Effectiveness of the Realistic Mathematics Education Approach in Enhancing Seventh-Grade Students' Conceptual Understanding in an Indonesian Madrasah

Siti Habibatul Masruroh, Fikri Apriyono ✉

Abstract: Mathematics instruction in Indonesian junior secondary schools often emphasizes procedures over conceptual understanding, limiting students' ability to apply knowledge in real contexts. This challenge is particularly evident in madrasah settings, where approaches such as Realistic Mathematics Education (RME) are rarely implemented. This study examined the effect of RME on students' conceptual understanding of fractions. Using a quasi-experimental design with non-equivalent control and experimental groups, 50 seventh-grade students at MTs Bustanul Ulum, Jember, participated in a six-week intervention. The experimental group was taught using RME principles, while the control group received conventional instruction. Pre-test and post-test data were analyzed using an independent samples t-test. Findings revealed a significant improvement in the experimental group's conceptual understanding, with post-test scores averaging 82.60 (SD = 5.97) compared with 74.40 (SD = 6.90) in the control group ($p < 0.001$). These results indicate that RME can enhance students' comprehension of mathematical concepts through contextual and student-centered learning. However, given the study's limited scope, further research is needed to confirm these findings and explore their implications for curriculum development and teacher training in Indonesia.

Introduction

The persistent challenge in mathematics education lies in students' inadequate conceptual understanding a foundational competency that supports reasoning, problem-solving, and the progression to advanced mathematical thinking (1, 2). Despite its central role in the curriculum, mathematics remains a difficult subject for many learners, largely because abstract concepts are often taught without meaningful context (3, 4). This difficulty is particularly evident at the junior secondary level, where students frequently struggle to transfer learned procedures to unfamiliar problems, reflecting a lack of deep comprehension (5-7). Data from Indonesia's *Badan Akreditasi Nasional Sekolah/Madrasah* (BAN-S/M, 2023) indicate that only 30–40% of junior secondary students demonstrate adequate mathematical proficiency, underscoring the urgent need for instructional models that promote contextual and meaningful learning (8).

Although various pedagogical innovations have been introduced to enhance mathematics instruction, many approaches continue to emphasize procedural fluency at the expense of conceptual insight (9). Teacher-centered methods often restrict student participation and provide limited opportunities to connect mathematical ideas with real-world experiences (10, 11). The Realistic Mathematics Education (RME) approach, developed in the Netherlands, addresses these shortcomings by situating mathematical learning within authentic contexts that encourage students to construct and reinvent concepts through guided discovery, modeling, and reflection (12, 13). Grounded in socio-constructivist learning theory, RME views knowledge as the result of active engagement and interaction rather than passive reception (14, 15). Recent international studies and meta-analyses have highlighted RME's effectiveness in strengthening conceptual understanding, fostering engagement, and enhancing problem-solving skills across diverse educational settings (16-18).

Despite these promising findings, the implementation of RME in Indonesia remains limited, particularly within *madrasah* institutions and semi-urban contexts. Previous Indonesian studies have predominantly focused on urban or general secondary schools, offering limited insight into how RME functions in more contextually constrained environments. This study seeks to address that gap by examining the effect of the RME model on seventh-grade students' conceptual understanding at MTs Bustanul Ulum Panti, Jember. By situating the research within a *madrasah* context, this study contributes new empirical evidence to the

growing body of literature on context-based mathematics instruction and provides practical implications for curriculum design and teacher professional development in Indonesia.

Methodology

Study Design and Rationale

This study employed a quasi-experimental design with a non-equivalent control group pretest–posttest format to examine the effect of the Realistic Mathematics Education (RME) model on students' conceptual understanding of mathematics. This design was chosen because intact classroom groups could not be randomized due to administrative constraints, while still allowing for comparative analysis between experimental and control conditions. The use of RME is theoretically grounded in constructivist learning principles, emphasizing students' active engagement with meaningful, context-based mathematical problems (19).

Population, Sample Size, and Sampling Criteria

The population comprised all seventh-grade students (N = 127) at MTs Bustanul Ulum Panti, Jember, Indonesia, during the 2021/2022 academic year. A purposive sampling technique was applied to select two classes that were comparable in terms of prior academic achievement and learning conditions. These classes were chosen based on the school's recommendation, considering that their students showed similar average mathematics grades in the previous semester and that both were taught by the same mathematics teacher using similar instructional schedules and resources. This approach ensured a balanced comparison between groups while minimizing teacher-related and environmental differences. Class VII-A (n = 25) was assigned as the experimental group, and Class VII-C (n = 25) as the control group. The total sample of 50 students was considered adequate for detecting medium-to-large effects in educational research, assuming a significance level of 0.05 and a statistical power of 0.80.

Instructional Materials and Instruments

The instructional intervention used a validated learning module designed according to the five key phases of RME: (1) introduction of contextual problems, (2) guided exploration, (3) model construction and concept development, (4) formalization, and (5) reflection and conclusion. The module covered the topic of ratio and proportion, consistent with the Indonesian national mathematics curriculum. Prior to implementation, the participating teacher completed a two-day training workshop on the RME approach, including demonstration lessons, contextual problem design, and guided facilitation practice. Instructional fidelity was maintained through biweekly classroom observations using an RME implementation checklist, which confirmed consistent adherence to the RME framework across sessions.

Conceptual understanding was measured using a researcher-developed test consisting of 15 open-ended items that assessed five indicators: restatement of concepts, classification of objects based on attributes, identification of examples and non-examples, representation of concepts in multiple forms, and application of appropriate procedures. Content validity was established through expert review by three mathematics education specialists, who evaluated each item for relevance to the curriculum, conceptual accuracy, linguistic clarity, and cognitive demand. Revisions were made based on their feedback. Reliability testing using Cronbach's alpha yielded a coefficient of 0.87, indicating high internal consistency.

Procedures

The study lasted four weeks, with each group receiving four 90-minute sessions per week. The control group was taught through conventional teacher-centered methods emphasizing direct instruction and procedural practice. The experimental group, in contrast, received instruction based on the RME model, beginning with contextual problems drawn from students' everyday experiences such as market transactions and travel distance comparisons. Students collaboratively explored these contexts, developed informal models, and gradually abstracted formal mathematical principles under the teacher's guidance.

Pre-tests were administered to both groups before the intervention, and post-tests were conducted immediately after the final session. All assessments were administered under standardized conditions without time limits.

Data analysis

size was calculated using Cohen's d to determine the practical significance of the findings. Data were analyzed using SPSS Version 26. Descriptive statistics (means and standard deviations) were calculated for both groups. Assumptions of normality and homogeneity of variance were tested using the Shapiro-Wilk and Levene's tests, respectively. Independent samples t-tests were performed to compare pre-test and post-test scores between groups, with significance set at p < 0.05. Effect size was calculated using Cohen's d to evaluate the practical significance of the intervention.

Results and Discussion

This study examined the effect of the Realistic Mathematics Education (RME) model on seventh-grade students' conceptual understanding of mathematics. A total of 50 students participated, divided equally into experimental and control groups. Baseline comparison showed no significant difference in pre-test scores between the experimental group (M = 29.00, SD = 6.15) and the control group (M = 27.40, SD = 5.80), confirming comparable initial ability levels.

Following the four-week intervention, both groups showed improvement, but the experimental group achieved notably higher post-test scores (M = 82.60, SD = 7.25) than the control group (M = 74.40, SD = 6.90). An independent samples t-test indicated that this difference was statistically significant ($p < 0.001$), with a large effect size (Cohen's d = 1.20), demonstrating that RME exerted a strong and practically meaningful impact on conceptual understanding

To enhance clarity of the results, **Figure 1** illustrates the comparison of pre-test and post-test mean scores between the two groups. The visualization highlights the substantial gain achieved by students who received RME-based instruction compared to those taught using conventional methods.

Performance analysis across conceptual indicators revealed that students in the experimental group exhibited the greatest gains in restating concepts and applying procedures to novel situations, indicating that RME fostered meaningful transfer of knowledge. Notable improvements
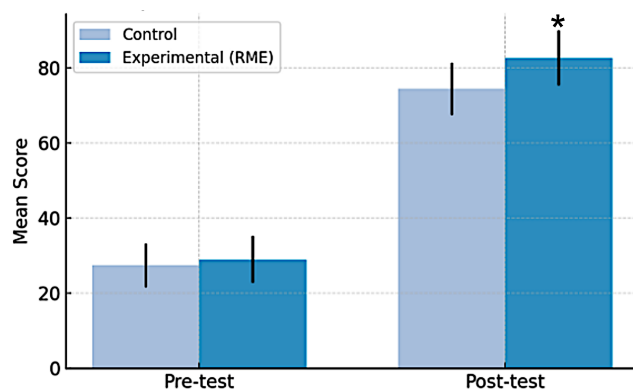
Figure 1. Comparison of pre-test and post-test mean scores for the experimental and control groups. A significant difference in post-test scores was observed between the experimental and control groups (*, p < 0.001; Cohen's d = 1.20).

were also observed in students' ability to classify examples, identify non-examples, and represent mathematical ideas through models or diagrams. These findings suggest that contextualized learning activities in RME effectively bridge abstract reasoning and everyday experience, enabling students to internalize mathematical structures more deeply.

The observed outcomes align with prior quasi-experimental studies conducted in Indonesian schools, such as those by Murni & Harjo (2025) and Putri, Juandi & Turmudi (2024), which reported similar positive effects of RME on students' conceptual understanding in urban contexts (20, 21). However, this study contributes new insight by demonstrating RME's effectiveness in a *madrasah* located in a semi-rural region an educational environment where innovative pedagogical models are rarely adopted. The successful implementation of RME in this faith-based institution underscores its flexibility and cultural adaptability, provided that contextual problems are drawn from students' lived experiences and local realities.

The mechanisms underlying RME's effectiveness can be explained through several pedagogical dimensions. First, RME situates abstract mathematical concepts within authentic, relatable contexts, allowing students to build intuitive understanding before formalization. Second, its emphasis on collaborative exploration supports the social construction of knowledge, consistent with socio-constructivist learning theory. Third, guided reflection helps students consolidate conceptual links and articulate reasoning processes, reinforcing metacognitive awareness and long-term retention.

Beyond the immediate learning outcomes, these results have broader pedagogical implications. Integrating RME principles into teacher professional development can empower educators to design contextually grounded, student-centered learning experiences. At the curriculum level, embedding RME-based activities within national mathematics materials could enhance conceptual depth while maintaining procedural fluency. Moreover, incorporating RME's contextual approach into madrasah education may support the harmonization of academic and moral learning objectives, aligning with holistic educational goals in Indonesia.

Nevertheless, several limitations should be acknowledged. The study involved a relatively small sample from a single institution and focused on one mathematical topic (ratios and proportions). The four-week duration limited the observation of long-term conceptual retention, and the use of one instructor introduced potential teacher-related bias. Future research should therefore include larger and more diverse samples, adopt longitudinal designs to evaluate retention, and explore the integration of RME across different mathematical domains. Investigating digital or blended implementations of RME may also extend its applicability in modern learning environments.

In conclusion, the findings provide strong empirical evidence that the RME model significantly enhances students' conceptual understanding of mathematics and demonstrate its potential for effective application within *madrasah* and other diverse educational settings across Indonesia.

Conclusion

The implementation of the Realistic Mathematics Education (RME) model led to a marked improvement in students' conceptual understanding of mathematics compared to conventional instruction. This outcome demonstrates that contextualized and student-centered learning can effectively support the internalization of abstract mathematical concepts. However, the findings should be interpreted within the study's limited scope one school, a single topic, and a short intervention period. The effectiveness of RME is likely influenced by factors such as teacher preparedness, class size, and the suitability of topics for contextual exploration.

Beyond its immediate results, this study highlights the broader educational value of adopting contextually and culturally responsive pedagogies that connect mathematics to students' lived experiences. Such approaches are particularly relevant for *madrasah* and other under-resourced learning environments, where culturally grounded instruction can foster deeper and more sustainable mathematical understanding.

Declarations

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Conflict of Interest

The authors declare no conflicting interest.

Data Availability

The unpublished data is available upon request to the corresponding author.

Ethics Statement

Not applicable.

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Additional Information

How to Cite

Siti Habibatul Masruroh, Fikri Apriyono. Effectiveness of the Realistic Mathematics Education Approach in Enhancing Seventh-Grade Students' Conceptual Understanding in an Indonesian Madrasah. *Education and Learning*. 2025;1(1):6-9

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