knowledge through experience and by engaging actively in real-world-like activities; (2) the principle of didactical phenomenology, which is emphasizes the importance of contextual problems to introduce mathematical topics by considering the suitability of contextual applications in learning mathematics; and (3) the principle of self-developed models, which is suggests that the problems experienced by students while learning mathematics result from the gap between their informal knowledge levels and their formal knowledge levels (Bayrak and Aslanci, 2022; Maulana, 2021).

Furthermore, Treffers (1991) stated the characteristics of RME in learning activities are (Basuki and Wijaya, 2018; Nugraheni and Marsigit, 2021):

a. Using real world context. RME learning begins with a mathematical situation derived from real problems (real-life contexts) that bring it to the everyday experience so that math becomes meaningful to learners.
b. Construction. Students are given the opportunity to develop a strategy in the problem solving informally that is in the form of constructivism results and then the students are led to develop the model into a more abstract or general one.
c. Using mathematization process. The students developed a mathematical model from the real-world situation in order to reach an abstract level. Then the students will discuss and collaborate with their group.
d. The existence of interactivity. The existence of student interactivity is a fundamental discussion in the process of mathematization.
e. Integrated learning (Intertwinement). The students integrate their previous and new knowledge to solve the problem.

The Roles of Realistic Mathematics Education in Indonesia

There are many studies that have succeeded in proving the effectiveness of RME in learning mathematics. RME helps the students to connect mathematics in everyday life so they can improve their mathematics skills as well, and it can help 'slow learners' to understand the concept (Hafidah and Rukli, 2022; Putranto and Marsigit, 2018).

RME has an important role to develop students' mathematical problem solving skills (Hasibuan et al., 2019; Kosim et al., 2020; Nurjamaludin, 2021; Nugraheni and Marsigit, 2021; Pratiwi and Widjajanti, 2020; Sari et al., 2021, Ulandari et al., 2019), mathematical reasoning skills (Da, 2022; Kusumawati, 2020; Salma and Fauzan, 2018), mathematics communication skills (Paroqi et al., 2020; Sa'id et al., 2021), mathematical literacy skills (Fauzana et al, 2020), mathematical connection (Hasbi et al., 2019), mathematical representation skills (Laelasari et al., 2020), critical and creative thinking skills (Cahyaningsih and Nahdi, 2021; Dhayanti et al., 2018; Ismunandar et al., 2020; Wulandari et al, 2020), algebraic thinking skills (Hajizah et al., 2021) and high order thinking skills (HOTS) (Fadlila and Sagala, 2021; Hilmi and Dewi, 2021). In addition, RME also can increase students' affective domain, namely learning independence (Hasibuan et al., 2019), self-efficacy (Ulandari et al., 2019), and self-confidence (Kosim et al., 2020; Wulandari et al., 2020). From these results, we can see that RME is very influential in improving students' mathematical problem-solving skills.

Mathematics topics that have been researched using RME are calculus (Da, 2022), derivative (Sari et al., 2021; Sulasmi et al., 2020), circle (Basuki and Wijaya, 2018), linear program (Laelasari et al., 2020), statistics (Paroqi et al., 2020), fraction (Cendekiawaty and Sugiman, 2020) and functions (Hajizah et al., 2021). It is very possible that RME can be applied to other topics.

4. Conclusions

RME is a learning activity with the idea that mathematics should be connected to the imaginable context of students' daily lives, so it will help students to construct their mathematical thinking and be able to find the exact answer. Mathematics learning using the RME approach has three main principles such as guided reinvention, didactical phenomenology, and self-developed models. RME has five fundamental characteristics, namely using real world context, construction, using mathematization process., the existence of interactivity, and integrated learning. RME can improve their mathematics skills as well, especially mathematical problem-solving skills. RME also helps 'slow learners' to understand mathematics' concepts through meaningful activity. In addition, RME can increase students' affective domain, namely learning independence, self-efficacy, and self-confidence.

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