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THE EFFECTIVENESS OF JARIMATIKA AND MNEMONIC STRATEGIES IN IMPROVING STUDENTS' INTEGER MULTIPLICATION SKILLS

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ABSTRACT
This study focuses on seventh-grade students at a junior high school in West Java who had not yet mastered integer multiplication skills, although these skills are expected to be acquired in Phase C of elementary education. The study aimed to analyze the effectiveness of Jarimatika and mnemonic strategies in improving integer multiplication skills. Jarimatika emphasizes the use of fingers as concrete representations, whereas the mnemonic strategy focuses on memory reinforcement through association and repetition. This study employed a mixed methods sequential explanatory design, in which quantitative data from pretests and posttests were followed by qualitative data from interviews, observations, and students' worksheets. The participants were 71 seventh-grade students from two intact classes selected through cluster random sampling, with each class receiving a different instructional strategy. Multiplication skills were measured based on accuracy and speed. The results showed that both strategies effectively improved students' skills, with Cohen's d values of 0.48 for Jarimatika and 0.52 for the mnemonic strategy, both indicating medium effect sizes. ANCOVA results, controlling for pretest scores as a covariate, showed no significant difference between the two strategies ($p = 0.541 > 0.05$). Interviews and observations identified three contributing factors: the use of fingers as visual and kinesthetic support, the use of songs and the SaKaTa phrase, and the learning environment. These findings suggest that both strategies are effective alternatives for teaching integer multiplication at the junior high school level.
Keywords: jarimatika; mixed methods; mnemonic; multiplication skills.

ABSTRAK
Studi ini berfokus pada peserta didik kelas VII di salah satu SMP di Jawa Barat yang belum menguasai keterampilan operasi perkalian bilangan bulat, padahal keterampilan tersebut seharusnya telah dikuasai pada fase C sekolah dasar. Penelitian ini bertujuan menganalisis efektivitas strategi jarimatika dan mnemonik dalam meningkatkan keterampilan operasi perkalian bilangan bulat. Jarimatika menekankan penggunaan jari sebagai representasi konkret, sedangkan mnemonik menekankan penguatan daya ingat melalui asosiasi dan pengulangan. Penelitian menggunakan metode campuran dengan desain sequential explanatory, yaitu pengumpulan data kuantitatif melalui pretest dan posttest yang dilanjutkan dengan data kualitatif melalui wawancara, observasi, dan lembar kerja peserta didik. Subjek penelitian terdiri atas 71 peserta didik kelas VII dari dua kelas utuh yang dipilih melalui cluster random sampling, dengan masing-masing kelas memperoleh strategi pembelajaran yang berbeda. Keterampilan perkalian diukur berdasarkan ketepatan dan kecepatan. Hasil penelitian menunjukkan bahwa kedua strategi efektif meningkatkan keterampilan peserta didik dengan nilai effect size Cohen sebesar d = 0,48 pada jarimatika dan d = 0.52 pada mnemonik, yang keduanya berada pada kategori sedang. Hasil ANCOVA dengan mengontrol kemampuan awal sebagai kovariat menunjukkan tidak terdapat perbedaan yang signifikan antara kedua strategi (p = 0.541 > 0.05). Wawancara dan observasi mengungkap tiga faktor yang berkontribusi terhadap efektivitas strategi, yaitu penggunaan jari sebagai alat bantu visual dan kinestetik, penggunaan lagu dan frasa SaKaTa, serta lingkungan

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belajar. Temuan ini menunjukkan bahwa strategi jarimatika dan mnemonik dapat digunakan sebagai alternatif pembelajaran yang efektif untuk meningkatkan keterampilan operasi perkalian bilangan bulat di SMP.
***Kata kunci**: jarimatika; keterampilan perkalian; metode campuran; mnemonik; sequential explanatory.*

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Introduction

Integer multiplication is a fundamental competency in mathematics learning at the junior high school level, serving as a foundation for more advanced topics such as algebra, geometry, and statistics (Van de Walle et al. 2012). In the Indonesian curriculum, this competency is expected to be mastered by the end of Phase C in elementary school. However, preliminary findings indicate that many seventh-grade students still experience difficulties in mastering multiplication skills. These difficulties are reflected not only in inaccurate answers but also in slow calculation performance (Cho, Vasilyeva, and Laski 2024). A report by Kementerian Pendidikan Dasar dan Menengah Republik Indonesia (2025) also shows that students' numeracy skills in Indonesia still need improvement. This condition indicates a gap between the expected competencies at the elementary level and the actual mathematical performance of students at the junior high school level, highlighting the need for effective instructional strategies to improve multiplication skills.

These findings are consistent with PISA-based research showing that Indonesian junior high school students' numeracy literacy remains below the international average (Darmastuti *et al.*, 2024). Previous studies also indicate that students' difficulties in mathematics are influenced by various internal factors, such as motivation, learning readiness, working memory, and executive functions, as well as external factors, including environmental support and parental involvement (Wei et al. 2024; Widayati *et al.*, 2025). This condition suggests that strengthening basic arithmetic skills remains an important need at the secondary education level.

Before the implementation of the Jarimatika and mnemonic strategies, a preliminary study was conducted involving 141 students from two junior high schools in Ciamis Regency, consisting of 104 students from the first school and 37 students from the second school. The study used 40 multiple-choice arithmetic items without word problems, including single-digit multiplication, single-digit by two-digit multiplication, and two-digit by two-digit multiplication (teen numbers). The results showed that students' accuracy ranged from 28% to 44% across different types of multiplication problems, indicating that difficulties in multiplication operations occur even at the basic level. These findings suggest the need for more effective instructional strategies to improve students' multiplication skills. The problem is not only related to students' cognitive factors but is also associated with the learning strategies used in mathematics instruction. Learning that emphasizes memorization without sufficient conceptual support tends to be less effective in developing computational skills (Fitriana and Sukarto 2022).

From a learning theory perspective, Bruner (1966) emphasizes the importance of concrete representation before students move toward abstract

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understanding, while Ausubel (1962) argues that learning becomes more meaningful when new information is connected to prior knowledge. In addition, Atkinson and Shiffrin (1968) explain that repetition and information encoding play important roles in strengthening long-term memory. These perspectives suggest that effective mathematics instruction should integrate both concrete and cognitive aspects to support students' computational skills.

Although previous studies have demonstrated positive results from the use of both jarimatika and mnemonic strategies, most of these studies have been conducted at the elementary school level or have focused on only one aspect of computational skills. Moreover, studies that directly compare these two strategies within the same learning context are still limited, particularly at the junior high school level. At this level, the ability to perform calculations both accurately and quickly is a critical prerequisite for mastering more advanced mathematical concepts. This indicates a research gap that needs to be addressed by examining both strategies simultaneously while considering the balance between accuracy and speed.

To address this issue, this study examines two instructional strategies, namely the Jarimatika strategy and the mnemonic strategy. Jarimatika uses fingers as concrete tools combined with number decomposition to support procedural understanding and calculation accuracy. Previous studies also show that finger-based motor involvement can enhance numerical understanding and arithmetic learning (Frey *et al*., 2024; Fischer *et al*., (2022). Meanwhile, the mnemonic strategy emphasizes memory reinforcement through songs, associations, repetition, and the SaKaTa phrase (Satuan, Kali, Tambah) to facilitate faster recall of multiplication procedures, consistent with information processing theory (Atkinson and Shiffrin 1968). Both strategies are also related to cognitive load theory (Sweller 1988), as Jarimatika reduces cognitive burden through step-by-step decomposition, while mnemonic strategies support information chunking and recall.

These two strategies have different characteristics. The jarimatika strategy tends to support students in understanding procedures in a gradual and systematic way through concrete representation, whereas the mnemonic strategy emphasizes speed in recalling and applying multiplication facts. This difference makes it important to examine both strategies, particularly in relation to multiplication skills that require a balance between accuracy and speed.

Therefore, this study aims to analyze the effectiveness of Jarimatika and mnemonic strategies in improving students' positive integer multiplication skills at the junior high school level. Specifically, this study examines (1) the effectiveness of each strategy, (2) differences in students' multiplication skill improvement between the two strategies while considering students' initial ability, (3) factors contributing to the effectiveness of each strategy, (4) explanations for any non-significant differences, and (5) students' thinking processes in solving multiplication problems through qualitative analysis.

Research Methods

This study employed a mixed methods approach with a sequential explanatory design consisting of a quantitative phase followed by a qualitative phase (Creswell & Clark, 2018; Sugiyono, 2013). The study was conducted during

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cocurricular learning sessions in the even semester of the 2025/2026 academic year and was implemented in five meetings consisting of one pretest session, three intervention sessions, and one posttest session. Each intervention session lasted approximately 80 minutes. The three intervention sessions focused on (1) strengthening basic multiplication facts (1–10), (2) developing multiplication skills involving one-digit and tens multipliers, and (3) reinforcing and applying strategies in larger-number multiplication problems. Both classes received the same mathematical content, learning duration, number of sessions, and practice structure, with the instructional strategy being the primary difference between the classes.

In the quantitative phase, pretest and posttest data on students' multiplication skills, measured through accuracy and speed, were collected from all 71 participants. ANCOVA was used to analyze differences in skill improvement between the Jarimatika class and the mnemonic class while controlling for students' initial ability through pretest scores as a covariate.

Based on the quantitative results, eight students were purposively selected as informants for the qualitative phase, consisting of four students from each group representing the highest posttest score, the lowest posttest score, the highest N-gain, and the lowest N-gain. In the qualitative phase, semi-structured interviews, classroom observations conducted during the three treatment sessions and posttest, and students' worksheets were used to explore students' thinking processes, factors contributing to the effectiveness of each strategy, and possible explanations for the quantitative findings. Integration between quantitative and qualitative data occurred during the interpretation stage, in which qualitative findings were used to help explain the ANCOVA results, particularly the absence of a statistically significant difference between the two instructional strategies.

Participants

This study employed a quasi-experimental design using an intact group comparison approach, in which existing classes were used without random assignment at the individual level. The selection of classes was based on the equivalence of students' initial mathematics ability as indicated by their previous semester mathematics grades, mathematics teacher recommendations, and the overall academic characteristics of the students in both classes. The mathematics teacher stated that the two classes had relatively similar academic abilities, and no streaming system based on academic achievement was implemented at the school. Based on these considerations, Class VIIA was assigned as the Jarimatika class, while Class VIIB was assigned as the mnemonic class.

Data Collection Techniques

The test was administered in digital format and consisted of 20 short-answer items with comparable difficulty levels for the pretest and posttest, covering various levels of positive integer multiplication complexity ranging from one-digit to four-digit multiplication. The digital platform automatically recorded two aspects for each student: (1) accuracy (correct or incorrect answers) and (2) response time (in seconds) for each correctly answered item. These data were used to calculate an integrated skill score combining accuracy and speed. The instrument was pilot-

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tested and validated qualitatively by an expert in mathematics education and was considered appropriate for use after minor revisions.
Observations were conducted during the three learning sessions and the posttest using a five-point Likert scale (Sugiyono, 2013). The observations focused on students' strategy application, procedural consistency, independence, accuracy, confidence, and engagement during learning activities.
Semi-structured interviews were conducted with eight students selected purposively based on quantitative results, consisting of students with the highest posttest score, the lowest posttest score, the highest N-gain, and the lowest N-gain from each class. The interview guide explored students' thinking processes, strategies used, contributing factors, and challenges encountered during multiplication tasks.

Scoring Procedure
Accuracy scores were calculated dichotomously, with 1 representing a correct answer and 0 representing an incorrect answer. Speed scores were calculated using Equation (1):

$$K_i = \frac{T_{min,i}}{T_i} \quad (1)$$

where $K_i$represents the speed score for item i, $T_{\min,i}$is the fastest response time for item $i$among students who answered correctly, and $T_i$is the response time of a student for the same item. If a student answered incorrectly, the speed score was automatically assigned a value of 0 regardless of response time.
The score for each item was calculated using Equation (2):

$$S_i = \frac{A_i + K_i}{2} \quad (2)$$

where S_i is the score for item i, $A_i$is the accuracy score, and K_i is the speed score. Accuracy and speed were weighted equally, each contributing 50% to the item score.

The final score for each student was obtained by averaging all item scores and converting the result into a percentage, as shown in Equation (3):

$$\text{Final Score} = \left(\sum \frac{S_i}{n}\right) \times 100 \quad (3)$$

where $n = 20$ represents the total number of test items.

Research Procedures
The procedure consisted of three stages: (1) pretest administration, (2) implementation of learning using Jarimatika and mnemonic strategies for three sessions, and (3) posttest administration.

Data Analysis
Quantitative analysis included descriptive statistics (mean, standard deviation, minimum, and maximum), prerequisite tests (Shapiro–Wilk for normality, Levene's test for homogeneity of variances, linearity test, and homogeneity of regression slopes), and hypothesis testing using ANCOVA with pretest scores as covariates. Effect sizes were calculated using Cohen's d (Cohen 1988) and partial eta squared (ηp^2) for the ANCOVA results. N-gain analysis was used as supporting data for

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selecting interview subjects. Qualitative data were analyzed through data reduction, data display, and conclusion drawing (Miles *et al*., 2014).

Results and Discussion

The results are presented using descriptive and inferential statistical analyses to provide an overview of students' skills in integer multiplication before and after the intervention. The data analyzed are skill scores obtained from the combination of accuracy and speed components.

Descriptively, both classes showed an increase in multiplication skill scores from pretest to posttest. The Jarimatika class improved from a mean score of 24.69 to 32.69, while the mnemonic class improved from 26.34 to 35.22. The standard deviations in both classes decreased after the intervention, indicating a more homogeneous distribution of students' scores. Cohen's *d* effect sizes were calculated to examine the practical significance of the improvements. The Jarimatika class obtained $d = 0.48$, while the mnemonic class obtained $d = 0.52$. According to Hattie (2009), both values exceeded the effectiveness threshold of $d > 0.40$. Based on Cohen's criteria (0.2 = small, 0.5 = medium, 0.8 = large), both values fall within the medium category. A summary of the descriptive statistics, N-gain, and effect sizes is presented in Table 1.

Table 1. Descriptive Statistics, N-Gain, and Effect Sizes of Multiplication Skills

Class	N	Pretest Mean (SD)	Posttest Mean (SD)	Mean Gain	Mean N-Gain	Cohen's *d*	Category
Jarimatika	36	24.69 (17.11)	32.69 (16.42)	8.00	0.10	0.48	Medium
Mnemonic	35	26.34 (18.71)	35.22 (15.49)	8.88	0.10	0.52	Medium

Inferential analysis using analysis of covariance (ANCOVA) showed that there was no statistically significant difference in multiplication skill improvement between the two classes after controlling for pretest scores as a covariate ($p = .541 > .05$). The ANCOVA results are presented in Table 2.

Table 2. ANCOVA Results for Posttest Scores

Source	df	F	p	ηp^2
Pretest (Covariate)	1	152.67	< .001	.696
Instructional Strategy	1	0.38	.541	.020

These findings indicate that statistically, neither instructional strategy was superior to the other in improving students' multiplication skills. However, both strategies demonstrated practical effectiveness, as reflected by the moderate Cohen's *d* values obtained in both classes.

The results showed no statistically significant difference in skill improvement between the two groups ($p = 0.541 > 0.05$). However, the absence of a significant difference does not imply that the two strategies are equivalent. Both strategies demonstrated moderate effect sizes (Jarimatika: $d = 0.48$; mnemonic: $d =$

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0.52), indicating meaningful practical improvements. Nevertheless, further research is needed to formally test the equivalence of the two strategies.

Based on interviews with eight students (four from each class), three main factors were identified as contributing to the effectiveness of both instructional strategies. First, the use of fingers as concrete and visual tools in the Jarimatika strategy helped students understand multiplication procedures more clearly. This was expressed by student S-14: "Pakai jari itu ngebantu, Bu... jadi bisa liat jumlahnya langsung, gak cuma di kepala" (theme: visual-kinesthetic support, mentioned by all four Jarimatika interviewees). This finding may help explain the relatively stable performance observed in the Jarimatika class across different levels of multiplication difficulty. Second, the use of patterns, rhythms, and the SaKaTa phrase in the mnemonic strategy facilitated students' recall of multiplication procedures. Student S-32 stated: "Inget SaKaTa... dari satuan, kali, tambah... jadi nggak ketinggalan urutannya" (theme: verbal recall, mentioned by three out of four mnemonic interviewees). These findings indicate that mnemonic elements supported procedural recall and helped students perform calculations more systematically. Third, repeated practice and supportive learning conditions were identified as external factors contributing to students' skill improvement. Student S-9 from the Jarimatika class stated: "Saya cek lagi, cek lagi... takut salah" (theme: over-checking), indicating a tendency to prioritize accuracy over speed. In contrast, student S-8 from the mnemonic class stated: "Sekarang lebih ikut urutan langkahnya... jadi lebih teratur" (theme: procedural consistency), suggesting that the mnemonic structure helped maintain procedural order during calculations.

Overall, the qualitative findings help explain the quantitative results. The Jarimatika strategy tended to support visual understanding and procedural stability, whereas the mnemonic strategy tended to support procedural recall and calculation fluency. These complementary strengths may explain why no statistically significant difference was found between the two instructional strategies (p = .541), as each strategy demonstrated different advantages in supporting students' multiplication skills.

These findings are supported by previous research indicating that the effectiveness of learning strategies is closely related to underlying cognitive and sensorimotor mechanisms. The use of fingers in Jarimatika supports numerical understanding through sensorimotor engagement (Artemenko *et al.*, 2022; Frey *et al*., 2024), while mnemonic strategies strengthen long-term memory through structured associations (Bellezza, 1981; Wulandary & Kawai, 2024).

From an embodied cognition perspective, physical movements such as finger use help make numerical representations more meaningful and cognitively accessible (Barrocas *et al*., 2020; Gordon & Ramani, 2021). This explains why the Jarimatika strategy tends to produce more stable accuracy.

Additionally, from a cognitive perspective, the mnemonic strategy is associated with chunking processes in short-term memory, namely simplifying complex information into more manageable patterns (Norris and Kalm 2021). This mechanism allows students to respond more quickly even without explicit calculation steps.

Interestingly, some findings did not fully align with theoretical expectations. From a learning theory perspective, (Bruner 1966) emphasizes the importance of

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using concrete representations before moving to abstract stages, while (Ausubel 1962) argues that learning becomes more meaningful when new information is connected to students' prior knowledge. However, in practice, some low-ability students still experienced difficulties despite the use of concrete tools. This suggests that learning success is also influenced by factors such as motivation and self-confidence. Furthermore, although information processing theory (Atkinson and Shiffrin 1968) emphasizes repetition in long-term memory formation, some students were able to recall multiplication results quickly without intensive repetition, indicating individual differences in cognitive processing. These findings are consistent with previous studies by Purwanti & Khoiriyah (2020) and (Apsoh 2024) on Jarimatika, as well as Verdianingsih (2020) and Alif *et al*. (2025) on mnemonic strategies.

In terms of students' thinking processes, the Jarimatika strategy demonstrated a systematic and controlled approach. This process model was derived from multiple data sources: (1) field observation notes during the three learning sessions and posttest, (2) semi-structured interviews with eight students (four from each group), and (3) analysis of students' worksheets, particularly students' written explanations of their calculation steps. Triangulation among these sources was used to construct the cognitive flow presented in Figure 1. Based on this evidence, students using Jarimatika were observed to use their fingers as concrete representations, follow step-by-step procedures, and perform error checking before writing their answers. This process tended to produce high accuracy, although it required more time, as illustrated in Figure 1.

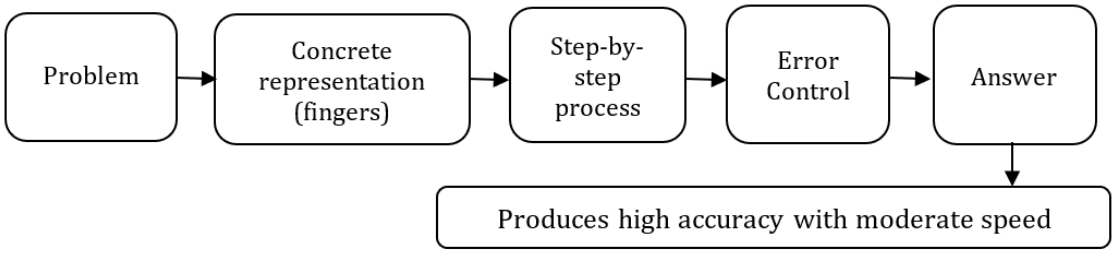


Figure 1. Thinking Process in the Jarimatika Strategy

In terms of students' thinking processes, the mnemonic strategy demonstrated a faster recall-based approach. This process model was derived from the same data sources: observations, interviews with eight students, and analysis of students' worksheets, particularly students' ability to recall the SaKaTa phrase and create their own mnemonics. Students were observed to recall the SaKaTa phrase ("Satuan, Kali, Tambah") from memory, perform calculations based on recall, and write answers without rechecking. This process tended to produce faster responses, although accuracy varied depending on problem complexity, as illustrated in Figure 2.

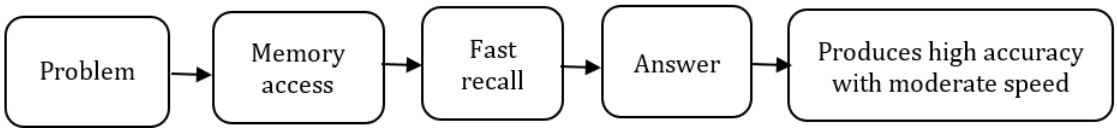


Figure 2. Thinking Process in the Mnemonic Strategy

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Integration of Research Findings

The integration of quantitative and qualitative findings shows that both strategies have strengths in different aspects. The Jarimatika strategy excels in stability and procedural thoroughness, while the mnemonic strategy excels in speed.

This difference reflects two distinct cognitive pathways: a procedural pathway (jarimatika) and a memory-based pathway (mnemonic). The relationship between both strategies and the research findings is illustrated in Figure 3.

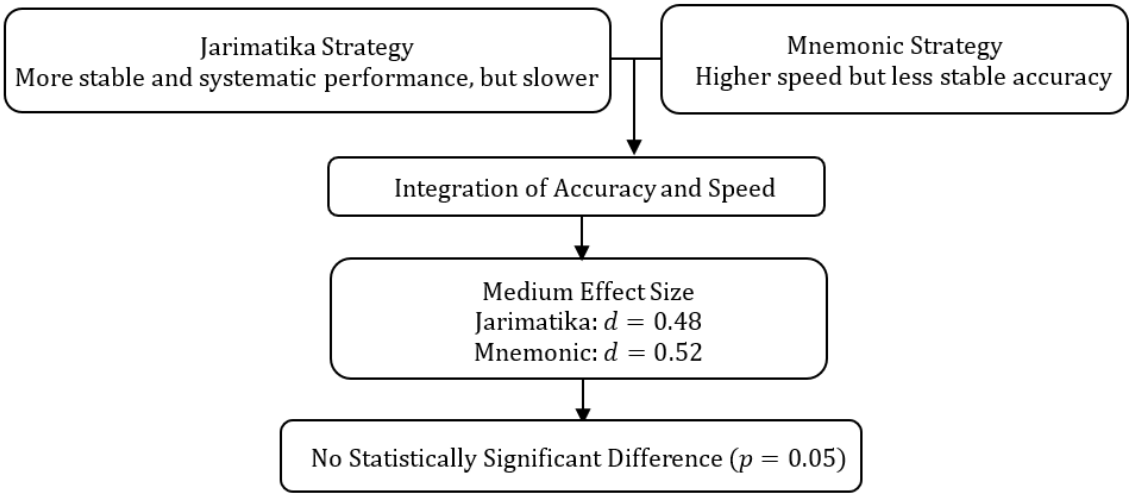


Figure 3. Integration of Research Findings

Thus, the absence of a statistically significant difference does not indicate that both strategies are ineffective. Instead, it suggests that they operate through different mechanisms while producing comparable outcomes.

Furthermore, mastery of basic multiplication facts plays an important role in the successful implementation of both strategies. Students with higher initial ability tend to utilize strategies more effectively. This finding aligns with research showing that arithmetic performance is influenced by cognitive factors such as working memory and executive function (Wei et al. 2024), as well as differences in students' initial abilities (Cheng et al. 2024).

From a practical perspective, the findings suggest that teachers can adapt instructional strategies based on students' characteristics. Jarimatika is more suitable for strengthening procedural understanding, while mnemonic strategies are more effective for improving calculation speed. Combining both strategies may yield more optimal results.

This study has several limitations. First, the intervention lasted only three instructional sessions (excluding the pretest and posttest), which limits conclusions regarding the long-term retention and sustainability of students' multiplication skills. Second, the sample was drawn from only one junior high school, limiting the generalizability of the findings to other educational contexts with different student characteristics and learning environments. Third, the study focused exclusively on positive integer multiplication, limiting the transferability of the findings to other mathematical topics, such as algebra or division, which may involve different cognitive and procedural demands. Therefore, further research involving longer intervention periods, more diverse samples, and broader mathematical topics is

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recommended. Overall, both jarimatika and mnemonic strategies can be considered effective alternatives for teaching integer multiplication, each offering distinct yet complementary advantages.

Conclusion and Suggestion

Based on the results of the study, it can be concluded that there was no statistically significant difference in the improvement of positive integer multiplication skills between students who learned using the Jarimatika strategy and those who learned using the mnemonic strategy (p = 0.541 > 0.05). Nevertheless, both strategies were found to be practically effective, as indicated by their moderate effect sizes (Jarimatika: d = 0.48; mnemonic: d = 0.52). These findings suggest that both strategies can serve as effective alternative instructional approaches for improving students' multiplication skills at the junior high school level.

The qualitative findings showed that the two strategies supported students' learning through different mechanisms. The Jarimatika strategy tended to support visual understanding and procedural stability through concrete finger representations, whereas the mnemonic strategy tended to facilitate procedural recall and calculation fluency through patterns, repetition, and the SaKaTa phrase. These complementary characteristics may explain why both strategies produced relatively equivalent outcomes despite their different instructional processes.

Based on these findings, the Jarimatika strategy may be used when students require concrete and step-by-step support to improve procedural accuracy, particularly for students who still struggle with basic multiplication concepts or place value decomposition. The mnemonic strategy may be more suitable for students who already understand multiplication procedures but need support in improving fluency, recall speed, and procedural consistency, especially when solving routine multiplication problems involving smaller numbers. Teachers may also combine both strategies in classroom practice by using Jarimatika to strengthen conceptual and procedural understanding, followed by mnemonic techniques to reinforce fluency, retention, and automaticity. In addition, for students with very limited mastery of basic multiplication facts, strengthening foundational skills should be prioritized before implementing either strategy, as this study identified basic fact mastery as an important prerequisite for successful strategy use.

Reference

Alif, Ummina Nurus, Lisanul Uswah Sadieda, and Suparto. 2025. "Penerapan Metode Mnemonic Untuk Meningkatkan Daya Ingat Siswa Dalam Pembelajaran Matematika Kurikulum Merdeka." *Jurnal Penelitian Matematika Dan Pendidikan Matematika* 8(3):729–38. https://doi.org/10.30605/proximal.v8i3.5458

Apsoh, Siti. 2024. "Pengaruh Metode Jarimatika Terhadap Kecepatan Berhitung Pada Mata Pelajaran Matematika Kelas II SDIT Mutiara Palabuhanratu." *JUPENJI: Jurnal Pendidikan Jompa Indonesia* 3(2):96–104. https://doi.org/10.57218/jupenji.Vol3.Iss2.1140

Artemenko, Christina, Silke Maria Wortha, Thomas Dresler, Mirjam Frey, Roberta Barrocas, Hans Christoph Nuerk, and Korbinian Moeller. 2022. "Finger-Based

Numerical Training Increases Sensorimotor Activation for Arithmetic in Children—An FNIRS Study." *Brain Sciences* 12:637. https://doi.org/10.3390/brainsci12050637

Atkinson, R. C., and R. M. Shiffrin. 1968. *Human Memory: A Proposed System and Its Control Processes*. Vol. 2. New York: Academic Press.

Ausubel, David P. 1962. "A Subsumption Theory of Meaningful Verbal Learning and Retention." *Journal of General Psychology* 66(2):213–24. https://doi.org/10.1080/00221309.1962.9711837

Barrocas, Roberta, Stephanie Roesch, Caterina Gawrilow, and Korbinian Moeller. 2020. "Putting a Finger on Numerical Development – Reviewing the Contributions of Kindergarten Finger Gnosis and Fine Motor Skills to Numerical Abilities." *Frontiers in Psychology* 11:1012. https://doi.org/10.3389/fpsyg.2020.01012

Bellezza, Francis S. 1981. "Mnemonic Devices: Classification, Characteristics, and Criteria." *Review of Educational Research* 51(2):247–75. https://doi.org/10.3102/00346543051002247

Bruner, Jerome S. 1966. *Toward a Theory of Instruction*. Cambridge, MA: Belknap Press of Harvard University.

Cheng, Stanley, Rebecca Bull, Emma C. Burns, and David Munez. 2024. "The Highs and Lows of Mathematical Ability : Shared and Distinct Longitudinal Predictors of Mathematical Ability Grouping." *Learning and Individual Differenceserences* 116((2024)):102570. https://doi.org/10.1016/j.lindif.2024.102570

Cho, Hyun Young, Marina Vasilyeva, and Elida V Laski. 2024. "Statistical Learning and Mathematics Knowledge: The Case of Arithmetic Principles." *Front. Dev. Psychol.* 2:1370028. https://doi.org/10.3389/fdpys.2024.1370028

Cohen, Jacob. 1988. *Statistical Power Analysis for the Behavioral Sciences*. 2nd ed. New York: Lawrence Erlbaum Associates.

Darmastuti, Lintang, Meiliasari, and Wardani Rahayu. 2024. "Kemampuan Literasi Numerasi: Materi, Kondisi Siswa, Dan Pendekatan Pembelajarannya." *JRPMS (Jurnal Riset Pembelajaran Matematika Sekolah)* 8(1):17–26. https://doi.org/10.21009/jrpms.081.03

Fischer, Ursula, Sebastian Paul Suggate, and Heidrun Stoeger. 2022. "Fine Motor Skills and Finger Gnosia Contribute to Preschool Children's Numerical Competencies." *Acta Psychologica* 226:103576. https://doi.org/10.1016/j.actpsy.2022.103576

Fitriana, Maulida Arum, and Sukarto. 2022. "Analisis Kemampuan Numerasi Dalam Memecahkan Masalah Matematika Di Sekolah Dasar." *JUPE: Jurnal Pendidikan Mandala* 7(4):1111–13. https://doi.org/10.58258/jupe.v7i4.4564

Frey, Mirjam, Venera Gashaj, Hans Christoph Nuerk, and Korbinian Moeller. 2024. "You Can Count on Your Fingers: Finger-Based Intervention Improves First-Graders' Arithmetic Learning." *Journal of Experimental Child Psychology* 244:105934. https://doi.org/10.1016/j.jecp.2024.105934

Gordon, Raychel, and Geetha B. Ramani. 2021. "Integrating Embodied Cognition and Information Processing: A Combined Model of the Role of Gesture in Children's Mathematical Environments." *Frontiers in Psychology* 12:650286. https://doi.org/10.3389/fpsyg.2021.650286

Hattie, John. 2009. *Visible Learning: A Synthesis of Over 800 Meta-Analyses Relating*

e-ISSN 2746-5594
p-ISSN 2746-5608

to Achievement. USA: Routledge.

Kementerian Pendidikan Dasar dan Menengah Republik Indonesia. 2025. *Naskah Akademik Pembelajaran Mendalam Menuju Pendidikan Bermutu Untuk Semua*. Jakarta: Pusat Kurikulum dan Pembelajaran Badan Standar, Kurikulum, dan Asesmen Pendidikan Kementerian Pendidikan Dasar dan Menengah Republik Indonesia.

Miles, Matthew B;, A. Michael Huberman, and Johnny Saldaña. 2014. *Qualitative Data Analysis: A Methods Sourcebook*. Vol. 17. 3rd ed. California: SAGE Publications.

Norris, Dennis, and Kristjan Kalm. 2021. "Chunking and Data Compression in Verbal Short-Term Memory." *Cognition* 208:104534. https://doi.org/10.1016/j.cognition.2020.104534

Purwanti, Kartika Yuni, and Ika Silfiana Arifatul Khoiriyah. 2020. "The Effectiveness of Jarimatika Methods with Tapertis Media on Students' Multiplication Concept Understanding." *Jurnal Penelitian Dan Pengkajian Ilmu Pendidikan: E-Saintika* 4(3):332–41. https://doi.org/10.36312/e-saintika.v4i3.267

Sweller, John. 1988. "Cognitive Load During Problem Solving: Effects on Learning." *Cognitive Science* 12:257–85. https://doi.org/10.1207/s15516709cog1202_4

Verdianingsih, Eliza. 2020. "Strategi Mnemonic Dalam Pembelajaran Matematika." *EDUSCOPE: Jurnal Pendidikan, Pembelajaran, Dan Teknologi* 6(1):78–85. https://doi.org/10.32764/eduscope.v6i1.879

Van de Walle, JA, KS Karp, JM Bay-Williams, Brass, Livy, Margaret Marshman, and Sharyn Livy. 2012. *Primary and Middle Years Mathematics: Teaching Developmentally*. 8th ed. Upper Saddle River, NJ: Pearson Education.

Wei, Wei, Chang Xu, Sara Caviola, and Irene C. Mammarella. 2024. "Affective and Cognitive Factors Associated with Chinese and Italian Children's Arithmetic Performance." *BMC Psychology* 12(466):1–13. https://doi.org/10.1186/s40359-024-01965-6

Widayati, Tri, Budi Usodo, and Sri Yamtinah. 2025. "An Analysis of Numeracy Skills and Factors Affecting Learners in Phase C of Class V of Primary School." *SHEs: Conference Series* 8(1):606–13. https://doi.org/10.20961/shes.v8i1.99020

Wulandary, Verra, and Norimune Kawai. 2024. "The Efficacy of Mnemonic Strategies in Improving the Basic Multiplication Facts Retrieval." *Journal of Education for Sustainability and Diversity* 3(1):211–37. https://doi.org/10.57142/jesd.v3i1.614