Primary Education Journal (2025)

Primary Education Journal

Journal homepage: e-journal.unimudasorong.ac.id/index.php/primadona

Optimizing the PADI (Diagram Board) Learning Media to Improve Mathematics Learning Outcomes of Grade III Students at Primary School

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ARTICLE INFO

Received: 23 July 2025
Revised: 11 August 2025
Accepted: 19 September 2025
Published Online: 30 October 2025

Keywords: PADI Learning Media, Diagram Board, Mathematics Learning Outcomes, Fractions, Pre-Experimental.

ABSTRACT

This study aims to determine the effect of the PADI (Diagram Board) learning media on the mathematics learning outcomes of Grade III students at SD Cinta Kasih, Sorong City, particularly on fraction material. A pre-experimental research design with a one-group pretest-posttest design was adopted to obtain objective data. The research sample comprised 22 Grade III students selected through total sampling. Data collection was carried out using multiple-choice pretest and posttest instruments. Data analysis included validity testing, reliability testing, normality testing using the Shapiro-Wilk test (SPSS version 27), and hypothesis testing through the paired sample t-test. Reliability analysis yielded a Cronbach's alpha of 0.679 for the pretest and 0.70 for the posttest, both exceeding the minimum threshold of 0.6. Normality test results showed Shapiro-Wilk significance values of 0.549 and 0.664 for the pretest and posttest, respectively, both greater than 0.05, indicating normal data distribution. Hypothesis testing produced a t-count of 9.988 with degrees of freedom n-1 (22-1 = 21), yielding a t-table of 1.721. Based on a significance level of 0.05 (Sig. = .000 < 0.05), H_2 is accepted and H_1 is rejected, confirming that the PADI (Diagram Board) learning

media has a significant positive effect on the mathematics learning outcomes of Grade III students at SD Cinta Kasih, Sorong City.

How to Cite: Manullang, T. R., Rabia, S. F., & Raharja, E. P. (2025). Optimizing the PADI (Diagram Board) learning media to improve mathematics learning outcomes of grade III students at primary school. *Primary Education Journal, 2*(1), 37-48.

INTRODUCTION

Education is a fundamental right and a cornerstone of human development. Ki Hajar Dewantara, the Father of Indonesian National Education, articulated that education is a necessity that must continue to grow and develop in children; its purpose is to guide all innate capacities within the child so that, as individuals and as members of society, they may achieve the highest possible levels of safety and well-being (Marisyah et al., 2019). Within this framework, schools serve as one of the most critical institutions of formal education, functioning as the primary arena for developing both the competence and character of students. A learning process is considered successful when a teacher has mastered the skills necessary to foster effective instruction within the classroom (Sujana, 2019).

Mathematics occupies a central and indispensable place in the primary school curriculum. The mathematician Carl Friedrich Gauss described mathematics as the queen of all sciences, underscoring its foundational role across all domains of knowledge (Suyitno et al., 2018). Accordingly, the goal of mathematics learning at the elementary school level is to cultivate students' capacity for logical, rational, precise, critical, and efficient thinking and to enable them to apply mathematical reasoning in everyday life and in the study of other disciplines (Bwarnirun & Santoso, 2021). Mathematics learning is a process of teaching and learning constructed by teachers to develop students' creative thinking and enhance their cognitive capacities (Bwarnirun & Santoso, 2021).

The state of mathematics literacy in Indonesia remains a pressing

concern. The Programme for International Student Assessment (PISA) 2022, which assessed approximately 690,000 students from 81 countries, recorded Indonesia's mathematics score at 366 points, placing the country 69th internationally. Indonesia ranked 6th out of 8 ASEAN countries, well below the OECD average of 489 (OECD, 2023). Previous analyses of PISA data for Indonesia from 2000 to 2018 similarly indicated a downward trend in both reading and mathematics literacy, with approximately 72% of Indonesian students performing at Level 1 or below on the six-level PISA mathematics literacy scale (Putrawangsa & Hasanah, 2022). These findings highlight the significant challenge facing Indonesian primary education in raising the quality of mathematics learning outcomes.

Table 1. PISA 2022 Mathematics Results: Selected Rankings

Rank	Country / Economy	Average Score
1	Singapore	559.7
2	Macao (China)	535.0
3	Chinese Taipei	533.0
4	Japan	533.0
5	South Korea	523.3
6	Hong Kong (China)	520.0
7	Estonia	515.7
8	Canada	506.3
9	Ireland	504.0
10	Switzerland	498.0
69	Indonesia	366.0 (Mathematics)
70	Albania	367.3
71	Guatemala	363.7

Source: OECD (2023)

One of the key contributors to students' difficulties in mathematics at the primary level is the limited variation in instructional approaches and the over-reliance on conventional, teacher-centered methods. Observations and interviews conducted at SD Cinta Kasih, Sorong City, revealed that the average mathematics learning outcomes prior to the intervention stood at 76.82, with the lowest score at 65. This outcome reflects a tendency among some teachers to underutilize learning media, which reduces the efficiency and effectiveness of instruction. The use of learning media has been widely recognised as a critical

factor in improving student engagement and comprehension (Nurrita, 2018; Valentina & Wulandari, 2022; Wulandari, 2021).

The PADI (Papan Diagram or Diagram Board) learning media represents a concrete, manipulative tool designed to support the teaching of fraction concepts at the primary school level. Prior research by Komariyah and Pramesti (2021) demonstrated that the use of PADI media had a positive influence on students' mathematics learning interest, with an effect size of 43.2%. Similarly, Listiyaningsih and Febriana (2022) confirmed the effectiveness of fraction board manipulatives in improving learning outcomes. Studies employing concrete and manipulative media in mathematics instruction have consistently demonstrated positive impacts on students' conceptual understanding and achievement, including in the domain of fractions (Kabel et al., 2024; Hs et al., 2023; Suryani et al., 2023). Building on these findings, this study seeks to empirically examine the effect of the PADI (Diagram Board) learning media on the mathematics learning outcomes of Grade III students at SD Cinta Kasih, Sorong City, specifically on fraction material.

METHODS

This study adopted a quantitative approach with a pre-experimental design. The research specifically employed a one-group pretest-posttest design, in which a single group of students was assessed both before and after receiving the treatment, without the inclusion of a control group (Sugiyono, 2012). This design was selected to allow for a direct comparison of students' mathematics learning outcomes before and after the implementation of the PADI (Diagram Board) learning media.

$\mathbf{O_1 \times O_2}$
Where:
$\mathbf{O_1}$: Pretest score (before treatment)
$\mathbf{O_2}$: Posttest score (after treatment)
X : Treatment – PADI (Diagram Board) learning media

Research Sample

The research population comprised all 22 Grade III students at SD Cinta Kasih, Sorong City, during the 2023/2024 academic year. Given the small and manageable population size, total sampling was applied, resulting in all 22 students serving as the research sample (Janna & Herianto, 2021). This approach is consistent with the recommendation that when the total population is fewer than 30 individuals, total sampling is appropriate to ensure comprehensive data coverage.

Instruments and Data Collection

Data collection was carried out through pretest and posttest instruments, each comprising multiple-choice questions on fraction material. The instruments were administered in three phases: preparation, implementation, and data analysis. During the preparation phase, the researcher developed and validated the PADI (Diagram Board) media and the test instruments. During the implementation phase, students completed the pretest prior to exposure to the PADI media, received the instructional treatment using the media, and subsequently completed the posttest. The PADI (Proportional Area Diagram Instrument) is a concrete, visual manipulative tool consisting of a diagram board that supports students' understanding of fraction concepts through interactive and hands-on exploration. The use of concrete media such as PADI aligns with Piaget's constructivist theory of learning, which posits that primary school-age children develop understanding through concrete manipulation and direct experience (as cited in Kabel et al., 2024).

Data Analysis

Data were processed using SPSS version 27. The analytical procedures consisted of (1) validity testing to establish the content and construct validity of the test instruments; (2) reliability testing using Cronbach's Alpha; (3) normality testing using the Shapiro-Wilk test to verify the assumption of normal data distribution; and (4) hypothesis testing using the Paired Sample t-Test to determine the statistical significance of the difference between pretest and posttest scores. The significance level was set at $\alpha = 0.05$.

RESULTS AND DISCUSSION

Descriptive Statistics

Based on the pretest and posttest results on fraction material among the 22 Grade III students, descriptive statistics were computed as presented in Table 2.

Table 2. Descriptive Statistics of Pretest and Posttest Scores

Statistics	Pretest	Posttest
N Valid	22	22
N Missing	0	0
Mean	76.82	88.64
Median	77.50	85.00
Mode	80	85
Std. Deviation	7.799	6.012
Variance	60.823	36.147
Range	25	20
Minimum	65	80
Maximum	90	100
Sum	1690	1950
Percentile 25	70.00	85.00
Percentile 50	77.50	85.00
Percentile 75	81.25	91.25

As shown in Table 3, the pretest scores ranged from a minimum of 65 to a maximum of 90, with a mean of 76.82 and a standard deviation of 7.799. Following the instructional treatment using the PADI (Diagram Board) learning media, the posttest scores improved markedly, with a minimum score of 80 and a maximum of 100, a mean of 88.64, and a standard deviation of 6.012. This represents an improvement of 11.82 mean score points, indicating a substantial positive effect of the PADI learning media intervention on students' mathematics achievement in fraction material.

Reliability Analysis

The reliability of the pretest instrument was assessed using Cronbach's Alpha, yielding a coefficient of 0.679, which exceeds the minimum acceptable threshold of 0.6 (0.679 > 0.6). Similarly, the posttest instrument obtained a Cronbach's alpha of 0.70, also surpassing the threshold (0.70 > 0.6). Both instruments therefore satisfy the reliability requirement and are suitable for use in this study (Janna & Herianto, 2021).

Normality Test

Prior to hypothesis testing, the normality of both the pretest and posttest

Data distributions were assessed using the Shapiro-Wilk test, the results of which are presented in Table 3.

Table 3. Shapiro-Wilk Normality Test Results

Variable	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pretest	0.145	22	.200*	0.963	22	0.549
Posttest	0.135	22	.200*	0.968	22	0.664

The Shapiro-Wilk significance values were 0.549 for the pretest and 0.664 for the posttest, both exceeding the significance threshold of 0.05. These results confirm that both data distributions are normal, satisfying the assumption required for parametric hypothesis testing.

Hypothesis Testing: Paired Sample t-Test

The research hypotheses were formulated as follows: H_0: there is no significant effect of the PADI (Diagram Board) learning media on the mathematics learning outcomes of Grade III students; H_2: there is a significant effect of the PADI (Diagram Board) learning media on the mathematics learning outcomes of Grade III students. The paired sample t-test results are presented in Table 4.

Table 4. Paired Sample t-Test Results (Pretest vs. Posttest)

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Dev.	Std. Err. Mean	95% CI Lower	95% CI Upper			
Pretest – Posttest	-15.227	7.151	1.525	-18.398	-12.057	-9.988	21	.000

The paired sample t-test yielded a t-count of 9.988, with degrees of freedom (df) of 21 (n - 1 = 22 - 1 = 21), and a t-table value of 1.721 at a significance level of 0.05. The two-tailed significance value was .000, which is less than 0.05 (Sig. = .000 < 0.05). As the t-count (9.988) exceeds the t-table (1.721) and the significance level is below the threshold, H_0 is rejected and H_2 is accepted. It is therefore concluded that the use of the PADI (Diagram Board) learning media has a statistically significant positive effect on the mathematics

learning outcomes of Grade III students at SD Cinta Kasih, Sorong City.

Discussion

The findings of this study confirm that the implementation of the PADI (Diagram Board) learning media significantly improved students' mathematics learning outcomes in fraction material. The improvement in mean score from 76.82 (pretest) to 88.64 (posttest) reflects the capacity of the PADI media to foster greater student engagement and conceptual understanding. During the learning process, students demonstrated high levels of enthusiasm and active participation, including asking questions, providing responses, and collaboratively constructing fraction patterns on the diagram board. This interactive quality of the PADI media is consistent with findings by Valentina and Wulandari (2022), who demonstrated that concrete mathematics media serve as effective alternative solutions to help students master mathematical concepts and principles, and by Nurrita (2018), who asserted that the use of learning media stimulates students' curiosity and facilitates comprehension of new material.

The results of this study also align with the findings of Komariyah and Pramesti (2021), who reported a positive effect of PADI media on students' mathematics learning interest, and with Suryani et al. (2023), who confirmed that the use of manipulative concrete objects significantly improves mathematics learning outcomes in fraction material at the elementary school level. Internationally, similar findings have been reported by Kabel et al. (2024), who documented that concrete and virtual manipulatives lead to a statistically significant improvement in fifth-grade students' mathematics achievement (pretest M = 22.71 vs. posttest M = 41.33), and by Hs et al. (2023), whose systematic literature review concluded that visual media consistently demonstrate positive effects on students' fraction comprehension across a range of primary school contexts.

The theoretical basis for these findings is grounded in the principle that primary school-age students require concrete, sensory, and experiential learning to develop abstract mathematical concepts (Mubarokah, 2021). The PADI

(Diagram Board) media provides a tangible and visual representation of fractions, enabling students to transition from concrete manipulation to abstract conceptual understanding. This pedagogical sequence is consistent with established learning theories and reinforces the importance of incorporating manipulative media in primary mathematics instruction. Furthermore, as noted by Helmiati (2013), innovative learning processes are central to effective instruction, and the integration of purpose-built learning media such as PADI constitutes a form of instructional innovation that directly benefits student achievement.

CONCLUSION

This study concludes that the use of the PADI (Diagram Board) learning media has a statistically significant positive effect on the mathematics learning outcomes of Grade III students at SD Cinta Kasih, Sorong City, in the domain of fraction material. The paired-sample t-test produced a t-count of 9.988, exceeding the t-table value of 1.721, with a two-tailed significance of .000, which is less than the 0.05 threshold. Mean scores improved from 76.82 on the pretest to 88.64 on the posttest, representing an improvement of 11.82 points. H_2 is accepted and H_0 is rejected. Students demonstrated heightened enthusiasm, active participation, and improved collaborative skills during the PADI-based learning process, all of which contributed to enhanced cognitive achievement in fraction material. It is recommended that teachers at the elementary school level, particularly in the Sorong region and similar geographically isolated contexts, integrate concrete manipulative media such as PADI into their mathematics instruction to maximize student engagement and learning outcomes. Future research should explore the longitudinal effects of PADI media use, its applicability across different grade levels and mathematical topics, and its potential in technology-enhanced or blended learning environments.

Acknowledgments

The authors express sincere gratitude to the principal, teachers, and Grade

III students of SD Cinta Kasih, Sorong City, for their cooperation and participation in this study. The authors also acknowledge the support of the Department of Primary School Teacher Education (PGSD), Faculty of Language, Social, and Sports Education, Universitas Pendidikan Muhammadiyah (UNIMUDA) Sorong, for institutional guidance throughout the research process.

Declarations

Author Contribution	: T. R. Manullang: Conceptualization, Data Collection, Formal Analysis, Writing - Original Draft; S. F. Rabia: Writing - Review & Editing and Methodology; E. P. Raharja: Validation and Supervision.
Funding Statement	: This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.
Conflict of Interest	: The authors declare no conflict of interest.
Additional Information	: Additional information is available for this paper.

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