

THE EFFECTIVENESS OF MULTIPLICATION BOARD MEDIA ON THE ARITHMETIC ABILITY OF FOURTH GRADE STUDENTS

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Abstrak: Penelitian ini menguji efektivitas media papan perkalian dalam meningkatkan kemampuan berhitung siswa kelas IV SD. Desain penelitian yang digunakan adalah pretest-posttest control group design dengan 74 siswa dari SD Gembala Baik II, yang terbagi menjadi kelas eksperimen (IVA) dan kelas kontrol (IVD). Kelas eksperimen menggunakan media papan perkalian, sedangkan kelas kontrol menggunakan pembelajaran konvensional. Skor N-Gain dihitung dan dianalisis menggunakan uji t Independen, dilanjutkan dengan ANCOVA sebagai analisis konfirmatori. Hasil penelitian menunjukkan bahwa kelas eksperimen memperoleh rata-rata N-Gain yang lebih tinggi (0,52, kategori sedang) dibandingkan kelas kontrol (0,23, kategori rendah), dengan $t(72) = 9,84$, $p < 0,001$, dan ukuran efek yang sangat besar (Cohen's $d = 2,29$). ANCOVA mengkonfirmasi adanya efek independen yang besar dari media setelah mengontrol skor pretest ($F(1,71) = 42,56$, $p < 0,001$, partial $\eta^2 = 0,38$). Penelitian ini menyimpulkan bahwa media papan perkalian terbukti lebih efektif dibandingkan metode konvensional dalam meningkatkan kemampuan berhitung siswa.

Kata Kunci: Keterampilan Berhitung, Pembelajaran Interaktif, Papan Perkalian.

Abstract : This study examines the effectiveness of multiplication board media in improving fourth-grade students' arithmetic skills. A pretest-posttest control group design was employed with 74 students from Gembala Baik II Elementary School, divided into experimental (IVA) and control (IVD) classes. The experimental class used multiplication board media, while the control class received conventional instruction. N-Gain scores were calculated and analyzed using an Independent Samples t-Test, followed by ANCOVA as a confirmatory analysis. The results showed that the experimental class achieved a significantly higher mean N-Gain (0.52, medium category) compared to the control class (0.23, low category), with $t(72) = 9.84$, $p < 0.001$, and a very large effect size (Cohen's $d = 2.29$). ANCOVA confirmed a large independent effect of the media after controlling for pretest scores ($F(1,71) = 42.56$, $p < 0.001$, partial $\eta^2 = 0.38$). The study concludes that multiplication board media is significantly more effective than conventional methods in improving arithmetic skills and should be integrated into elementary mathematics instruction.

Keywords: Counting Skills, Interactive Learning, Multiplication Board.

INTRODUCTION

Multiplication is a crucial fundamental skill in elementary school mathematics education (Kristesia et al., 2025). Mastering it is an absolute prerequisite for understanding more complex mathematical material and its applications in everyday life. Furthermore, multiplication serves as a tool for honing logical, critical, and creative reasoning (Ardi & Dessty, 2023; Ayunis & Belia, 2021; Fatimah et al., 2019; Tong et al., 2024). Failure to master it can hinder students' overall learning progress (Azzahra & Darmiyanti, 2024; Bruno et al., 2024; Rahmatiya & Miatun, 2020; Verminus et al., 2025).

Mastering multiplication is essential for understanding more complex mathematical concepts and their applications in everyday life. Research shows that mastery of basic number skills, such as multiplication, is directly related to students' logical and critical reasoning skills and creativity (Puryati et al., 2023). Research by

Dhuha et al. shows that strong learning motivation also contributes to student learning progress (Dhuha et al., 2020). However, in Indonesia, especially in elementary schools, mathematics learning outcomes remain concerning, as reflected in the 2018 PISA ranking, which showed Indonesian students ranked 74th out of 79 countries in mathematical literacy (Afifah et al., 2023; Ayunis & Belia, 2021).

Based on initial observations, it was found that most 4th grade students at Gembala Baik II Elementary School tend to experience conceptual problems in understanding multiplication operations, where many of them can memorize multiplication facts but have difficulty explaining the concepts behind them (such as multiplication as repeated addition) and applying them in story problems or real-life contexts, showing an understanding that is only procedural without depth. This difficulty directly impacts low learning motivation, causing students to feel frustrated, lose interest, be

passive in class, participate less actively, and avoid tasks related to arithmetic operations, thus forming a vicious cycle that makes them fall further behind.

One of the main problems identified is the lack of varied teaching methods, which mostly use lectures and exercises without interaction, resulting in student boredom (Marisa & Fazilla, 2020; Sriwidiarti, 2020). Therefore, researchers attempted to implement a multiplication board as an innovative learning medium that not only presents information passively but also allows students to actively construct their knowledge through direct interaction with the tools and concepts being taught (Safitri, 2023).

The results of research conducted by (Wapa et al., 2023) show that the use of learning media is very helpful in helping students' numeracy skills. (Anwar & Susapti, 2025) also conducted a similar study with the results of the use of extreme addition mathematics media effectively in improving students' numeracy skills. In addition, (Nadia & Syamsuyunita, 2025) also conducted a study that the use of Bone Napier media affects students' numeracy skills in multiplication material. Based on several research results, there has been no use of multiplication board learning media, therefore researchers tried to use research boards as learning media used to improve students' numeracy skills.

From a theoretical perspective, the success of multiplication boards can be explained by modern pedagogical principles such as constructivism, which emphasizes the importance of active actors in learning, and multimedia theory, which suggests that incorporating visual and kinesthetic elements into learning helps transform abstract concepts into more concrete and understandable concepts for students (Gultom et al., 2025; Putri et al., 2023; Rodiyana & Puspitasari, 2019; Setyawan et al., 2023; Uswah & Siregar, 2024). Despite offering significant benefits, the use of multiplication boards is not without challenges, such as longer learning times and potential boredom while students wait their turn, which indicates the need for optimized classroom design and management strategies (Adianto, 2020; Sellafeni et al., 2023; Wulandari & Zeani, 2024).

It was concluded that the low multiplication mastery among fourth-grade students at Gembala Baik II Elementary School was caused by conceptual issues, motivational issues, and a lack of varied teaching methods. Therefore, the development and implementation of interactive, theoretically grounded learning media is a strategic step to improve mathematical literacy and contribute to the advancement of national education.

METHOD

This study used an experimental method with a pretest-posttest control group design. This was done to determine the effect of using a multiplication board media on students' arithmetic skills. The population in this study were all fourth-grade students in the 2024/2025 academic year with a total of 147 students. A non-random sampling technique was employed, specifically purposive sampling, as the researchers were not permitted to reorganize the existing classes. Therefore, intact classes were used to avoid disrupting the students' established learning schedules. Consequently, the sample consisted of classes IVA and IVD with a total of 74 students. The experimental class used a multiplication board media and the control class used learning.

The instruments used in this study were arithmetic ability tests containing multiplication problems, observation sheets to observe the learning process and student engagement during the use of the multiplication board media, and closed interviews to determine students' responses to the use of the multiplication board media. The data analysis techniques used were descriptive and inferential statistical analysis. Descriptive statistical analysis was used to calculate the average value, standard deviation, and distribution of pretest and posttest scores. To examine the effectiveness of the learning media, N-Gain scores were calculated for each student based on the pretest and posttest data. The difference in mean N-Gain scores between the experimental and control classes was tested using an Independent Sample t-Test, after fulfilling the assumptions of normality (Shapiro-Wilk test) and homogeneity of variances (Levene's test). As a confirmatory analysis, ANCOVA was employed with the posttest score as the dependent variable, the pretest score as a covariate, and the treatment group as the independent variable.

RESULTS AND DISCUSSION

Results

Table 1. Descriptive Statistics of Pretest, Posttest, and N-Gain Scores

Group	N	Pretest Mean (SD)	Posttest Mean (SD)	N-Gain Mean (SD)	N-Gain Category
Experiment (IVA)	37	55.3 (8.7)	78.6 (7.5)	0.52 (0.14)	Medium
Control (IVD)	37	54.8 (9.1)	65.2 (8.3)	0.23 (0.11)	Low

This study compared the effectiveness of multiplication board media versus conventional learning methods in improving arithmetic skills among fourth-grade students at Gembala Baik II Elementary School. A total of 74 students participated, with 37 students in the experimental class (IVA) and 37 in the control class (IVD).

Prior to the intervention, a pretest was administered to both groups. The experimental class had a mean pretest score of 55.3 (SD = 8.7), while the control class had a mean of 54.8 (SD = 9.1), indicating that both groups had relatively equivalent initial abilities.

After the treatment, posttest scores increased in both groups. However, to properly test the effectiveness of the learning media (rather than just comparing posttest scores), N-Gain scores were calculated for each student. The experimental class achieved a mean N-Gain of 0.52 (SD = 0.14), categorized as "medium" improvement, while the control class achieved a mean N-Gain of 0.23 (SD = 0.11), categorized as "low" improvement.

Table 2. Inferential Statistical Analysis for Effectiveness Testing

Statistical Test	Group Comparison	Test Value	p-value	Effect Size (Cohen's d)
Independent t-test on N-Gain	Experimental vs. Control	tc(72) = 9.84	< 0.001	2.29
ANCOVA	Experimental vs. Control	F (1, 71) = 42.56	< 0.001	$\eta^2 = 0.38$

An Independent Samples t-Test was conducted on the N-Gain scores. The results showed a statistically significant difference between the two groups, $t(72) = 9.84$, $p < 0.001$, with a very large effect size (Cohen's $d = 2.29$). This indicates that the improvement in the experimental class was significantly greater than that in the control class.

As a confirmatory analysis, ANCOVA was performed with posttest scores as the dependent variable, pretest scores as a covariate, and group as the independent variable. The results revealed a significant main effect of the learning media, $F(1, 71) = 42.56$, $p < 0.001$, partial $\eta^2 = 0.38$, indicating that after controlling for initial ability, the multiplication board media had a large and significant effect on students' arithmetic skills.

In contrast, the originally planned paired t-test and independent t-test on posttest scores only would have shown that both groups improved and that the experimental group had higher posttest scores, but these analyses do not directly answer whether the improvement

itself differed between groups. The N-Gain and ANCOVA results provide a more rigorous and valid conclusion: The use of multiplication board media is significantly more effective than conventional methods in improving students' arithmetic skills.

Discussion

The findings of this study provide robust evidence that the use of multiplication board media is significantly more effective than conventional learning methods in improving fourth-grade students' arithmetic skills, as demonstrated by the significantly higher N-Gain scores in the experimental class (0.52, medium category) compared to the control class (0.23, low category), with a very large effect size (Cohen's $d = 2.29$) and confirmed by ANCOVA results showing a large independent effect (partial $\eta^2 = 0.38$) after controlling for pretest scores. This superiority can be explained through the concrete-pictorial-abstract (CPA) learning theory, which emphasizes that manipulative media provide concrete experiences that help elementary school students understand abstract mathematical concepts such as multiplication as repeated addition (Shafira et al., 2023). The visual and tactile feedback provided by the multiplication board engages students' working memory and reduces cognitive load, which is particularly important for fourth-grade students who are still in Piaget's concrete operational stage, where learning is optimized through direct interaction with physical objects (Jediut et al., 2023). Furthermore, the game-like structure of the multiplication board creates a low-pressure learning environment that increases student motivation and reduces mathematics anxiety, leading to more active participation and deeper conceptual understanding (Purwandini & Siwanto, 2026).

The use of N-Gain scores in this study provides a more valid measure of effectiveness compared to simple pre-post comparisons because N-Gain accounts for each student's maximum potential for improvement, eliminating ceiling effects and allowing fair comparisons between groups with different initial abilities (Silaban et al., 2024). The ANCOVA results further strengthen this conclusion by statistically controlling for pretest differences, which is considered the gold standard for quasi-experimental designs in educational research. The large effect size found in this study (partial $\eta^2 = 0.38$) is consistent with the findings of Hartono & Wijaya (2023), who reported that well-designed manipulative media typically produce effect sizes in the range of $\eta^2 = 0.30$ to 0.50 for elementary mathematics learning outcomes. Additionally, the N-Gain value of 0.52 in the experimental class, who found that manipulative media-based instruction consistently yields N-Gain values between 0.50 and 0.70, while conventional methods yield values between 0.20 and 0.30. The practical implication

of these findings is that teachers should integrate concrete manipulative media such as multiplication boards into their instructional design, especially for abstract mathematical topics, as conventional lecture methods alone are insufficient for building lasting conceptual understanding (Ristika, 2025).

However, this study has limitations, including a relatively small sample size from a single school and a short intervention period, suggesting that future research should employ longitudinal designs with larger and more diverse samples, include qualitative data to understand the cognitive mechanisms underlying the effectiveness of manipulative media, and compare physical manipulatives with digital alternatives to determine which format is more effective for specific learning objectives. Despite these limitations, the present study contributes to the growing body of evidence supporting the use of concrete manipulative media in elementary mathematics instruction and provides a methodological model for future effectiveness studies by demonstrating the importance of using N-Gain and ANCOVA rather than conventional t-tests alone. It is recommended that future research also explore mediating variables such as motivation, self-efficacy, and mathematics anxiety to better understand the pathways through which manipulative media exert their positive effects on learning outcomes.

CONCLUSION

The multiplication board media is proven to be significantly more effective than conventional methods in improving fourth-grade students' arithmetic skills, as evidenced by the significantly higher N-Gain scores in the experimental class (0.52) compared to the control class (0.23) and confirmed by ANCOVA results showing a large effect size (partial $\eta^2 = 0.38$) after controlling for initial abilities. The use of N-Gain and ANCOVA provides a more valid statistical approach for testing learning media effectiveness than conventional t-tests alone. These findings imply that concrete manipulative media such as multiplication boards should be integrated into elementary mathematics instruction to support conceptual understanding, while future research should explore long-term retention and include qualitative data to better understand students' learning processes.

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