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The Use of Manipulative Media to Improve Elementary School Students' Understanding of Fraction Concepts

Abdul Majid & Syarifuddin
Makassar State University, Indonesia
abdul.majid@unm.ac.id; syarifuddin@unm.ac.id

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Abstract

Although students' understanding of fraction concepts in elementary mathematics has received increasing scholarly attention, research specifically examining the use of manipulative media to improve conceptual understanding in rural primary school contexts remains limited. This study aims to evaluate the effectiveness of manipulative media in enhancing students' understanding of fraction concepts at SDN 38 Bonto Perak, Pangkep Regency. A Classroom Action Research (CAR) design was employed, involving 20 students selected through purposive sampling. Data were collected through achievement tests, observation sheets, and documentation, and analyzed using descriptive quantitative techniques. The findings indicate that the use of manipulative media improved students' conceptual understanding of fractions, as reflected in an increase in the average score from 62 in Cycle I to 82 in Cycle II and an improvement in learning mastery from 45% to 85%. These results suggest that manipulative media can facilitate hands-on and meaningful learning by helping students construct a clearer understanding of abstract fraction concepts. This study contributes to the literature on constructivist learning and elementary mathematics education by providing empirical evidence on the role of manipulative media in strengthening conceptual understanding. Practically, the

findings imply that teachers should integrate manipulative media consistently into classroom instruction to enhance student engagement, conceptual comprehension, and mathematics learning outcomes.

Keywords: Manipulative Media; Fraction Concepts; Conceptual Understanding; Elementary Mathematics; Classroom Action Research

INTRODUCTION

Mathematics learning in elementary school plays a fundamental role in developing students' logical, critical, and systematic thinking skills. One of the essential yet challenging topics for students is the concept of fractions. Fractions are part of rational numbers and serve as a foundation for more advanced mathematical topics, such as algebra and proportional reasoning. However, numerous studies indicate that students' understanding of fractions remains relatively low, not only at the national level but also globally (Zhang et al., 2024). This difficulty is largely due to the abstract nature of fractions, which requires deep conceptual understanding rather than mere procedural knowledge.

In practice, fraction instruction is often delivered using conventional approaches, where teachers emphasize formulas and repetitive exercises without providing meaningful learning experiences. As a result, students tend to memorize procedures rather than truly understand the concept of fractions. This leads to difficulties when students encounter problems in different contexts or require conceptual reasoning. Previous studies have shown that many students struggle to distinguish between numerators and denominators and to interpret fractions as parts of a whole (Irmayanti et al., 2026).

From the perspective of constructivist learning theory, knowledge cannot simply be transferred from teacher to student; instead, it must be actively constructed through meaningful learning experiences. In elementary mathematics education, especially for young learners, the use of concrete learning media is essential to bridge the gap between abstract concepts and students' understanding. Children at the elementary level are typically in the concrete operational stage, meaning they learn best through direct interaction with tangible objects rather than abstract symbols. Therefore, the use of manipulative media becomes a highly relevant strategy to enhance conceptual understanding in mathematics, particularly in learning fractions.

Manipulative media refer to physical tools that students can touch, move, and manipulate to explore mathematical concepts in a concrete way. Examples of such media in fraction learning include fraction strips, fraction circles, and fraction blocks. These tools allow students to visualize and experience fractions as parts of a whole, thereby facilitating deeper conceptual understanding. Research has shown that the use of manipulative media significantly improves students' mathematical understanding and learning outcomes (Al Ayyubi et al., 2025).

Several previous studies have examined the effectiveness of manipulative media in mathematics learning. For instance, Rukono et al. (2025) found that the use of manipulatives such as paper-based fraction models and blocks effectively improved students' achievement in fraction topics. Similarly, Rosalin and Tatang (2024) reported that Montessori-based concrete media enhanced students' conceptual understanding and problem-solving skills in learning fractions. Furthermore, recent innovations such as Smartbox, which integrates manipulative tools with simple technology, have also been shown to increase student engagement and understanding (Rahmawati & Wardana, 2026).

Despite these promising findings, there remains a research gap, particularly in the implementation of manipulative media in specific local contexts such as SDN 38 Bonto Perak, Pangkep Regency. Most previous studies have been conducted in urban settings or have employed experimental designs, while classroom action research focusing on continuous improvement of teaching practices is still limited. Moreover, few studies have specifically explored how manipulative media can enhance students' understanding of fractions through iterative and reflective learning processes across multiple cycles.

The novelty of this study lies in the application of manipulative media within a Classroom Action Research (CAR) framework, which allows for continuous improvement in teaching practices. This study not only evaluates learning outcomes but also examines the learning process, student engagement, and behavioral changes across cycles. In addition, it integrates constructivist learning theory with hands-on learning approaches, contributing to the development of more effective and contextually relevant mathematics instruction.

In the context of elementary education in Indonesia, particularly in Pangkep Regency, this study is highly relevant as it provides practical solutions for teachers to address students' difficulties in understanding fractions. By utilizing simple and accessible manipulative media, teachers can create more engaging, interactive, and meaningful

learning experiences. This approach aligns with current educational demands that emphasize student-centered learning and the development of critical thinking skills.

Based on the above considerations, this study aims to improve elementary school students' understanding of fraction concepts through the use of manipulative media. Specifically, it seeks to examine the improvement in students' learning outcomes, their engagement during the learning process, and the overall effectiveness of manipulative media in enhancing the quality of mathematics instruction at SDN 38 Bonto Perak, Pangkep Regency.

METHODS

This study employed a quantitative approach using Classroom Action Research (CAR) to improve students' understanding of fraction concepts through the use of manipulative media in elementary school. Classroom Action Research is a reflective research approach conducted by teachers in their own classrooms to systematically improve the quality of teaching and learning processes as well as student outcomes (Creswell & Creswell, 2020; Darmadi et al., 2024). CAR was chosen because it provides direct solutions to classroom problems and allows continuous improvement through iterative actions.

The research design followed the CAR cycle model consisting of four main stages: planning, acting, observing, and reflecting. These stages are implemented in a cyclical and repetitive manner until the expected outcomes are achieved. Each stage informs improvements in the subsequent cycle, making the process dynamic and reflective (Wikanta & Sumandya, 2023; Nugroho et al., 2025). In this study, the intervention was conducted in two cycles, with each cycle consisting of two learning sessions.

The participants of this study were 20 fourth-grade students of SDN 38 Bonto Perak, Pangkep Regency, consisting of both male and female students. The participants were selected using purposive sampling, based on the consideration that these students experienced difficulties in understanding fraction concepts (Etikan, 2021). This sampling technique is commonly used in educational research as it allows researchers to focus on specific groups requiring instructional intervention (Sugiyono, 2021).

The research instruments included: (1) achievement tests, used to measure students' understanding of fraction concepts; (2) student observation sheets, to assess students' activity and engagement during the learning process; (3) teacher observation sheets, to

evaluate the implementation of instruction; and (4) documentation, including photographs and field notes of classroom activities. The use of multiple instruments aimed to ensure data validity and comprehensiveness through methodological triangulation (Miles et al., 2020).

Data collection techniques involved tests, observations, and documentation. Tests were administered at the end of each cycle to evaluate improvements in students' learning outcomes. Observations were conducted during the learning process to examine students' engagement and the effectiveness of manipulative media. Documentation served as supporting evidence to strengthen the findings. In CAR, data collection is carried out simultaneously with the implementation of actions to obtain a comprehensive understanding of both the process and outcomes of learning (Rahmawati, 2020; Utomo et al., 2024).

Data analysis in this study employed descriptive quantitative and qualitative methods. Quantitative data from test results were analyzed by calculating the class average score and the percentage of students achieving mastery learning. The minimum mastery criterion (MMC) was set at 75. Meanwhile, qualitative data from observations were analyzed descriptively to illustrate students' activities and the overall learning process. Data analysis was conducted in each cycle to monitor students' progress and evaluate the effectiveness of the implemented actions (Wikanta & Sumandya, 2023).

The success indicators of this study were defined as follows: (1) at least 80% of students achieve mastery learning, (2) there is a consistent improvement in the class average score across cycles, and (3) there is an increase in students' activity and participation during the learning process. These indicators serve as benchmarks to determine the effectiveness of the intervention in Classroom Action Research (Nugroho et al., 2025).

In conclusion, this research method was designed systematically, reflectively, and iteratively to provide a comprehensive understanding of the effectiveness of manipulative media in improving students' conceptual understanding of fractions. The CAR approach enables continuous improvement in instructional practices, thereby contributing to the enhancement of mathematics learning quality in elementary education.

RESULTS

A. Initial Condition (Pre-Action)

To identify students' initial level of understanding of fraction concepts before the implementation of the intervention, a preliminary assessment (pre-test) was conducted. The results of this assessment are summarized in Table 1.

Table 1. Students' Initial Understanding of Fraction Concepts (Pre-Action)

No	Category	Number of Students	Percentage
1	Mastery (≥75)	9	45%
2	Non-Mastery (<75)	11	55%
	Total	**20**	**100%**

Table 1 reveals that students' initial understanding of fraction concepts was still relatively low and had not yet met the expected learning standards. Out of 20 students, only 9 students (45%) achieved the minimum mastery criterion, while the majority, 11 students (55%), failed to reach the required level of competency. This condition indicates that more than half of the students experienced significant difficulties in understanding fundamental fraction concepts.

A closer look at students' performance suggests that these difficulties were related to several aspects, such as identifying the numerator and denominator, interpreting fractions as parts of a whole, and representing fractions in visual or concrete forms. Many students also tended to rely on memorization rather than conceptual understanding, which made it difficult for them to solve problems presented in different contexts. This finding is consistent with common issues in elementary mathematics learning, where abstract concepts are often introduced without sufficient concrete representation.

Furthermore, the low level of mastery observed in Table 1 reflects that the instructional strategies previously used in the classroom were not yet effective in facilitating meaningful learning. The absence of hands-on learning experiences and limited use of instructional media may have contributed to students' lack of engagement and understanding. As a result, students were less active during the learning process and had difficulty constructing their own understanding of the material.

Therefore, the results presented in Table 1 highlight the urgent need for an alternative instructional approach that can bridge the gap between abstract mathematical concepts and students' cognitive development. The use of manipulative media is considered a suitable strategy, as it allows students to interact directly with learning

materials, visualize fraction concepts more clearly, and actively participate in the learning process. This initial condition serves as a strong foundation for implementing improvement actions in the subsequent learning cycles.

B. Results of Cycle I

After the implementation of learning activities using manipulative media in Cycle I, an evaluation was conducted to measure students' improvement in understanding fraction concepts. The results of this assessment are presented in Table 2.

Table 2. Students' Learning Outcomes in Cycle I

No	Category	Number of Students	Percentage
1	Mastery (≥75)	13	65%
2	Non-Mastery (<75)	7	35%
	Total	**20**	**100%**

Table 2 shows that there was a noticeable improvement in students' learning outcomes after the implementation of Cycle I. The number of students who achieved the minimum mastery criterion increased to 13 out of 20 students (65%), while 7 students (35%) still did not meet the required standard. This indicates a positive shift compared to the pre-action condition, where only 45% of students achieved mastery.

The improvement suggests that the use of manipulative media had a beneficial impact on students' understanding of fraction concepts. Through hands-on activities such as using fraction strips and visual models, students were able to better grasp abstract concepts by interacting directly with concrete representations. This approach helped students visualize fractions as parts of a whole and improved their ability to solve related problems.

However, despite the progress, the results in Table 2 also indicate that the learning outcomes had not yet reached the predetermined success indicator of 80% mastery. A significant number of students still faced difficulties, particularly in applying fraction concepts independently and in solving more complex problems. Some students were still dependent on teacher guidance and had not fully developed conceptual understanding.

Additionally, observational data during Cycle I revealed that while student engagement increased, not all students were equally active in the learning process. Some students were still hesitant to participate in discussions or manipulate the learning media effectively. This suggests that further refinement in instructional strategies, classroom management, and guidance is needed.

Therefore, although Table 2 demonstrates an encouraging improvement, it also highlights the need for continued intervention and improvement in Cycle II to achieve optimal learning outcomes and ensure that most students reach the expected level of understanding.

C. Results of Cycle II

After implementing improvements based on the reflection from Cycle I, the learning process was continued in Cycle II using refined strategies and more effective use of manipulative media. At the end of Cycle II, an evaluation was conducted to measure students' understanding of fraction concepts. The results of this evaluation are presented in Table 3.

Table 3. Students' Learning Outcomes in Cycle II

No	Category	Number of Students	Percentage
1	Mastery (≥75)	17	85%
2	Non-Mastery (<75)	3	15%
	Total	**20**	**100%**

Table 3 shows a significant improvement in students' learning outcomes after the implementation of Cycle II. A total of 17 out of 20 students (85%) successfully achieved the minimum mastery criterion, while only 3 students (15%) remained below the expected standard. This result indicates that the predetermined success indicator, which required at least 80% of students to achieve mastery, has been successfully attained.

The substantial increase in mastery level from Cycle I to Cycle II demonstrates the effectiveness of the improved instructional strategies and the consistent use of manipulative media. Students were able to better understand fraction concepts through more structured guidance, clearer explanations, and increased opportunities for hands-on activities. The use of concrete materials allowed students to visualize and internalize abstract concepts, leading to deeper conceptual understanding.

In addition, students showed greater confidence and independence in solving fraction problems. They were more capable of representing fractions, comparing values, and performing basic operations without relying heavily on teacher assistance. This indicates that learning in Cycle II not only improved cognitive outcomes but also supported the development of students' learning autonomy.

However, despite the overall success, a small number of students still did not achieve mastery. This may be due to individual differences in learning abilities, prior

knowledge, or learning pace. These findings suggest that while the intervention was generally effective, additional support or differentiated instruction may be needed for certain students.

Overall, the results presented in Table 3 confirm that the use of manipulative media, combined with improved teaching strategies, is highly effective in enhancing students' understanding of fraction concepts and achieving the desired learning outcomes.

D. Comparison of Learning Outcomes Across Cycles

To provide a comprehensive overview of students' progress throughout the study, a comparison of learning outcomes across all stages—pre-action, Cycle I, and Cycle II—was conducted. This comparison highlights the development of students' understanding of fraction concepts after the implementation of manipulative media in each cycle. The summarized results of this comparison are presented in Table 4.

Table 4. Comparison of Learning Outcomes (Pre-Action, Cycle I, and Cycle II)

Stage	Average Score	Mastery Percentage
Pre-Action	60	45%
Cycle I	70	65%
Cycle II	82	85%

Table 4 presents a comprehensive comparison of students' learning outcomes across the three stages of the study: pre-action, Cycle I, and Cycle II. The data clearly show a consistent and significant improvement in both the average scores and the percentage of students achieving mastery learning at each stage.

In the pre-action stage, the average score was 60, with only 45% of students meeting the minimum mastery criterion. This indicates that students' initial understanding of fraction concepts was relatively low and required instructional improvement. After the implementation of Cycle I, the average score increased to 70, and the mastery percentage rose to 65%. This improvement suggests that the use of manipulative media began to positively influence students' understanding, although the results had not yet reached the predetermined success criteria.

The most significant improvement occurred in Cycle II, where the average score increased to 82, and the mastery percentage reached 85%. This result not only shows a substantial gain in students' conceptual understanding but also indicates that the success indicator of the study had been achieved. The continuous increase from pre-action to Cycle II demonstrates the effectiveness of the implemented intervention.

Furthermore, the data in Table 4 highlight that the use of manipulative media contributed to a gradual and structured improvement in learning outcomes. Students were able to build their understanding step by step through repeated exposure and active engagement in the learning process. This reinforces the importance of using concrete learning tools in teaching abstract mathematical concepts.

Overall, Table 4 confirms that the integration of manipulative media in mathematics instruction is an effective strategy for improving students' understanding of fraction concepts, as evidenced by the steady increase in both performance and mastery levels across the research cycles.

E. Observation Results of Student Activities (Cycle I and Cycle II)

In addition to measuring students' learning outcomes, this study also observed students' activities during the learning process to evaluate their engagement and participation when using manipulative media. The results of student activity observations in Cycle I and Cycle II are presented in Table 5.

Table 5. Student Activity Observation Results

Aspect	Cycle I	Cycle II
Activeness	65%	85%
Participation	60%	82%
Collaboration	62%	80%

Table 5 shows a noticeable improvement in students' learning activities from Cycle I to Cycle II across several observed aspects, including activeness, participation, and collaboration. In Cycle I, students' activeness reached 65%, participation was 60%, and collaboration was 62%. These results indicate that although students began to engage in the learning process, their involvement was not yet optimal.

After improvements were made in Cycle II, student activity increased significantly. Activeness rose to 85%, participation to 82%, and collaboration to 80%. This improvement reflects that students became more confident and actively involved in the learning process. They were more willing to participate in discussions, ask questions, express their ideas, and work together with their peers.

The increase in activity levels suggests that the use of manipulative media created a more interactive and engaging learning environment. Students were not only passive recipients of information but also active participants who explored and constructed their own understanding through hands-on experiences. This aligns with the principles of

student-centered learning, where active involvement plays a key role in achieving meaningful learning outcomes.

Furthermore, the improvement in collaboration indicates that students developed better social and communication skills during group activities. They were able to share ideas, solve problems collectively, and support each other in understanding fraction concepts.

Overall, Table 5 confirms that the use of manipulative media not only improved students' cognitive achievement but also significantly enhanced their engagement and participation in the learning process, making the classroom environment more dynamic and effective.

DISCUSSION

The findings of this study indicate that the use of manipulative media has a significant positive impact on improving elementary school students' understanding of fraction concepts. This improvement is evident across all stages of the study—from the pre-action phase to Cycle I and Cycle II—both in terms of learning outcomes and student engagement. These results suggest that learning approaches involving direct, hands-on experiences through concrete objects are effective in helping students understand abstract mathematical concepts.

From a theoretical perspective, these findings are consistent with constructivist learning theory, which posits that knowledge is actively constructed by learners through interaction with their environment (Creswell & Creswell, 2020). In the context of mathematics learning, particularly fractions, the use of manipulative media allows students to construct their own understanding through direct experiences, such as dividing objects into equal parts or representing fractions visually. This process helps bridge the gap between abstract symbols and concrete understanding, leading to more meaningful learning.

The improvement in learning outcomes from pre-action to Cycle II demonstrates the effectiveness of manipulative media in enhancing students' conceptual understanding. Initially, many students struggled with basic fraction concepts, such as identifying numerators and denominators and interpreting fractions as parts of a whole. However, after the implementation of manipulative-based instruction, there was a significant increase in both average scores and mastery levels. These findings are in line with previous studies

indicating that concrete learning media can significantly improve mathematics achievement and conceptual understanding (Fitriani & Wahyuni, 2022; Lestari & Putra, 2023).

In addition to improving academic performance, the use of manipulative media also enhanced students' engagement and participation in the learning process. Observational data revealed that students became more active, participative, and collaborative during classroom activities. This indicates a shift from teacher-centered instruction to student-centered learning, where students play a more active role in constructing knowledge. This finding supports previous research suggesting that activity-based learning increases student motivation and engagement in mathematics learning (Wahyuni & Hasanah, 2023).

Despite these positive outcomes, the study also identified several challenges. A small number of students did not achieve mastery learning by the end of Cycle II, indicating individual differences in learning abilities. Some students still required additional guidance and more time to fully understand the concepts. Furthermore, during Cycle I, several students were still dependent on teacher assistance and had not yet developed independent learning skills. These findings suggest that while manipulative media are effective, their implementation should be supported by appropriate instructional strategies, such as scaffolding and differentiated instruction.

In terms of implications, this study contributes both theoretically and practically. Theoretically, it reinforces the importance of constructivist approaches in mathematics education, particularly in facilitating the understanding of abstract concepts through concrete experiences. Practically, the findings provide an alternative instructional strategy for teachers to improve the quality of mathematics learning in elementary schools. The use of manipulative media can serve as an effective solution to address students' learning difficulties, especially in abstract topics such as fractions.

However, this study has several limitations. It was conducted in a single class with a relatively small number of participants, which limits the generalizability of the findings. In addition, the study was carried out over only two cycles, which may not fully capture the long-term effects of the intervention. Therefore, future research is recommended to involve a larger sample size, apply different research designs, and examine the long-term impact of manipulative media in mathematics learning.

Overall, the results of this study confirm that the use of manipulative media is an effective strategy for improving students' understanding of fraction concepts. When

implemented appropriately, manipulative media not only enhance academic achievement but also create a more active, interactive, and meaningful learning environment.

CONCLUSION

This study concludes that the use of manipulative media effectively improves elementary school students' understanding of fraction concepts at SDN 38 Bonto Perak, Pangkep Regency. The findings show a consistent and significant improvement in students' learning outcomes from the pre-action stage to Cycle I and Cycle II, as reflected in the increase in average scores and the percentage of students achieving mastery learning. These results indicate that the implementation of manipulative media successfully addressed students' initial difficulties in understanding abstract fraction concepts.

In addition to improving academic achievement, the use of manipulative media also enhanced students' engagement, participation, and collaboration during the learning process. Students became more active and confident in exploring mathematical concepts through hands-on activities, which contributed to a more meaningful and student-centered learning environment.

This study provides both theoretical and practical contributions. Theoretically, it supports constructivist learning theory by demonstrating that students learn more effectively when they actively construct knowledge through concrete experiences. Practically, it offers an alternative instructional strategy for teachers to improve the quality of mathematics teaching, particularly in abstract topics such as fractions.

However, the study is limited by its small sample size and short duration. Therefore, future research is recommended to involve a larger number of participants, apply different research designs, and explore the long-term effectiveness of manipulative media in various educational contexts.

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