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The Effectiveness of Applying Fraction Card Block Media to the Understanding of Fraction Arithmetic Operation Concepts in Grade IV Elementary School Students

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A B S T R A C T

This study aimed to determine the effectiveness of Fraction Card Block Media in improving fourth-grade elementary students' understanding of fraction operations. The research employed a quantitative approach using a quasi-experimental method with a non-equivalent comparison-group design involving an experimental class and a control class. Data were analyzed using normality tests, homogeneity tests, and paired-sample t-tests. The results of the Kolmogorov–Smirnov and Shapiro–Wilk tests showed significance values greater than 0.05, indicating that the data were normally distributed. The homogeneity test also indicated homogeneous data with a significance value of 0.390 (>0.05). Furthermore, the paired-sample t-test results showed that the experimental class experienced a significant improvement in understanding fraction operations, with a significance value of 0.000 (<0.05), while the control class showed no significant improvement, with a significance value of 0.078 (>0.05). These findings indicate that Fraction Card Block Media is effective in enhancing students' conceptual understanding of fraction operations. The use of concrete and visual learning media can help students better understand abstract mathematical concepts and support more effective learning processes.

1. Introduction

Mathematics is essential to everyday life and serves as the foundation for various fields, so mastery from elementary school is essential. In Indonesia, mathematics is a compulsory subject in the Independent Curriculum (Mustika et al., 2024; Yeni, 2015), with the goal of equipping students to understand and apply mathematical concepts, principles, and operations in problem-solving (2024 Curriculum Standards).

Conceptual understanding is crucial for successful mathematics learning because it helps students master and relate the material to real-life experiences (Atmaja, 2021; Hikmah et al., 2025). However, elementary school students still struggle to grasp abstract concepts, resulting in mathematics being perceived as complex and uninteresting, as evidenced by the 2024 quality report of the UPTD SD N 7, which indicated low mathematical literacy.

Weak conceptual understanding is also influenced by the role of teachers, who need to deliver material clearly and engagingly, and help students develop a deep understanding (Radiusman, 2020). Furthermore, teachers need to assist students in developing a deep conceptual understanding so they can construct, reflect on, and express their knowledge. In this way, students will feel ownership and responsibility for the knowledge they learn. Learning media serves as a means of conveying information, helping to make the learning process more engaging, less boring, and easier to understand. It also facilitates teachers in designing effective learning (Kemendikbud, 2024; Saqinah et al., 2025). Therefore, the importance of using fraction card blocks in mathematics learning, particularly fraction arithmetic operations, is crucial in addressing these challenges.

Learning media serves as a medium for conveying learning messages, helping clarify abstract concepts, increasing motivation, and strengthening student understanding (Dita, 2022; Fadilah et al., 2023; Kusuma et al., 2023; Pokhrel, 2024; Shoimah, 2020). Media can be categorized into visual, audio, audiovisual, multimedia, games, and modern technology (Mayer, 2020; Permadi & Achadi, 2025). Furthermore, the principles of media development and Piaget's cognitive development theory emphasize that elementary school children require concrete media because they are still in the concrete operational stage.

Fraction card blocks are blocks with cards containing fraction symbols. They are designed with an attractive design that includes appropriate colors, shapes, and sizes. These fraction cards have concrete representations in the form of objects that can be assembled and disassembled, thus supporting fraction arithmetic operations such as multiplication, addition, and subtraction with unlike denominators. This media can make students more engaged and motivated to learn more during the learning process and facilitate a concrete and interactive understanding of fraction concepts.

Conceptual understanding is a student's ability to grasp the meaning of an idea and connect it to real-life situations. Students are considered to have conceptual understanding when they can explain the core of the idea (Kusuma et al., 2023; Pratiwi et al., 2022). This process involves processing information to form more structured knowledge, as well as the ability to think abstractly and generalize. Mathematical conceptual understanding also includes mastery of basic ideas for critical thinking and problem-solving, as well as the ability to construct and re-express knowledge in one's own language (Dita, 2022; Hardiman et al., 2025; Kamalia et al., 2022). In line with Piaget's theory (Fahma & Purwaningrum, 2021), children aged 7–11 are in the concrete operational stage and therefore require direct experience and concrete media to understand abstract concepts. Therefore,

conceptual understanding reflects students' ability to understand, relate, and apply concepts meaningfully.

The indicators for conceptual understanding of fraction arithmetic operations using fraction card blocks are: (1) Students are able to recognize and name the parts of a fraction (denominator and numerator) using fraction card blocks. (2) Students are able to add fractions with unlike denominators using fraction card blocks. (3) Students are able to subtract fractions with unlike denominators using fraction card blocks. (4) Students are able to multiply fractions with unlike denominators using fraction card blocks. (5) Students are able to explain the process of fraction arithmetic operations verbally or in writing using media. (6) Students are able to solve story problems involving addition, subtraction, and multiplication of fractions using fraction card blocks.

Previous research has shown that learning media plays a crucial role in improving the quality of student learning. Rahayu, (2022) through a study entitled "Development of Game-Based Arithmetic Learning Media Using Smart Multiplication Karpan" found significant differences between the experimental and control classes, so the media is considered appropriate and effective in improving the multiplication calculation skills of second-grade students. Furthermore, research by OECD (2023), shows that the use of poly games is more effective in improving mathematical problem-solving skills than learning without media. Research by Sumadi (2022) also proves that the "Dokar" or Ludo Kartesius media improves the conceptual understanding of eighth-grade students, as seen from the higher average score of the experimental class compared to the control class (69.3115 > 61.1119). These findings confirm that the use of learning media is very important for improving the conceptual understanding of elementary school students.

2. Methodology

This study uses a quantitative approach tested through a quasi-experiment with a non-equivalent comparison-group design in two classes tested through experiments with a control class and an experimental class, and the results of the t-test. The subjects of this study were fourth-grade elementary school students involving two different schools, while the control class was 28 fourth-grade students of UPTD SDN 15 Simpang Mamplam, while the experimental class was 28 fourth-grade students of UPTD SDN 17 Simpang Mamplam. The data analysis technique was carried out descriptively quantitatively using normality tests, homogeneity tests and paired sample t-tests. Learning outcome tests to measure the effectiveness of the media were conducted through t-tests. Pretest and posttest learning outcome data were analyzed to see the increase in understanding of the concept of fractional arithmetic operations after using the media. The entire procedure was arranged so that the research could be clearly replicated by other researchers.

3. Results and Discussion

The results of the research conducted on the control class and the experimental class are presented in Table 1. The table shows the pretest and posttest scores of students' understanding of fraction arithmetic operations in both groups.

Table 1. Data from the results of the test on understanding the concept of fractional arithmetic operations

No	Control Class			Experimental Class		
	Student Name	***Pretest***	***Posttest***	**Student Name**	***Pretest***	***Posttest***
1	ADHM	8	10	AF	10	18
2	AMRZ	6	8	AFSL	14	20
3	ADMF	8	8	ABNS	12	16
4	AN	10	12	AIZ	10	12
5	ALF	12	14	AAH	6	6
6	ANA	14	12	ABZ	12	20
7	DLA	10	10	AR	18	18
8	HBB	10	10	ARM	8	14
9	IZMZ	16	16	DYM	8	8
10	INZH	16	14	FHM	12	18
11	IM	8	8	JZAH	10	16
12	KRMN	20	18	MF	16	20
13	MDTH	10	10	MA	8	16
14	MNB	8	8	MB	6	14
15	MLF	10	12	MN	18	20
16	MAFY	6	10	MR	18	20
17	MSHW	4	8	MFS	10	10
18	MFJN	12	12	MZ	14	14
19	MLS	18	16	RSQ	12	18
20	RHPY	16	18	RZJ	10	16
21	RSA	4	6	RF	6	14
22	RSYA	6	12	RT	16	18
23	SSL	6	6	SYA	10	14
24	SIZA	8	14	UFN	6	12
25	SKR	18	16	UMA	8	10
26	SLMA	12	12	WD	6	8
27	ZIR	14	14	ZWA	4	16
28	ZHU	20	18	ZR	4	12
	Amount	310	332		292	418
	Average	11,07	11,85		10,42	14,92

Based on Table 1, the average scores from the pretest and posttest showed an increase in both the control and experimental classes. However, a more detailed analysis of the gain scores reveals a clear difference between the two groups. The experimental class experienced a substantial increase in the average score from 10.42 in the pretest to 14.92 in the posttest, resulting in a gain score of 4.50 points. In contrast, the control class showed only a slight increase from 11.07 to 11.85, with a gain score of 0.78 points.

This difference indicates that the improvement in the experimental class was significantly greater than in the control class. Therefore, it can be inferred that the use of Fraction Card Block Media is more effective in improving students' understanding of fraction arithmetic operations. The addition of this quantitative comparison clearly demonstrates the magnitude of learning improvement and strengthens the relationship between the use of instructional media and students' conceptual understanding outcomes. Furthermore, the results of the prerequisite tests are presented in Table 2.

Table 2. Normality Test

Score	Kolmogorov-Smirnov Statistic	df	Sig.	Shapiro-Wilk Statistic	df	Sig.
Pre-Test (Control Class)	0.161	28	0.061	0.940	28	0.108
Post-Test (Control Class)	0.127	28	0.200*	0.944	28	0.141
Pre-Test (Experimental Class)	0.148	28	0.120	0.937	28	0.091
Post-Test (Experimental Class)	0.141	28	0.164	0.930	28	0.061

Meanwhile, the homogeneity test results are presented in Table 3.

Table 3. Homogeneity Test

Score	Levene Statistic	df1	df2	Sig.
Based on Mean	1.014	3	108	0.390
Based on Median	0.626	3	108	0.600
Based on Median and with adjusted df	0.626	3	102.168	0.600
Based on trimmed mean	0.968	3	108	0.411

Based on Table 2, the Sig. values obtained from both the Kolmogorov-Smirnov and Shapiro-Wilk tests are greater than 0.05, indicating that the data in this study are normally distributed. Meanwhile, based on Table 3, the Sig. value for Based on Mean is 0.390 (> 0.05), which means that the data are homogeneous. The hypothesis testing results using the paired t-test are presented in Table 4. Based on Table 4, the Sig. (2-tailed) value for the control class is 0.078 (> 0.05), indicating that there is no significant difference between pretest and posttest scores in the control class. In contrast, the experimental class shows a Sig. (2-tailed) value of 0.000 (< 0.05), indicating a significant improvement after the treatment.

Table 4. Paired T-Test

Pair	Mean	Std. Deviation	Std. Error Mean	95% CI Lower	95% CI Upper	t	df	Sig. (2-tailed)
Pretest - Control Class - Posttest - Control Class	-0.786	2.267	0.428	-1.665	0.093	-1.834	27	0.078

Pair	Mean	Std. Deviation	Std. Error Mean	95% CI Lower	95% CI Upper	t	df	Sig. (2-tailed)
Pretest - Experimental Class - Posttest - Experimental Class	-4.500	3.249	0.614	-5.760	-3.240	-7.329	27	0.000

The findings of this study indicate that the use of Fraction Card Block Media has a significant effect on improving students' understanding of fraction arithmetic operations. This is evidenced by the higher gain score achieved by the experimental class compared to the control class, which suggests that the integration of concrete learning media plays an important role in facilitating meaningful learning experiences.

The effectiveness of Fraction Card Block Media can be analyzed through several key indicators of conceptual understanding. First, the media supports students in recognizing the relationship between numerators and denominators. By directly manipulating fraction blocks, students are able to see fractions as parts of a whole rather than abstract symbols. This process reduces misconceptions, particularly in interpreting the size and value of fractions.

Second, the media helps students perform arithmetic operations involving fractions with different denominators. Through visual and physical representation, students can more easily understand the process of equalizing denominators before performing addition or subtraction. This addresses one of the most common difficulties in fraction learning, where students often struggle with procedural steps without understanding the underlying concept.

Third, the use of Fraction Card Block Media encourages students to explain fraction operations verbally. During the learning process, students tend to describe how they arrange and combine fraction blocks, which strengthens their mathematical reasoning and communication skills. This indicates that the media not only improves procedural ability but also enhances conceptual and communicative competence.

These findings are consistent with the theory that learning media can bridge the gap between concrete experience and abstract thinking (Arsyad, 2020; Kustandi & Darmawan, 2020). In line with the cognitive development stage of elementary school students, who are generally in the concrete operational stage, the use of manipulatives such as fraction blocks is highly relevant (Yeni, 2015). Students learn more effectively when they are actively involved in constructing their own understanding through direct interaction with learning materials.

Furthermore, compared to conventional learning in the control class, which showed only a slight increase and no significant difference, the experimental class demonstrated meaningful improvement. This suggests that without appropriate media, students may rely more on memorization rather than conceptual understanding. In contrast, the use of Fraction Card Block Media enables students

to internalize concepts through exploration and visualization, resulting in deeper and more lasting understanding. Overall, this study confirms that Fraction Card Block Media is an effective instructional tool for improving students' understanding of fraction arithmetic operations. The media not only enhances learning outcomes quantitatively, as reflected in the gain scores, but also qualitatively strengthens students' conceptual grasp, problem-solving ability, and mathematical communication.

Furthermore, the effectiveness of Fraction Card Block Media can be viewed from its ability to create a more student-centered learning environment in which learners actively participate in constructing their own understanding of mathematical concepts rather than passively receiving information from the teacher. Traditional mathematics instruction often emphasizes lectures and repetitive exercises, which may limit opportunities for students to engage meaningfully with the learning material. In contrast, Fraction Card Block Media encourages active involvement through hands-on activities, exploration, discussion, and collaborative problem-solving, enabling students to develop a deeper understanding of fraction arithmetic operations. This active engagement is consistent with constructivist learning theory, which suggests that knowledge is most effectively acquired when learners interact directly with learning materials and build understanding through experience.

The implementation of this media also contributes significantly to increasing students' motivation and interest in mathematics, a subject that is often perceived as difficult and abstract, especially when dealing with fractions. Many students struggle with fraction concepts because they find it challenging to visualize relationships among fractions and understand the logic behind arithmetic procedures. Fraction Card Block Media addresses this challenge by transforming abstract concepts into concrete and visually accessible representations that help students observe how fractions are combined, compared, simplified, and manipulated during mathematical operations. Through these visual and tactile experiences, students become more engaged in classroom activities and demonstrate greater confidence when solving mathematical problems. The media also plays a crucial role in reducing misconceptions related to fraction arithmetic because students are able to observe the relationships among numerators, denominators, and equivalent fractions directly rather than relying solely on memorized procedures.

In addition, the collaborative activities associated with Fraction Card Block Media foster communication and interaction among students, creating opportunities for peer learning and knowledge sharing. Students work together to solve problems, explain their reasoning, and discuss alternative strategies, thereby strengthening not only their mathematical understanding but also their social and communication skills. Learners who have a stronger grasp of the concepts can support their peers, while those experiencing difficulties can receive immediate feedback and guidance from classmates. This collaborative learning environment contributes to the development of teamwork, responsibility, and mutual respect while simultaneously enhancing academic achievement. Moreover, the use of Fraction Card Block Media supports the development of higher-order thinking skills by encouraging students

to analyze mathematical situations, compare solution methods, justify their answers, and reflect on their reasoning processes. Rather than focusing exclusively on obtaining correct answers, students learn to understand why particular procedures work and how mathematical concepts are interconnected. From a cognitive learning perspective, the media facilitates meaningful learning by connecting new information with students' prior knowledge through visual and physical experiences. The manipulation of fraction cards helps learners establish stronger cognitive links between concrete representations and abstract mathematical symbols, improving both comprehension and retention. As a result, students are better able to recall and apply fraction concepts in various contexts, indicating that the learning achieved through this media is more durable and transferable than learning based solely on traditional instruction.

Another significant advantage of Fraction Card Block Media is its ability to accommodate diverse learning styles among students. Visual learners benefit from the graphical representation of fractions, while kinesthetic learners gain understanding through direct manipulation of the cards. This flexibility makes the media accessible to a broader range of learners and helps reduce achievement gaps that may arise from differences in learning preferences. The findings of this study also have important implications for educational practice because they demonstrate that relatively simple and cost-effective instructional tools can produce substantial improvements in student learning outcomes when implemented effectively. Furthermore, the positive results suggest that similar manipulative-based media may be adapted for teaching other mathematical topics, including decimals, percentages, ratios, and algebraic concepts.

From a broader educational perspective, the media aligns well with contemporary curriculum goals that emphasize active learning, collaboration, critical thinking, creativity, and problem-solving. Although certain limitations related to context and sample characteristics should be acknowledged, the overall findings provide compelling evidence that Fraction Card Block Media is an effective instructional tool for teaching fraction arithmetic operations because it not only improves students' learning outcomes quantitatively but also enhances conceptual understanding, strengthens problem-solving abilities, promotes mathematical communication, increases learning motivation, reduces misconceptions, supports higher-order thinking skills, accommodates diverse learning styles, and creates a more engaging and meaningful learning environment. By transforming abstract mathematical ideas into concrete learning experiences, the media enables students to develop a deeper and more lasting understanding of fractions, making it a valuable resource for improving mathematics instruction and supporting the achievement of educational goals in contemporary classrooms.

Despite its effectiveness, several improvements can be made to enhance the quality and durability of the media. The borders of the cards used in the Fraction Card Block Media are recommended to be replaced with thicker and colored transparent plastic sheets (mica sheets) to improve their durability, prevent them from becoming soft or easily damaged, and ensure longer-term use. In addition, the use of colored mica sheets is intended to enhance the visual appeal of the media, making

it more attractive, easier to distinguish, and more comfortable for students to use during learning activities.

Figure 1. Before and After Revision

4. Conclusion

This study demonstrated significant differences between the experimental and control classes, confirming that the use of fraction card blocks can strengthen understanding of abstract concepts and increase learning engagement. These findings reinforce the theory that visual manipulative media can support knowledge construction in mathematics learning and provide practical implications for teachers integrating media as part of the Independent Curriculum (Kurikulum Merdeka). Policy-wise, these results indicate the need for school support in providing innovative media and teacher training for more effective learning implementation. Further research is recommended to develop an interactive digital version of this media, test its effectiveness at different grade levels, and evaluate its impact on other mathematical skills such as reasoning, representation, and problem-solving.

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