

Effects of Lined Ice Cream Stick Media and Learning Motivation on Elementary Students' Numeracy Skills

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ABSTRACT

This study examined the effects of lined ice cream stick media and learning motivation on elementary students' numeracy skills and their interaction. A quasi-experimental method with a non-equivalent control group design and a 2×2 factorial design was employed. The participants were 54 second-grade students of SDN Klender 12 Pagi, East Jakarta, divided into an experimental group ($n = 27$) taught with lined ice cream stick media and a control group ($n = 27$) taught with conventional finger counting. Data were collected through a numeracy skills test and a learning motivation questionnaire and analyzed using a two-way ANOVA at a significance level of 0.05. The experimental group obtained a higher post-test mean numeracy score (14.00) than the control group (12.00). Lined ice cream stick media had a significant effect on numeracy skills ($F = 5.912$; $p = 0.018$), as did learning motivation ($F = 6.342$; $p = 0.018$), and a significant interaction between the two factors was found ($F = 7.912$; $p = 0.008$), indicating that the effect of the media depended on students' motivation levels. These findings suggest that simple, low-cost concrete media combined with motivation-sustaining strategies can support the development of elementary students' numeracy skills.

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Introduction

Mathematics is a central subject in elementary education because it develops students' ability to reason, calculate, recognize patterns, and solve problems systematically, which forms the foundation of their numeracy skills (Ariska et al., 2025). In Indonesia, the Merdeka Curriculum encourages more engaging and student-centered learning experiences (Nugroho et al., 2025). However, the results of the Programme for

International Student Assessment (PISA) 2022 showed that Indonesian students' mathematics performance remained below the OECD average (OECD, 2023). Students in the lower grades, in particular, require learning experiences that connect abstract mathematical concepts with concrete objects and real-life situations (Tran & Duong, 2023; Yuliani & Kaltsum, 2026).

Numeracy is one of the essential competencies that needs to be developed through elementary mathematics learning. Numeracy is not merely the ability to perform calculations; it also involves understanding numbers, applying mathematical concepts, reasoning, and solving problems in meaningful contexts. Lower-grade students often struggle when concepts are presented only through abstract symbols, because they benefit from concrete experiences that allow them to manipulate and represent mathematical ideas directly. Appropriate learning media and innovative instructional models are therefore important for bridging abstract concepts and students' concrete experiences (Amaliyah, 2021; Maulidiyah et al., 2024). For example, Farda and Amaliyah (2023) reported that cooperative learning assisted by puzzle media produced significantly better mathematics learning outcomes among second-grade students than conventional instruction.

The need to improve numeracy skills was also evident at SDN Klender 12 Pagi. Based on the school's 2024 education report, only 6.67% of students demonstrated numeracy performance above the minimum competency level, while 50% reached the minimum competency level, 36.67% were below it, and 6.67% were far below it. Achievement in the number domain was 45.76%, and the overall numeracy achievement was 56.67%. These figures show that basic calculation skills remained an important instructional concern at the school. Recent research has shown that concrete media combined with appropriate instructional models can improve the numeracy skills of lower-grade elementary students (Nusantoro & Sanoto, 2026).

One potential alternative is the use of lined ice cream stick media, that is, ice cream sticks marked with colored stripes that students can arrange, count, group, and manipulate directly during mathematics learning. Such media are inexpensive, easily accessible, and appropriate for elementary school students. Previous studies have supported the potential of ice cream stick media in early mathematics learning. Fajhriany and Ramadan (2025) developed ice cream stick media based on the Montessori method for arithmetic operations in Grade II and found the media to be highly valid and well received by teachers and students. Nurfajriah et al. (2024) reported an increase in second-grade students' mathematics learning outcomes after the use of ice cream stick counting media, while Muis (2023) found that ice cream sticks helped first-grade students perform addition and subtraction more accurately. Ice cream sticks have also supported multiplication learning (Harsono et al., 2022), early numeracy literacy (Nursyafitri et al., 2025), and early literacy in a quasi-experimental setting (Anggraini et al., 2023).

Learning media, however, may not be the only factor influencing students' numeracy achievement. Learning motivation is another important factor that determines students' engagement and persistence during learning activities. According to self-determination theory, intrinsic and well-internalized forms of motivation sustain students' engagement in learning (Ryan & Deci, 2020), while social cognitive theory emphasizes that motivation and self-efficacy shape students' learning behaviors (Schunk & DiBenedetto, 2020). Engaging and interactive learning media have been reported to enhance elementary students' learning motivation (Lestari et al., 2024; Yusniar et al.,

2026), and colorful ice cream stick media have been found to make students more active and motivated in learning mathematics (Alwi & Wandini, 2023).

Despite these promising findings, most previous studies on ice cream stick media have focused on the development of the media, used one-group pretest–posttest designs, or applied classroom action research, and have examined the media independently of students' learning motivation (Fajhriany & Ramadan, 2025; Harsono et al., 2022; Nurfajriah et al., 2024). Studies that have tested the interaction between learning media and learning motivation remain limited and inconclusive; for example, a recent factorial study in elementary science learning found significant main effects of learning media and learning motivation but no interaction between them (Misliza et al., 2025). To date, no study has simultaneously examined the main effect of lined ice cream stick media, the main effect of learning motivation, and the interaction between these two factors on the numeracy skills of second-grade students.

Therefore, the novelty of this study lies in integrating a simple, low-cost concrete manipulative medium with students' learning motivation within a 2×2 factorial experimental framework. Specifically, this study aimed to (1) determine the effect of lined ice cream stick media on the numeracy skills of second-grade students at SDN Klender 12 Pagi; (2) determine the effect of learning motivation on students' numeracy skills; and (3) determine the interaction between lined ice cream stick media and learning motivation on students' numeracy skills. It was hypothesized that both the learning media and learning motivation would significantly affect students' numeracy skills and that there would be a significant interaction between them.

Method

This study employed a quantitative approach with a quasi-experimental method, using a non-equivalent control group design combined with a 2×2 factorial design (Sugiyono, 2023). The factorial design involved two independent variables, namely learning media (lined ice cream stick media versus conventional finger counting) and learning motivation (high versus low), and one dependent variable, namely numeracy skills. This design allowed both main effects and their interaction to be tested simultaneously (Misliza et al., 2025). The design of the study is presented in Figure 1.

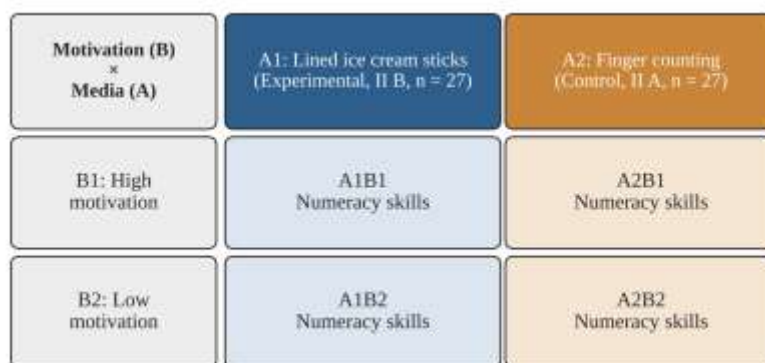


Figure 1. The 2×2 Factorial Research Design

The research was conducted at SDN Klender 12 Pagi, East Jakarta, during the second semester of the 2024/2025 academic year. The participants were 54 second-grade students in two intact classes: Class II B (27 students) was assigned as the experimental

group and received mathematics instruction using lined ice cream stick media, whereas Class II A (27 students) was assigned as the control group and received conventional instruction using finger-counting techniques. Based on their learning motivation questionnaire scores, students in both classes were classified as having high or low learning motivation, resulting in four cells: A1B1, A1B2, A2B1, and A2B2.

Data were collected using a numeracy skills test and a learning motivation questionnaire, both of which were prepared and tried out before being administered to the participants. The data collection procedure consisted of preliminary interviews, preparation of the instruments and learning media, implementation of the learning treatment, administration of the learning motivation questionnaire, and measurement of students' numeracy skills through a post-test. Prior to hypothesis testing, prerequisite analyses were conducted using the Kolmogorov–Smirnov and Shapiro–Wilk normality tests and Levene's test of homogeneity of variance. The hypotheses were then tested using a two-way analysis of variance (two-way ANOVA) at a significance level of 0.05 to determine the effects of learning media, learning motivation, and their interaction on students' numeracy skills (Sugiyono, 2023).

Results and Discussion

The findings indicated that students who learned using lined ice cream stick media achieved better numeracy skills than those who received conventional instruction. The descriptive statistics of the post-test numeracy scores of both groups are presented in Table 1 and Figure 2.

Table 1. Descriptive Statistics of Post-Test Numeracy Scores

Group	N	Mean	SD	Minimum	Maximum
Experimental (lined ice cream stick media)	27	14.00	4.00	10	18
Control (finger counting)	27	12.00	7.00	5	19

Table 1 shows that the experimental group achieved a post-test mean score of 14.00 (SD = 4.00; minimum = 10; maximum = 18), whereas the control group achieved a mean score of 12.00 (SD = 7.00; minimum = 5; maximum = 19). The experimental group thus obtained a higher mean and a smaller spread of scores, indicating more consistent performance (Figure 2).

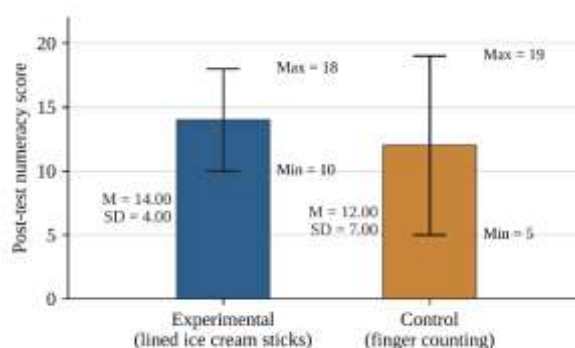


Figure 2. Comparison of Post-Test Numeracy Scores between the Experimental and Control Groups

Before hypothesis testing, a normality test was conducted to determine whether the post-test data of the experimental class were normally distributed. The test used the Kolmogorov–Smirnov and Shapiro–Wilk methods at a significance level of 0.05, and the results are presented in Table 2.

Table 2. Results of the Normality Test of the Experimental Class

Group	Variable	Kolmogorov–Smirnov			Shapiro–Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Experimental	Post-test	0.157	27	0.086	0.937	27	0.103

Based on Table 2, the Kolmogorov–Smirnov statistic was 0.157 with a significance value of 0.086, and the Shapiro–Wilk statistic was 0.937 with a significance value of 0.103. Because both significance values exceeded 0.05 ($0.086 > 0.05$ and $0.103 > 0.05$), the data were considered normally distributed. The homogeneity of variance was then examined using Levene’s test, with the results presented in Table 3.

Table 3. Results of the Homogeneity Test (Levene’s Test) of the Experimental Class

Levene’s Test (Post-test)	Levene Statistic	df1	df2	Sig.
Based on mean	0.395	4	17	0.809
Based on median	0.344	4	17	0.845
Based on median and with adjusted df	0.344	4	11.309	0.843
Based on trimmed mean	0.395	4	17	0.810

Levene’s test based on the mean yielded a significance value of 0.809, which is greater than $\alpha = 0.05$. The tests based on the median, the median with adjusted df, and the trimmed mean likewise produced significance values of 0.845, 0.843, and 0.810, respectively. Therefore, the null hypothesis of equal variances was not rejected, and the data were considered homogeneous. Because the normality and homogeneity assumptions were met, the hypotheses were tested using a two-way ANOVA, with the results presented in Table 4.

Table 4. Results of the Two-Way ANOVA Hypothesis Test (Dependent Variable: Numeracy Skills)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	3236.833	4	66.058	6.746	0.037
Intercept	10497.446	1	10497.446	1072.080	0.000
Learning Media	19.643	1	245.000	5.912	0.018
Learning Motivation	1793.270	1	1793.270	6.342	0.018
Learning Media $\times$ Learning Motivation	0.286	1	0.286	7.912	0.008
Error	39.000	49	9.792		
Total	4000.000	54			
Corrected Total	3256.833	53			

The first hypothesis test produced an F-value of 5.912 for learning media, which was greater than the critical F-value of 4.04 ($p = 0.018 < 0.05$). Therefore, the null hypothesis was rejected, indicating that lined ice cream stick media had a significant effect on students' numeracy skills. The second hypothesis test produced an F-value of 6.342 for learning motivation, which was also greater than 4.04 ($p = 0.018 < 0.05$), indicating a significant effect of learning motivation on numeracy skills. Furthermore, the interaction between learning media and learning motivation produced an F-value of 7.912, which exceeded the critical value of 4.04 ($p = 0.008 < 0.05$), indicating a significant interaction. The comparison of the F-values with the critical F-value is presented in Figure 3.

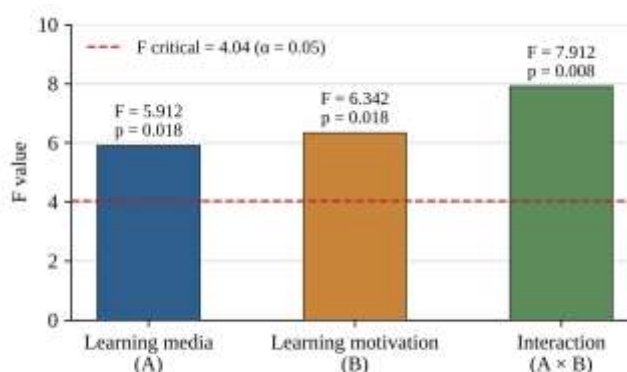


Figure 3. Comparison of the Calculated F-Values with the Critical F-Value

The findings demonstrated that lined ice cream stick media significantly improved the numeracy skills of second-grade students at SDN Klender 12 Pagi. The sticks helped students understand addition and subtraction through concrete objects that could be counted, grouped, and regrouped directly, so that abstract number operations became visible and manipulable. This finding is consistent with previous studies showing that concrete props and ice cream stick media support elementary students' understanding of mathematical operations and improve their learning outcomes (Muis, 2023; Nurfajriah et al., 2024; Tran & Duong, 2023). It also extends earlier development and classroom action studies (Fajhriany & Ramadan, 2025; Harsono et al., 2022; Nusantara & Sanoto, 2026) by providing quasi-experimental evidence with a control group.

Learning motivation was also found to have a significant effect on students' numeracy skills. Highly motivated students tended to show greater persistence and attention when solving numeracy tasks. This result is in line with self-determination theory and social cognitive theory, which emphasize the role of motivation in sustaining engagement and shaping learning behaviors (Ryan & Deci, 2020; Schunk & DiBenedetto, 2020). It is also consistent with studies reporting that concrete, joyful, and interactive learning experiences strengthen elementary students' motivation (Lestari et al., 2024; Yuliani & Kaltsum, 2026; Yusniar et al., 2026).

Furthermore, the study revealed a significant interaction between lined ice cream stick media and learning motivation. This indicates that the effect of the learning media on numeracy skills was not independent of students' motivation level: highly motivated students tended to explore and use the sticks more actively when solving numeracy tasks, whereas students with low motivation showed more limited participation. This finding differs from that of Misliza et al. (2025), who reported significant main effects but no interaction between learning media and motivation in elementary science learning.

Differences in subject matter, grade level, type of media, and sample characteristics may explain this discrepancy.

Practically, lined ice cream sticks can serve as a simple, inexpensive, and accessible learning medium for developing the numeracy skills of lower-grade elementary students, particularly in addition and subtraction. Teachers may combine the media with games, group challenges, and positive feedback so that less motivated students also benefit. Nevertheless, the results should be interpreted with caution because the study involved intact classes from a single school and a relatively small sample.

Conclusion

This study concluded that lined ice cream stick media and learning motivation significantly affected the numeracy skills of second-grade students at SDN Klender 12 Pagi, both individually and through their interaction. Students who learned using the media achieved a higher mean score than those who received conventional finger-counting instruction, students with high learning motivation showed better numeracy skills than those with low motivation, and the significant interaction indicated that the effectiveness of the media was associated with students' motivation levels. The novelty of this study lies in demonstrating the interaction between a simple concrete learning medium and learning motivation in supporting numeracy development among lower-grade elementary students, so that lined ice cream stick media can serve as a practical and accessible alternative for basic numeracy instruction, provided that teachers also foster students' motivation. Future research is recommended to involve larger and more diverse samples and to examine the application of similar concrete media across different mathematical topics, grade levels, and learning contexts.

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Author Contributions

Conceptualization: EL, NA; Methodology: EL, NA, SEP; Formal analysis: EL, SEP; Investigation: EL, NA, SEP; Writing – original draft: EL, NA, SEP; Writing – review & editing: EL, NA, SEP; Supervision: EL, NA.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Use of Artificial Intelligence

The authors used Claude (Anthropic) to assist with language editing, grammar improvement, and the refinement of sentence clarity, including the condensation of the abstract. The AI tool was not used to generate research data, perform statistical analyses, or draw scientific conclusions. All AI-assisted suggestions were carefully reviewed, edited, and verified by the authors, who take full responsibility for the accuracy, originality, and final content of the manuscript.

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