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Effectiveness of RME Model Using Rocket Miniset Manipulatives on Fraction Understanding in Elementary School Students

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ABSTRACT
Understanding the concept of fractions is still a challenge in learning mathematics in elementary schools because of its abstract nature and teaching methods that do not involve students' concrete experiences. This study aims to examine the effectiveness of the Realistic Mathematics Education (RME) model assisted by rocket miniset manipulative media in improving students' understanding of fraction concepts. This study used a mixed methods approach with a quasi-experimental pretest-posttest control group design. The research subjects consisted of 28 fifth grade students of SDN Sabajaya I as the experimental group and 27 students of SDN Sumurlaban II as the control group, which were selected through a purposive sampling technique. The experimental group used RME model learning with rocket miniset media, while the control group used conventional learning. Data were collected through written tests, observations, interviews, and documentation. Quantitative data were analyzed using a paired sample t-test and N-Gain analysis, while qualitative data were analyzed thematically. The results showed a significant increase in the experimental group's posttest score compared to the control group, with a moderate N-Gain category. Qualitative findings showed that students were more enthusiastic, interested, and easier to understand the concept of fractions when using manipulative media. This study concludes that the RME model combined with concrete and contextual media is effective in improving the understanding of fraction concepts and encouraging students' learning motivation in learning. These findings support the importance of real experience-based mathematics learning at the primary school level.
***Keywords**: RME; manipulative media; rocket miniset; fractional comprehension; elementary mathematics learning.*

ABSTRAK
Pemahaman konsep pecahan masih menjadi tantangan dalam pembelajaran matematika di sekolah dasar karena sifatnya yang abstrak dan metode pengajaran yang kurang melibatkan pengalaman konkret siswa. Penelitian ini bertujuan untuk mengkaji efektivitas model *Realistic Mathematics*

Education (RME) berbantuan media manipulatif miniset roket dalam meningkatkan pemahaman konsep pecahan siswa. Penelitian ini menggunakan pendekatan *mixed methods* dengan desain kuasi eksperimen *pretest-posttest control group*. Subjek penelitian terdiri atas 28 siswa kelas V SDN Sabajaya I sebagai kelompok eksperimen dan 27 siswa SDN Sumurlaban II sebagai kelompok kontrol, yang dipilih melalui teknik *purposive sampling*. Kelompok eksperimen menggunakan pembelajaran model RME dengan media miniset roket, sedangkan kelompok kontrol menggunakan pembelajaran konvensional. Data dikumpulkan melalui tes tertulis, observasi, wawancara, dan dokumentasi. Data kuantitatif dianalisis menggunakan uji-t berpasangan (*paired sample t-test*) dan analisis *N-Gain*, sedangkan data kualitatif dianalisis secara tematik. Hasil menunjukkan adanya peningkatan signifikan pada skor posttest kelompok eksperimen dibandingkan kelompok kontrol, dengan kategori *N-Gain* sedang. Temuan kualitatif menunjukkan bahwa siswa lebih antusias, tertarik, dan lebih mudah memahami konsep pecahan saat menggunakan media manipulatif. Penelitian ini menyimpulkan bahwa model RME yang dipadukan dengan media konkret dan kontekstual efektif dalam meningkatkan pemahaman konsep pecahan serta mendorong motivasi belajar siswa dalam pembelajaran. Temuan ini mendukung pentingnya pembelajaran matematika berbasis pengalaman nyata di tingkat sekolah dasar.

Kata Kunci: RME; media manipulatif; miniset roket; pemahaman pecahan; pembelajaran matematika SD.

INTRODUCTION

The comprehension of fractions is a fundamental aspect of mathematical understanding in elementary education and remains a persistent challenge for students globally. Fractions encompass sophisticated concepts such as part-whole relationships, equivalency, and proportional reasoning, which necessitate more than procedural knowledge. However, a review of international studies, including PISA and TIMSS, as well as national assessments such as Indonesia's AKM, reveals a consistent pattern of elementary students encountering difficulties in mastering fraction concepts. This phenomenon is partly attributed to the use of abstract instructional methods that lack practical real-life applications (NCTM, 2014).

Concrete learning experiences are imperative for developing conceptual understanding at the elementary level. In accordance with Piaget's theory of cognitive development, children in the concrete operational stage (typically ages 7–11) demonstrate optimal learning through the tactile manipulation of objects (Woolfolk, 2005). Therefore, the use of manipulative media, such as physical models, is pedagogically appropriate to support students' transition from concrete to abstract thinking. Research by Asoy et al., (2022) confirms that manipulatives significantly enhance fraction comprehension, while Bush (2020) demonstrates the same effect through digital tools. These findings align with Bruner's theory of representation, which suggests that learners develop understanding through enactive, iconic, and symbolic stages (Bruner, 1966).

Realistic Mathematics Education (RME) is based on Freudenthal's constructivist philosophy. It supports the idea that mathematics should be experienced as a human activity that is connected to the real world (Freudenthal, 2006). Research by Nurjamaludin et al., (2021) and Ndiung, (2021) shows that RME is good at helping people solve problems and think more creatively. However, most current literature on the subject looks at RME and manipulative media separately. Umar dan Zakaria (2022) say that we need to combine both, but there aren't many studies on combining RME with specific tools like rocket minisets in fraction learning.

This study tries to fill that gap by exploring how RME can be used with rocket minimanipulatives to help grade V students understand fractions better. The new idea is combining a way of teaching that is based on the context with a medium that is interesting and has a lot of different elements. This medium is specifically designed to support the development of ideas. This approach helps students improve their math skills, feel more motivated, work well with others, and enjoy math. Vygotsky's sociocultural theory says that meaningful learning happens through interaction and tools that help us understand things (Peppler, 2017). This approach has the potential to be beneficial in the long term. It can help students understand and feel more confident in their math skills. It can also help teachers implement a strategy that is in line with the curriculum's goals. With the right training and support, this model can be used in many different classrooms .

In summary, this study addresses the pressing need for meaningful, engaging mathematics instruction by bridging concrete experience and conceptual understanding, particularly in the domain of fraction learning, which is known to be characterized by persistent learning gaps. The findings are expected to contribute both theoretically and practically to elementary mathematics education.

METHODS Type and Design

This research employs a mixed methods approach, integrating quantitative and qualitative methods to achieve a comprehensive understanding of the phenomenon under study. The quantitative approach is used to determine the effectiveness of the Realistic Mathematics Education (RME) learning model based on rocket mini-set manipulative media in improving understanding of fraction concepts. The qualitative approach aims to describe the learning experiences and perceptions of students and teachers during the learning process.

This research design constitutes a quasi-experiment with a pretest-posttest control group design. Two classes were selected for the experimental and control groups, respectively. The experimental group employed the RME model, which was based on rocket mini-set manipulative media, while the control group utilized conventional learning methods. The rationale behind this design is its capacity to objectively and systematically assess the impact of treatment on alterations in student learning outcomes (Hakim et al., 2022; Ardina et al., 2019) as shown in Table 1.

Table 1. The experimental and control group treatment design is outlined as follows

Group	Pretest	Treatment	Posttest
Experiment	O_1	RME Model + Rocket Miniset Media	O_2
Control	O_1	Conventional Method	O_2

Remarks :

O_1 = Prestest

O_2 = Posttest

The instruments utilized in this study encompassed both written tests and observation sheets. The written test was designed based on four main aspects of understanding fractions: (1) identifying part-whole relationships, (2) understanding equivalent fractions, (3) comparing fractions, and (4) ordering fractions. Each aspect is supported by specific indicators. For

example, part-whole understanding is measured through tasks involving the division of shapes or sets. In contrast, comparison tasks involve reasoning using benchmarks or visual models.

Concurrently, the observation sheets concentrated on aspects of student behavior during the learning process, with indicators such as participation, engagement with manipulative media, collaboration in group discussions, and verbal expression of mathematical thinking. These instruments provided qualitative insights into how students interacted with the RME model in practice.

The RME learning protocol was developed based on syntax that refers to the principles of contextual constructivism and realistic models. The learning stages encompass the introduction of a realistic context, the exploration of mathematical models, and the reflection on the process of conceptual understanding. The efficacy of this approach in enhancing problem-solving skills and fostering comprehension of mathematical concepts in elementary school students has been empirically substantiated (Azizah et al., 2025; Rahayu et al., 2021)

Data and Data Sources

The data presented herein are utilized to address the research questions previously formulated, particularly concerning the efficacy of the Realistic Mathematics Education (RME) model, which utilizes rocket miniset manipulative media, in enhancing elementary school students' comprehension of fraction concepts. The research approach that has been selected dictates the type of data that is collected; that is to say, the data collected may be quantitative or qualitative.

Quantitative data was obtained from the results of the pretest and posttest given to both groups (experimental and control). The test questions employed in this study measured the subjects' understanding of fraction concepts before and after the treatment. The test contains questions that focus on various aspects of understanding the concept of fractions, including comparison, addition, and subtraction of fractions.

Qualitative data was obtained through observation, in-depth interviews, and documentation during the learning process. A series of observations were conducted with the objective of assessing students' interaction with the rocket mini-manipulative media and their level of involvement in learning activities. To this end, interviews were conducted with the teacher and a selection of students to ascertain their perceptions of the learning that had been done. Documentation was conducted through the collection of field notes, which recorded significant events that transpired during the learning process.

The data for this study were derived from fifth grade students at two public elementary schools in Karawang Regency, Tirtajaya District. The experimental group was comprised of 28 students from class V SDN Sabajaya I, who received instruction utilizing the Realistic Mathematics Education model, which employed rocket miniset manipulative media. The control group, consisting of 27 students from class V SDN Sumurlaban II, received conventional instruction. The selection of students from two different classes and schools but with comparable academic abilities aims to maintain the internal validity of the research.

In order to facilitate a comprehensive comprehension of the data that has been collected, the subsequent table presents a detailed exposition of the characteristics of the data that has been utilized in the present study, as displayed in Table 2.

Table 2. Characteristics and Analysis of Research Data

Data type	Data source	Data Collection Instruments	Data Analysis Technique
Quantitative	Grade V students from two elementary schools	Pretest and posttest questions	Statistical analysis (t-test)
Qualitative	Students, teachers, class documentation, and field notes	Interview, observation, documentation	Thematic analysis

The following table illustrates the type of data utilized in the research, the data sources from which it was obtained, the instruments employed for data collection, and the data analysis techniques applied. For the purpose of quantifying the data, pretests and posttests are utilized to assess changes in students' comprehension of the concept of fractions. For the purpose of collecting qualitative data, interviews and observations are employed to explore the perceptions and experiences of students and teachers during the learning process. The data obtained will be subjected to statistical analysis, including quantitative data tests and thematic analysis for qualitative data.

Data collection technique

The data collection process for this study involved the implementation of three primary techniques. The efficacy of this intervention was assessed by administering written tests before and after treatment, serving as a pretest and posttest, respectively. These tests were designed to evaluate the students' comprehension of fraction concepts. The observation process was integrated into the learning process to document students' activities and their engagement with the miniset rocket manipulative media. To this end, a series of interviews were conducted with members of the teaching staff and a selection of students. The objective of these interviews was to explore their perceptions of the applied learning. Furthermore, documentation was utilized to record physical evidence of learning activities, including photographs, teacher notes, and student worksheets.

Data analysis

This study employed a concurrent mixed methods approach, in which quantitative and qualitative data were collected and analyzed during the same phase of the research process. This methodological approach facilitated the acquisition of a comprehensive and corroborated understanding of the effectiveness of the Realistic Mathematics Education (RME) model supported by rocket mini-set manipulative media on students' comprehension of fractions.

For the quantitative analysis, the data obtained from the pretest and posttest scores were first cleaned and verified. Descriptive statistics, including mean scores and percentage improvement, were employed to summarize the data. To ascertain whether there were

statistically significant differences between the experimental and control groups, a paired sample t-test was conducted. This test is appropriate for the purpose of comparing two related groups and measuring the effect of an intervention. The relevance and application of this test in educational research have been thoroughly discussed by Talikan (2025).

Furthermore, an N-Gain analysis was conducted to assess the relative learning gains of each student. The N-Gain score was determined by calculating the difference between the posttest and pretest scores, and dividing that by the maximum possible score improvement. The resulting value indicates the extent to which a student's understanding improved relative to their initial ability. These scores were then interpreted using established criteria: low (< 0.3), medium (0.3–0.7), and high (> 0.7) learning gains.

Concurrently, the qualitative analysis was executed through a thematic analysis approach, as delineated by (Kushnir, 2025). The process encompassed six distinct steps: initial engagement with the data, generation of preliminary codes, identification of themes, review of themes, designation of themes, and formulation of a narrative report. This method was employed to analyze students' engagement, responses, and learning behavior, particularly how they interacted with the RME model and manipulative media.

After a thorough examination of the available data, a decision was made to proceed with the integration of both types of data. This decision was made with the objective of producing a holistic understanding. The quantitative results indicated a statistically significant improvement in students' understanding of fractions, while the qualitative findings revealed strong engagement, collaboration, and conceptual clarity. This integration provided empirical evidence supporting the efficacy of contextual and manipulative-based learning models in the field of mathematics education.

RESULTS AND DISCUSSION

Effectiveness of RME Model Based on Manipulative Media Rocket Miniset in Improving Understanding of Fraction Concepts

The objective of this study is to assess the efficacy of the Realistic Mathematics Education (RME) model, as implemented through the use of rocket mini-set manipulative media, in facilitating the comprehension of fraction concepts among elementary school students. To this end, pretests and posttests were administered to the experimental and control groups. The subsequent data set contains the mean results of the pretest and posttest for each group.

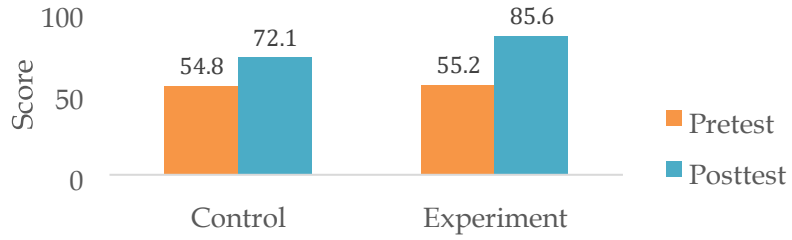

Figure 1. This is a Figure Comparison of pretest…

As demonstrated in figure 1, a quantitative analysis of the data reveals that the mean posttest score of the experimental group (85.60) exceeds that of the control group (72.10). The mean difference in scores between the pretest and posttest in the experimental group was 30.40, while in the control group it was 17.30. Furthermore, the N-Gain value of the experimental group attained 0.68, falling within the medium category, while the control group registered at 0.38, categorizing it as low. The findings indicated that the Realistic Mathematics Education (RME) model, which utilizes rocket miniset manipulative media, was effective in enhancing the comprehension of fraction concepts. The experimental group demonstrated a substantial increase in scores when compared to the control group, as indicated by both the score difference and the N-Gain, which reached the medium category. This finding suggests that interventions employing contextual manipulative media can positively influence student learning outcomes (Aurachman, 2021).

Quantitative findings were obtained through the administration of conceptual understanding assessments of the concept of fractions in two groups (experimental and control) prior to and following treatment. Subsequent to the intervention, a t-test and an NGain analysis were conducted. The findings indicated statistically significant disparities ($p < 0.05$), thereby substantiating the notion that the utilization of manipulatives, such as rocket minisets, fosters effective fraction learning (Tjandra, 2023). The qualitative data were obtained through observation of learning activities, student and teacher interviews, and documentation of the learning process. For instance, during the interviews, some students noted that "fractions are easily conceptualized because of the existence of rockets that can be divided." The instructor further noted that the media facilitated students' ability to "avoid confusion when comparing fractions".

The enhancement in comprehension of the notion of fractions can be attributed to the concrete and contextual nature of the rocket miniset media, which facilitates students' engagement with fractions through visual and kinesthetic means. This approach aligns with the tenets of constructivism, a philosophy that underscores the significance of active engagement in the learning process (Adegboyega et al., 2023; Widiana et al., 2023). Furthermore, the integration of media has been shown to enhance student motivation by offering engaging and pertinent learning experiences (Hidayah et al., 2020).

This finding aligns with the conclusions of previous studies, which have demonstrated that concrete media facilitates the comprehension of mathematical concepts, particularly those pertaining to abstract subjects such as fractions (Farokhah et al., 2024; Fauzan et al., 2024). Research by Zubainur et al., (2020) also demonstrates that the utilization of concrete media exerts a substantial influence on students' mathematical representation skills. Indeed, the RME approach, when employed in conjunction with local or contextual media, has been demonstrated to enhance the efficacy of learning (Romo Vázquez, 2015).

These results contribute to the development of mathematics learning theory in elementary schools by offering reinforcement to the RME model combined with game-based concrete media. This approach broadens the scope of RME implementation, expanding beyond the confines of everyday life and encompassing the engineering of props such as number rockets, which integrate visual, motor, and contextual elements (Umbara & Nuraeni, 2019). This can be used as a basis for modifying the RME model to make it more adaptive to the characteristics of early childhood students.

Student response to learning using the RME model with rocket miniset manipulative media

The ensuing discourse will present the findings of research conducted on the subject of students' responses to learning using the RME model with miniset rocket manipulative media. The research was conducted through the use of observation and interviews. Observations were made during the learning process using a rating scale instrument to assess student response indicators, including enthusiasm, cooperation, interest, and activity. The following table presents the results of the score obtained during the observation conducted in the experimental class as shown in Table 3.

Table 3. Student response score results

Student Response Indicator	Maximum Score	Average Score	Percentage (%)	Category
Enthusiasm	100	86	86%	Very good
Cooperation	100	83	83%	Very good
Interest	100	91	91%	Very good
Activity	100	88	88%	Very good
Liveliness		**87**	**87%**	**Very good**

This text offers a synopsis of the results of student responses, which are based on five observed indicators. These indicators were recorded during the implementation of the RME model with rocket mini-media. The highest mean score was observed in the interest indicator (91%), followed by activity (88%), liveliness (87%), enthusiasm (86%), and cooperation (83%). All available data indicate that students demonstrated robust engagement, active participation, and positive attitudes throughout the learning process, thus falling within the "very good" category. A total of ten students from the experimental group were interviewed, and the thematic results of these interviews are as follows, as shown in Table 4.

Table 4. Thematic results of interviews

Main Theme	Frequency of Occurrence	Relevant Citation
Learning is more fun	9/10 students	"I enjoy learning fractions because the rocket toy is fun."
Easy to understand media	8/10 students	"With the rocket, I can figure out half and quarter fractions faste."
Collaborative	7/10 students	"I can work in groups with my friends and help each other."

Helps understand fractions	10/10 students	"If you just look at a book, you'll be confused, but if you use a rocket, you'll immediately understand."

The findings, derived from both observational studies and interviews, indicate that students respond favorably to the RME model, particularly when it is employed in conjunction with miniset rocket manipulative media for educational purposes. This finding addresses the problem formulation concerning how students respond to RME-based learning supported by concrete tools, which has been proven to increase students' interest, active participation, and understanding of the concept of fractions. The findings were obtained through data triangulation, a methodological approach that combines structured observations with in-depth interviews. This methodological approach ensures data validity by leveraging two distinct yet complementary sources of information.

The students' response to the learning environment was favorable, particularly with regard to the Realistic Mathematics Education (RME) approach, which utilizes concrete media such as rocket minisets. This approach emphasizes direct experience as a crucial component of the learning process. This response is indicative of a profound cognitive and affective engagement in the learning process. This pedagogical approach has been demonstrated to enhance the comprehension of fraction concepts, as evidenced by the research findings of (Imam et al., 2025). Specifically, their study revealed that the utilization of manipulatives significantly augmented the comprehension of fraction operations. Furthermore, (Carbonneau et al., 2023) Using concrete media has been found to significantly influence the development of fundamental mathematical concepts, especially when it helps learners transition from concrete experiences to abstract reasoning. This is consistent with Bruner's theory of representation, which suggests that learners develop a mathematical understanding progressively through enactive, iconic and symbolic stages. Quane, (2024) emphasised that manipulatives are most effective when integrated into structured, concept-driven instruction, rather than being used merely for hands-on or recreational purposes, as this encourages deeper reasoning and meaningful conceptual connections..

The findings of this study corroborate the tenets of constructivism espoused by Piaget, which posits that knowledge is not merely transmitted from the instructor to the students; rather, it is actively constructed by the students themselves through meaningful learning experiences and direct interaction with their environment. In this context, the use of manipulative media, such as rocket minisets, provides opportunities for students to explore mathematical concepts concretely, thereby accelerating the knowledge construction process. This finding is consistent with Jerome Bruner's learning theory, which posits that an effective learning process involves the stages of enactive (action), iconic (image), and symbolic (abstract) representations. In this theory, manipulative media plays an important role in facilitating the transition between these stages. This finding is further corroborated by the research of Widodo et al., (2023) and Fauzan et al., (2024), which demonstrated that the implementation of the contextual approach within the Realistic Mathematics Education (RME) model led to a substantial enhancement in students' literacy and numeracy competencies at the primary school level. Furthermore, Ardiyani & Gunarhadi, (2018) underscored that the integration of RME with cooperative learning strategies fosters an active learning environment, promotes

students' emotional and social engagement, and enhances conceptual comprehension through collaborative efforts and group discussions. Consequently, the implementation of RME, grounded in manipulative media, serves to fortify the theoretical underpinnings of mathematics education while concurrently effecting a tangible enhancement in the quality of student-centered learning.

In light of these findings, a revised theoretical framework may be proposed. This framework posits that the implementation of media-based RME tailored to children's contexts (for instance, rocket minisets) not only fosters the development of mathematical knowledge but also establishes an engaging and collaborative learning environment. The integration of concrete media, such as rockets, into the learning process fosters imagination and profound affection, particularly in the context of mathematics education.

CONCLUSION

The findings of this study indicate that the implementation of the Realistic Mathematics Education (RME) model, supported by rocket mini-set manipulative media, is effective in improving students' understanding of fraction concepts. This assertion is substantiated by substantial enhancements in posttest scores and favorable student responses during the learning process. The findings are consistent with Piaget's theory of cognitive development, which posits that children at the concrete operational stage exhibit an enhanced capacity to comprehend concepts through direct, tangible experiences. The media employed in this study facilitated the transformation of abstract fraction concepts into concrete forms, enabling students to develop a gradual understanding in accordance with Bruner's representation stages: enactive, iconic, and symbolic. In the interest of further research, the model can be explored in other mathematical topics, such as geometry, measurement, or proportional reasoning, in order to assess its broader impact. Furthermore, subsequent studies may investigate the incorporation of digital manipulatives within the framework of RME. This inquiry would align with Vygotsky's sociocultural theory, which underscores the significance of tools in the context of mediated learning. Involving teachers more directly in designing and implementing this model may also provide insights into classroom challenges and support its long-term sustainability. These considerations will contribute to the expansion of the pedagogical reach of RME, rendering mathematics learning more meaningful, contextual, and student-centered.

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