Realistic Mathematics Education as a Contextual Approach in Overcoming Learning Difficulties Circle

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Abstract

This study explores the application of the Realistic Mathematics Education (RME) model as a contextual approach to overcome learning difficulties among eighth-grade students in understanding the topic of circles. The research was conducted through a Classroom Action Research (CAR) method in two cycles at SMPN SATAP 1 Pringgabaya, involving 13 students as subjects. The implementation of RME focused on bridging abstract mathematical concepts with real-life experiences through contextualized problem-solving, group activities, and visual representations. Data were collected through tests, questionnaires, and classroom observations. The results showed a notable improvement in students' conceptual understanding, with the average score increasing from 62.91 in cycle I to 72.5 in cycle II, and classical completeness rising from 58.33% to 75%. Furthermore, learning interest increased from 61.42% to 79.45%. These findings indicate that RME not only enhances students' cognitive outcomes but also positively influences their engagement and motivation. Thus, RME serves as an effective pedagogical strategy for teaching geometry, particularly in visualizing and contextualizing mathematical concepts such as circles.

Keywords: Realistic Mathematics Education, learning difficulties, geometry, circle, contextual learning, conceptual understanding.

INTRODUCTION

Geometry is an important part of mathematics learning in junior high school (SMP), especially on the topic of circles. This material not only requires an understanding of abstract concepts such as radius, diameter, circumference, and area, but also requires the ability to visualize geometric shapes in a real context. Unfortunately, many students still have difficulty in understanding these concepts in depth.

This is caused by various factors, one of which is a learning approach that is not contextual and too focused on algorithmic procedures without involving a strong conceptual understanding.

The difficulties experienced by students in understanding the concept of circles are often related to the lack of connection between the subject matter and the reality of their lives. Meryansumayeka et al., (2022) emphasized that students experience obstacles when they have to understand the basic properties of circles such as the relationship between diameter and radius, and the relationship between central angles and circumference angles. The lack of geometric visualization skills also makes things worse, where students have difficulty imagining physical and conceptual representations of circles. As a result, many students are unable to properly explain the structure of a circle and fail to apply the concept in other contexts.

One of the main causes of this low understanding is the dominance of conventional learning methods in the classroom. Conventional learning models usually rely on one-way lectures, mechanistic practice questions, and minimal contextual interaction. As reported by Effendi et al., (2019), this approach makes students only trained to memorize formulas and procedures, but do not understand the meaning behind them. This has an impact on students' ability to solve problems that require a deep and flexible understanding of concepts. In the context of circle material, conventional approaches often fail to bridge the gap between mathematical symbols and students' everyday experiences, so that learning becomes irrelevant and abstract.

In contrast, more dynamic learning models such as Realistic Mathematics Education (RME) have been shown to provide more positive results in improving student understanding. Do et al., (2021) and Listiawati

et al., (2023) showed that students who learned with the RME approach showed significant development in understanding circle geometry compared to students who learned through traditional methods. This model places real-world contexts as a starting point in building mathematical concepts, making learning more meaningful and enjoyable. Therefore, it is very important to explore the potential of the RME approach in overcoming students' learning difficulties.

The basic principle of the Realistic Mathematics Education approach is to relate mathematical concepts to students' real lives. Freudenthal, the main initiator of RME, stated that mathematics is a human activity and must be actively constructed by students through realistic experiences. RME prioritizes the process of reinvention of mathematical concepts by students through structured guidance. In the context of circle learning, this approach allows students to understand concepts through activities involving real objects or situations, such as bicycle wheels, dinner plates, or wall clocks. Nguyen & Pham, (2023) stated that this approach encourages students to explore, construct meaning, and understand concepts in a more natural and contextual way.

In addition, the RME approach also facilitates students in building connections between concepts. Ardiyani et al., (2018) emphasized that with RME, students not only understand mathematical concepts separately, but are able to see the relationship between concepts and apply them in various situations. In geometry learning, especially on the topic of circles, this approach encourages students to engage in exploratory activities that strengthen their understanding of the characteristics of the shape and properties of circles. These activities include group discussions, contextual problem solving, and presentation of findings, all of which contribute to active and collaborative learning.

The effectiveness of the RME approach in improving understanding of abstract concepts at the junior high school level has been proven by many studies. Rusiyanti et al., (2022) and Listiawati et al., (2023) showed that this approach not only significantly improves students' learning achievement but also increases their participation and motivation in learning mathematics. One of the main strengths of RME is its ability to help students build understanding from the bottom up, starting from concrete contexts to formal abstractions. Thus, students not only understand "how" a concept is used, but also "why" the concept works. This is an important foundation in forming sustainable conceptual understanding.

The use of real-life contexts in mathematics learning has been shown to be effective in increasing student engagement and understanding. Canto López et al., (2022) noted that when students can see the relevance of mathematics in their daily lives, they become more motivated to learn. The application of real-life situations in learning, such as calculating the area of a circular garden or measuring a bicycle wheel, not only makes learning interesting but also relevant. Listiawati et al., (2023) added that familiar contexts provide a strong framework for students to understand new concepts, making learning more accessible and meaningful.

Previous research also supports the effectiveness of RME in the context of circle material specifically. Armiati et al., (2022) found that RME can improve students' critical thinking skills in solving geometry problems. Rusiyanti et al., (2022) stated that this model helps students relate their real experiences to mathematical symbols, especially in understanding elements such as the radius, diameter, and circumference of a circle. By using relevant contexts and cognitively challenging tasks, students are encouraged to think deeper and develop flexible and effective problem-solving strategies.

Furthermore, Sahara et al., (2023) explained that RME encourages students to build reflective understanding. They do not only memorize formulas, but also understand the origins and meanings of the formulas. In the case of circles, students learn to calculate area and circumference not only as numerical procedures, but also as concepts that arise from exploring circular shapes around them. Thus,

this approach contributes significantly to overcoming learning difficulties that students often experience, while building strong and lasting conceptual understanding.

Based on this background, this study aims to explore the effectiveness of the Realistic Mathematics Education model as a contextual approach in overcoming mathematics learning difficulties, especially on the topic of circles. The focus of the study is not only on improving learning outcomes, but also on how this model can build meaningful understanding through relevant contexts and students' real experiences. The uniqueness of this study lies in the in-depth exploration of the learning process itself, as well as how a contextual approach can transform learning challenges into opportunities for better understanding. This study is expected to provide theoretical and practical contributions to the development of a more effective and humanistic mathematics learning model at the junior high school level.

RESEARCH METHOD

This study uses a Classroom Action Research (CAR) approach designed to improve the mathematics learning process through reflective and collaborative cycles. CAR was chosen because it provides a systematic framework that allows teachers and researchers to identify real problems in the classroom, design and implement instructional solutions, and evaluate the effectiveness of these solutions in real contexts. As explained by Fauziah et al., (2020), the CAR design provides space for pedagogical interventions that can be tailored to students' needs directly, especially through the application of the Indonesian Realistic Mathematics Education (PMRI) model, a local adaptation of the Realistic Mathematics Education (RME) approach.

2.1 Types and Design of Research

The design of this study follows a two-cycle action format, each consisting of four main stages: planning, acting, observing, and reflecting. This model aims to improve students' mathematics learning difficulties gradually and continuously, with an approach that allows for the development of learning solutions that are data-based and oriented towards improving practice. In accordance with the findings of Apsari et al., (2019), the systematic steps in CAR allow for adjustments to be made to the intervention based on accurate observation results and retrospective analysis.

2.2 Research Subjects and Locations

The research was conducted at SMPN SATAP 1 Pringgabaya in the 2023/2024 academic year. The subjects of the study consisted of 13 grade VIII students who were selected based on the results of initial observations that showed high difficulty in understanding the concept of circle geometry. The location was chosen because it was representative of the challenges of learning mathematics in schools with limited resources, and because of the low achievement of learning outcomes on the topic of circles based on the results of previous formative assessments.

2.3 Data Collection Techniques and Procedures

Data was collected through instrument triangulation, namely:

- Student questionnaire, to identify perceptions of learning difficulties and motivation to learn mathematics before and after the intervention.
- Student worksheets (LKS) based on RME, to explore students' thinking processes and problem-solving strategies in relevant contexts.
- Learning outcome evaluation test, to measure students' mastery of basic circle concepts cognitively.
- Observation of teacher and student activities, to record interactions, involvement, and changes in learning behavior in the classroom during the intervention.

According to research by Cahyono et al., (2020), questionnaires and tests were designed to assess students' conceptual understanding in contextual situations that reflect the principles of RME. Meanwhile, LKS were used to facilitate the exploration of mathematical ideas and show students'

thinking patterns when facing real problems. Sari et al., (2020) emphasized that this type of instrument is effective in detecting changes in students' understanding of abstract material.

2.4 Validity and Reliability of Instruments

To ensure validity, each instrument was developed based on learning indicators from the national curriculum and the principles of RME pedagogy. Content validation was carried out through expert testing by two experienced mathematics teachers and one supervisor in the field of research methodology. The reliability of the instrument was tested through limited trials on other students at the same school, and analyzed using the Cronbach Alpha technique for questionnaire instruments and written tests. This refers to the approach of Son et al., (2020), which emphasizes the importance of instrument validity in measuring the influence of learning models on problem-solving abilities.

2.5 Data Analysis Techniques

Data were analyzed using a mixed quantitative and qualitative approach. Quantitative analysis was used to evaluate student learning outcomes based on the percentage of individual and classical learning completion, as well as the average score of the questionnaire and evaluation test. Meanwhile, qualitative analysis was used to interpret observation data and student work results in the LKS, which reflect changes in students' thinking strategies and conceptual understanding. The results of these two approaches are combined to provide a comprehensive understanding of the effectiveness of the RME model in overcoming learning difficulties on the topic of circles.

The first cycle was used to identify students' initial responses to the RME approach and test the planned learning design. Based on the results of the reflection, revisions were made to the learning strategy for the second cycle to improve the effectiveness of the intervention. This process was repeated until real improvements in learning outcomes and a significant reduction in students' difficulty levels were achieved.

RESULTS

3.1 Identification of Student Learning Difficulties (Pre-Cycle)

Before the intervention was carried out, the researcher conducted initial observations of mathematics learning, especially on the circle material in class VIII of SMPN SATAP 1 Pringgabaya. The results of observations and interviews showed that most students had difficulty in understanding the basic concepts of circles such as radius, diameter, circumference, and area. These difficulties were evident from the low participation of students during the teaching and learning process, the lack of ability to answer applicable questions, and the many students who complained that they had difficulty imagining the shape and relationship between elements in a circle. This condition was reinforced by the results of the initial test which showed that only 4 out of 13 students achieved scores above the Minimum Completion Criteria (KKM).

This difficulty is strongly suspected to originate from two main factors: (1) the use of conventional methods that emphasize memorizing formulas without context, and (2) the absence of media or activities that support concrete visualization of concepts. Based on these conditions, the Realistic Mathematics Education (RME) approach was chosen as an intervention strategy in cycle I.

3.2 Student Responses to the RME Model in Cycle I

In cycle I, learning is carried out by applying RME principles such as the use of real-life contexts, group activities, and visual exploration. The material presented includes an introduction to the elements of a circle. Learning activities are designed so that students can identify radii, diameters, and arcs through concrete objects such as bottle caps, plates, and circular images.

The observation results showed that most students began to show interest in learning activities. However, participation was still limited to a few active students. Based on the results of the first cycle formative

evaluation, the average student score reached 62.91 with a classical completion rate of 58.33%. Of the 12 students who took the test, only 7 students achieved a score ≥ KKM. In addition, the results of the learning interest questionnaire showed a percentage of 61.42%, which was categorized as sufficient interest.

Reflection shows that the main obstacle in cycle I was the lack of motivational reinforcement and opportunities for students to reflect on the material. Therefore, in cycle II, the learning strategy was improved by adding group presentation activities and emphasizing the relationship between circle elements in everyday life.

3.3 Strategy Improvement and Attitude Change in Cycle II

In cycle II, the intervention focused on the material of circumference and area of a circle. Learning was carried out through a more explicit contextual approach, for example by calculating the area of a bucket lid, the circumference of a bicycle tire, and using a simulation of measuring a circle using thread. The teacher also provided explicit motivation and involved students more in group discussions and presentations.

The impact of this strategy improvement is significant. The results of the cycle II evaluation showed an increase in the average value to 72.5 with classical completeness reaching 75%. The learning interest questionnaire showed an increase to 79.45%, which is included in the good category. In addition, the results of observations showed an increase in student activity in group activities and courage in expressing opinions.

The final reflection shows that the RME approach successfully overcomes students' main difficulties, namely in understanding the concept of circle geometry contextually and visually. Students are not only able to remember the formulas, but also understand the meaning and application of these concepts in everyday life. This shows that the use of the RME model is effective in developing meaningful mathematical understanding and improving the quality of mathematics learning in class VIII of SMPN SATAP 1 Pringgabaya.

DISCUSSION

The application of the Realistic Mathematics Education (RME) approach in learning mathematics on circle material in class VIII of SMPN SATAP 1 Pringgabaya has a positive impact on students' conceptual understanding abilities, especially in overcoming previously identified learning difficulties. This approach has been proven to be able to change students' learning methods from being passive to being more active, participatory, and reflective. This is in accordance with the main principle of RME which emphasizes the importance of linking mathematical material to students' real-life contexts (Nguyen & Pham, 2023).

Before the intervention, the majority of students had difficulty understanding the basic concepts of circles. They showed difficulty in identifying elements such as radius, diameter, and arc, and were unable to apply the formulas for circumference and area of a circle in real contexts. These results are in line with the findings of Meryansumayeka et al., (2022) which revealed that the lack of visualization skills and connections between abstract concepts and concrete experiences are the main causes of students' low understanding of geometry material.

The implementation of RME in cycle I began to show changes in students' mindsets. Although it has not shown a significant increase in quantitative terms, students' involvement in the learning process began to be seen, especially when they were invited to use concrete objects and context-based activities. As explained by Efriani et al., (2019), context-based activities can help students reconstruct the meaning of mathematical concepts through their own experiences. However, obstacles in students' internal motivation and the lack of opportunities to reflect on the material are factors that hinder the optimization of results in the first cycle.

Reflections from cycle I were used to design more appropriate strategies in cycle II. Improvements were made through strengthening motivation, increasing the use of concrete media, and involving students in group presentations. This approach proved effective, as indicated by the increase in classical learning completion to 75% and the increase in the average score to 72.5. These results support the findings of Rusiyanti et al. (2022) that RME is not only effective in improving learning outcomes but also in building students' conceptual understanding and mathematical communication skills.

The increase in students' interest in learning is also an indicator of the success of this approach. The questionnaire showed a spike from 61.42% to 79.45%, which illustrates how relevant contexts and meaningful activities can build students' emotional involvement in learning. According to Listiawati et al., (2023), learning that involves students' personal contexts is better able to motivate students to be active in the process of mathematical thinking and problem solving.

One of the main strengths of the RME approach is its ability to build bridges between abstract concepts and students' real-world experiences. In the context of circles, this means that students do not simply memorize formulas.πr^2or 2πr, but understand the origin and meaning of the formula through direct exploration of the circular objects around them. This is consistent with Freudenthal's view that mathematics should be studied as a human activity, not simply a collection of mechanistic procedures.

However, the implementation of RME in practice also has challenges. One of them is the limited time and resources, especially in designing contextual activities that are appropriate to the cognitive level of students and local school conditions. In addition, the role of teachers is very important in facilitating the process of student exploration. Teachers must have a strong understanding of the philosophy of RME and skills in managing dynamic classes.

Overall, the results of this study strengthen previous findings that RME is an effective and relevant approach to be applied in mathematics learning, especially in geometry materials such as circles. This approach not only touches on the cognitive aspects, but also the affective and psychomotor aspects of students. Students are invited to think, feel, and act as problem solvers in real and meaningful contexts. Thus, RME not only answers the challenges of learning difficulties experienced by students, but also becomes a way to form a more meaningful and sustainable learning experience.

CONCLUSION

Based on the results of the research that has been conducted, it can be concluded that the application of the Realistic Mathematics Education (RME) model has proven effective in overcoming the difficulties of learning mathematics in class VIII students on the topic of circles at SMPN SATAP 1 Pringgabaya. RME provides a significant contribution in improving students' conceptual understanding through a contextual approach that connects abstract concepts with real experiences. The improvement can be seen from the increase in the average value of student learning outcomes from 62.91 in cycle I to 72.5 in cycle II, as well as the increase in classical completeness from 58.33% to 75%. In addition, students' interest in learning also increased from 61.42% to 79.45%. The application of RME not only helps students understand and remember formulas, but also makes them more active, motivated, and able to explain mathematical concepts reflectively. Thus, the RME model is worthy of being applied more widely in mathematics learning, especially in visual and conceptual materials such as circles.

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