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Strategies for Improving Multiplication Skills Using Stick Manipulatives Among Second-Grade Elementary School Students in Balikpapan

Amalia Nailoe Rahmah*, Ahmad Susanto, Muhamad Sofian Hadi

Universitas Muhammadiyah Jakarta, Jakarta, Indonesia
*amelyasin68@gmail.com

* corresponding author

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ABSTRACT

Multiplication skills are fundamental competencies in elementary mathematics education because they provide an essential foundation for understanding more complex mathematical concepts, including fractions, decimals, and algebra. However, many students in the early grades experience difficulties in understanding multiplication as repeated addition and tend to rely primarily on memorizing multiplication tables. These difficulties may affect students' motivation, self-confidence, and ability to solve contextual problems. This study aimed to examine the effectiveness of using stick manipulatives to improve the multiplication skills of second-grade students in three elementary schools in Balikpapan, representing a public school, a private school, and an Islamic elementary school (Madrasah Ibtidaiyah). The study employed a descriptive qualitative approach, with data collected through pre-tests, post-tests, observations, interviews, and documentation. The findings showed substantial improvement in students' multiplication skills, with mean scores increasing by more than 25 points and the percentage of students achieving the learning mastery criterion rising from 20–33% to 80–90%. Students also demonstrated greater enthusiasm and active participation during the learning process. Teachers reported that stick manipulatives facilitated the explanation of abstract multiplication concepts and promoted a more interactive classroom environment. These findings indicate that stick manipulatives offer a simple, practical, and effective instructional strategy for strengthening students' conceptual understanding of multiplication while fostering more positive attitudes toward mathematics.

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INTRODUCTION

Mathematics is one of the school subjects that plays a strategic role in developing logical, critical, and systematic thinking from an early age. Several studies have emphasized that mastery of mathematics at the elementary level is crucial to students' academic success at subsequent stages of education (Susanto, 2013; Suprihatiningrum, 2016). At the elementary school level, mathematics is not only a subject that students need to master but also a foundation for developing more complex academic skills at higher levels of education. One of the fundamental concepts in mathematics is multiplication. Mastery of multiplication provides an essential foundation for students to

understand more advanced topics, such as division, fractions, decimals, and algebra (Trisnani & Sari, 2020). Moreover, multiplication is closely related to everyday activities, such as calculating the number of items, managing money, and solving simple problems that require numerical skills (Hudojo, 2005). Therefore, students' ability to understand and master multiplication from an early age contributes directly to their future learning success.

Currently, many elementary school students still experience difficulties in understanding the concept of multiplication. These difficulties are not merely a local phenomenon but have also been identified in various mathematics learning contexts across Indonesia (Jarmita, 2015; Rahmawati, 2021). Observations conducted in several schools in Balikpapan indicated that nearly 60% of second-grade students had not yet understood multiplication as repeated addition. Most students tended to memorize multiplication tables without understanding the underlying concepts. Consequently, when confronted with contextual problems, they often became confused and were unable to solve the problems independently. This situation may lead to decreased learning motivation, low self-confidence, and a stronger perception of mathematics as a difficult and intimidating subject. If these difficulties are not adequately addressed, they may negatively affect the development of students' critical thinking and problem-solving skills (Priastuti, 2019; Patmawati, 2021).

Students' difficulties in learning multiplication are closely associated with the continued dominance of conventional teaching methods. Teachers tend to rely on lectures, worked examples, and individual exercises without incorporating concrete learning media that can facilitate students' conceptual understanding. Such practices position students as passive listeners and memorizers rather than active learners who explore mathematical concepts (Sulistyowati, 2014). This issue is further compounded by the limited availability and use of instructional media that can connect abstract concepts with concrete experiences. Without appropriate visualization tools, students may struggle to construct meaningful understandings of multiplication. As a result, mathematics learning can become a mechanical routine rather than a meaningful learning experience (Rostina, 2016; Arsyad, 2016).

To address these challenges, various studies have highlighted the importance of using concrete and interactive learning media. Ruseffendi (2006) stated that manipulatives play an important role in clarifying abstract concepts, while Setiawan et al. (2020) demonstrated that interactive digital media can improve students' motivation and understanding of multiplication. Handayani (2020) also reported that simple manipulatives, such as colored buttons, effectively helped young learners understand multiplication patterns. These empirical findings indicate that both concrete and digital

learning media can bridge the gap between abstract mathematical concepts and students' concrete experiences. In addition, Piaget's (1952) theory suggests that elementary school students are generally in the concrete operational stage of cognitive development. Therefore, manipulating physical objects is particularly relevant to strengthening their conceptual understanding.

One simple yet potentially effective concrete learning medium is the use of sticks or popsicle sticks. By using sticks, students can directly manipulate and group objects according to the multiplication problems presented. These activities provide both visual and kinesthetic learning experiences that can help students understand multiplication as repeated addition (Hartono, 2020). The use of sticks can also facilitate collaborative learning activities. In addition to strengthening cognitive understanding, students can develop social skills such as communication, cooperation, and responsibility through group-based learning.

However, it is important to emphasize that this study goes beyond the claim that sticks can facilitate students' understanding of multiplication, as this benefit has already been reported in previous studies. The novelty of this study lies in its context and implementation strategy. First, the study was conducted in three schools with different institutional backgrounds in Balikpapan, namely a public elementary school, a private elementary school, and an Islamic elementary school (*madrasah ibtidaiyah*). This setting provides a more comprehensive perspective on the effectiveness of stick manipulatives across diverse educational contexts. Second, the study not only examined improvements in learning outcomes through pre-tests and post-tests but also explored students' and teachers' responses through observations and interviews, thereby generating richer and more comprehensive data. Third, the study specifically considers students' learning motivation and engagement, dimensions that have often received limited attention in similar studies. Thus, this study seeks to address a gap in previous research that has predominantly focused on cognitive outcomes by incorporating students' affective and social dimensions into the analysis.

The importance of this study is therefore closely related to ongoing efforts to improve the quality of mathematics instruction in elementary schools. Students need a strong conceptual understanding of multiplication as a foundation for learning more advanced mathematical topics, while teachers require appropriate instructional strategies to present mathematical concepts in engaging, meaningful, and developmentally appropriate ways. Therefore, using stick manipulatives as a strategy for improving multiplication skills warrants further investigation. This study aims to examine the effectiveness of this strategy while offering both theoretical and practical contributions. Theoretically, it seeks to enrich the literature on concrete manipulative-based

mathematics learning. Practically, it offers teachers an alternative strategy for designing creative, innovative, and applicable mathematics learning experiences.

METHOD

This study employed a descriptive qualitative approach to provide an in-depth account of how stick manipulatives can be used as an instructional strategy to improve multiplication skills among second-grade elementary school students. A qualitative approach was selected because it enables the investigation of learning phenomena in their natural settings, emphasizes the researcher's direct engagement with participants, and allows for a richer analysis of students' behaviors, responses, and interactions during the learning process. The participants consisted of second-grade students from three elementary schools with different institutional backgrounds in Balikpapan, namely a public elementary school, a private elementary school, and an Islamic elementary school (*madrasah ibtidaiyah*). These research sites were selected to obtain diverse data and capture multiplication learning practices across different educational contexts.

Data were collected through classroom observations, interviews, written tests, and documentation. Classroom observations were conducted to record students' behaviors, teachers' instructional strategies, and students' engagement in activities involving stick manipulatives. Structured interviews were conducted with teachers and students to explore their experiences during the learning process, including the challenges they encountered and the perceived benefits of using the manipulatives. Written tests were administered to assess students' initial multiplication skills before the intervention and were subsequently compared with their performance after the intervention to identify changes in learning outcomes. Documentation, including students' achievement records, photographs of learning activities, and relevant school documents, was used as supplementary evidence to support the primary findings.

Data were analyzed interactively based on the model proposed by Miles, Huberman, and Saldaña (2014), which comprises three main stages: data condensation, data display, and conclusion drawing. During data condensation, relevant information from observations, interviews, and test results was selected and organized according to the research objectives. To ensure the quality of the measurement instrument, the written test was subjected to expert judgment by the academic supervisor and classroom teachers. Its reliability was also examined using Cronbach's alpha coefficient to determine its internal consistency. The organized data were then presented in narrative descriptions, tables, and figures to facilitate interpretation and further analysis. Finally, conclusions were drawn by relating the empirical findings to the theoretical framework, thereby providing a comprehensive understanding of the effectiveness of stick manipulatives in

improving students' multiplication skills. To enhance the credibility of the findings, data triangulation was conducted by comparing evidence obtained from observations, interviews, and documentation.

Through this methodological approach, the study seeks to provide a comprehensive understanding of the contribution of stick manipulatives to improving elementary school students' multiplication skills. Furthermore, the study aims to generate practical recommendations for teachers and schools in designing mathematics instruction that is more effective, engaging, and appropriate to the cognitive development of elementary school students.

RESULTS AND DISCUSSION

This study was conducted in three elementary schools with different characteristics in Balikpapan, namely SDN 020 Perumnas Balikpapan Utara, SD Muhammadiyah Balikpapan Tengah, and MI Darutta'lim Balikpapan Kota. These schools were selected to ensure that the findings represented mathematics learning across different educational settings, including public, private, and Islamic elementary schools. The primary focus of the study was to examine the effectiveness of stick manipulatives as an instructional strategy for improving multiplication skills among second-grade students. Data were collected through a pre-test, the implementation of stick manipulative-based learning, a post-test, interviews, and classroom observations.

Prior to the implementation of stick manipulatives, students were given a pre-test to assess their initial multiplication skills. The test consisted of basic problems designed to assess students' understanding of multiplication as repeated addition. The pre-test results indicated that most students experienced difficulties both in solving basic multiplication problems and in visualizing the relationships among numbers.

Table 1. Pre-Test Results of Students' Multiplication Skills

School	Mean Score	Number of Students Achieving the Minimum Mastery Criterion (76)	Percentage of Students Achieving Mastery
SDN 020 Perumnas	60	10 out of 30 students	33%
SD Muhammadiyah	50	6 out of 30 students	20%
MI Darutta'lim	50	5 out of 20 students	25%

The table above shows that the percentage of students achieving the minimum mastery criterion was still relatively low. Only approximately one-third of the students at SDN 020, one-fifth at SD Muhammadiyah, and one-quarter at MI Darutta'lim met the

minimum achievement standard. The main difficulty experienced by students was understanding multiplication as repeated addition. Most students relied heavily on memorizing multiplication tables. Consequently, they experienced difficulties when multiplication problems were presented in contextual forms.

After the initial data were collected, instruction was conducted using stick manipulatives. The teacher prepared colored or marked popsicle sticks to help students organize numbers into groups. Students were asked to arrange the sticks according to the multiplication problems presented. For example, was represented by three groups, each consisting of four sticks.

The learning activities were conducted in groups to encourage social interaction and collaboration among students. The teacher acted as a facilitator by providing guidance and ensuring that each student actively participated in the activities. Through this approach, students not only observed the concept of multiplication but also developed a concrete understanding through direct manipulative activities.

During the implementation process, students demonstrated a substantial increase in enthusiasm and active participation. Students who had previously been passive appeared more confident because the manipulatives helped them solve multiplication problems. Teachers also reported that the use of sticks created a more engaging and enjoyable classroom environment compared with the previous learning activities, which tended to be monotonous.

After completing the learning activities using stick manipulatives, students were given a post-test to assess the extent of improvement in their multiplication skills. The post-test results showed a considerable increase in the mean scores across all three schools.

Table 2. Post-Test Results of Students' Multiplication Skills

School	Mean Score	Number of Students Achieving the Minimum Mastery Criterion (76)	Percentage of Students Achieving Mastery
SDN 020 Perumnas	85	27 out of 30 students	90%
SD Muhammadiyah	80	27 out of 30 students	90%
MI Darutta'lim	78	16 out of 20 students	80%

The results presented in the table indicate that students' mean scores increased substantially compared with their pre-test scores. The percentage of students who achieved the Minimum Mastery Criterion (KKM) also increased considerably, reaching 90% at SDN 020 and SD Muhammadiyah and 80% at MI Darutta'lim. These findings

indicate that the use of stick manipulatives was effective in helping students develop a more concrete understanding of multiplication concepts. To provide a clearer illustration of students' improvement, a comparison of the mean pre-test and post-test scores is presented below:

Table 3. Improvement in Mean Pre-Test and Post-Test Scores

School	Mean Pre-Test Score	Mean Post-Test Score	Improvement
SDN 020 Perumnas	60	85	+25
SD Muhammadiyah	50	80	+30
MI Darutta'lim	50	78	+28

The table shows that all three schools experienced an increase of more than 25 points. SD Muhammadiyah recorded the greatest improvement, with an increase of 30 points. This finding suggests that although students initially relied heavily on memorization, the use of stick manipulatives helped bridge the gap between procedural memorization and concrete conceptual understanding.

In addition to the quantitative data, this study collected qualitative information through interviews with students and teachers. The interview findings indicated that most students found multiplication easier to learn with the assistance of stick manipulatives. They reported that the learning activities were more enjoyable because they resembled games. Several students who had previously felt anxious about mathematics also reported greater confidence in attempting multiplication problems after using the manipulatives.

Teachers also responded positively to the use of stick manipulatives. They reported that the manipulatives helped students who experienced difficulties in understanding abstract mathematical concepts. Teachers also perceived the learning process as more interactive because students actively participated in group activities. The main challenge concerned time, as activities involving manipulatives required more instructional time than conventional teaching methods. Nevertheless, teachers considered the benefits to outweigh this limitation.

The findings of this study are consistent with Piaget's theory of cognitive development, which suggests that elementary school students generally operate at the concrete operational stage. At this stage, children understand concepts more effectively through direct experiences and the manipulation of concrete objects than through verbal explanations alone. Stick manipulatives enable students to manipulate physical objects and visualize multiplication as repeated addition, thereby strengthening their conceptual understanding.

Furthermore, the findings support Vygotsky's concept of the Zone of Proximal Development (ZPD), in which students can develop an understanding of more complex concepts with appropriate support from teachers and peers. The integration of stick manipulatives with collaborative group activities enables students to support one another and facilitates the learning process.

These findings are also consistent with previous studies. Handayani (2020) demonstrated that concrete manipulatives in the form of colored buttons significantly improved students' understanding of multiplication. Arsyad and Rahmatullah (2020) emphasized the important role of visual aids in elementary mathematics instruction. The findings of the present study provide further evidence that simple manipulatives, such as popsicle sticks, can serve as an effective alternative for improving students' mathematics learning outcomes.

The practical implication of this study concerns the important role of teachers in designing creative and innovative learning activities. Teachers should not merely deliver mathematical content but also act as facilitators who create engaging and meaningful learning experiences. Such an approach can help students move beyond memorization toward a deeper conceptual understanding of multiplication.

CONCLUSION

Based on the findings from the three elementary schools in Balikpapan, it can be concluded that the use of stick manipulatives is an effective strategy for improving multiplication skills among second-grade students. Prior to the implementation of this strategy, the pre-test results indicated that most students had not yet developed an adequate understanding of multiplication as repeated addition. They tended to rely on memorizing multiplication tables without fully understanding the underlying concepts. This condition was associated with low learning motivation, limited self-confidence, and difficulties in solving contextual problems. Following the implementation of learning activities using stick manipulatives, however, substantial improvements were observed in students' conceptual understanding, engagement, and learning outcomes.

Quantitatively, students' mean post-test scores increased by more than 25 points across all three schools, while the percentage of students achieving the minimum mastery criterion increased from approximately 20–33% at the pre-test stage to 80–90% after the intervention. These findings indicate that concrete manipulatives can help students construct visual and kinesthetic representations of abstract mathematical concepts. Consequently, multiplication is no longer perceived merely as a process of mechanical memorization but as a concrete and meaningful learning experience. Students were able to manipulate the sticks to represent multiplication patterns, such as arranging sticks into

groups according to given numbers, which made the concept of repeated addition easier to understand. The interview findings further revealed that students felt more enthusiastic, confident, and interested in learning mathematics because the activities provided an enjoyable, game-like learning experience.

From the teachers' perspective, stick manipulatives not only facilitated the explanation of multiplication concepts but also promoted a more interactive classroom environment. Teachers were able to observe students' participation more directly, while students became more actively involved in group discussions and learning activities. Although the use of manipulatives required more instructional time than conventional teaching methods, teachers perceived that the benefits outweighed this limitation because the activities supported both students' conceptual understanding and social skills. These findings are consistent with Piaget's theory, which emphasizes the importance of concrete experiences during the concrete operational stage, as well as Vygotsky's theory concerning the role of social interaction in facilitating learning.

From a practical perspective, this study suggests that teachers should consider incorporating simple manipulatives, such as sticks, into mathematics instruction in the early grades. Schools should also support the availability of appropriate learning materials and provide opportunities for teachers to develop innovative instructional practices. Furthermore, these findings may provide a foundation for future studies investigating the use of similar manipulatives in other mathematical topics, such as division, fractions, and geometry. Thus, concrete manipulative-based learning strategies have the potential not only to improve students' academic achievement but also to foster self-confidence, intrinsic motivation, and positive attitudes toward mathematics from an early age.

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