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The effectiveness of the 'matahari' method in improving basic arithmetic skills of junior high school students

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Abstract

The persistent disparity in students' mastery of basic arithmetic concepts presents a critical challenge in mathematics education, particularly in regions with limited pedagogical resources. While traditional approaches often fall short in addressing foundational numerical skills, there is a lack of practical, culturally adaptable methods tailored to early secondary learners. This study introduces the "Matahari" method an acronym for *Matematika Hitung Jari* as a novel instructional strategy that integrates finger-counting techniques with repetitive practice to enhance arithmetic fluency. The primary aim of this research is to examine the effectiveness of the Matahari method in improving the basic arithmetic skills of seventh-grade students at SMP Biji Sesawi Wamena. Employing a quasi-experimental design with a non-equivalent pretest-posttest control group, the study used random sampling to assign students to experimental and control classes. Validated instruments were utilized for data collection, including tests, questionnaires, observations, interviews, and documentation, while data analysis was conducted using One-Way ANOVA and t-tests. The findings revealed a statistically significant improvement in the arithmetic performance of the experimental group, with an average gain of 14.31 compared to 5.46 in the control group. Moreover, the method received highly favorable responses from both students (87.35%) and teachers (78.33%). These results suggest that the Matahari method holds substantial pedagogical value in enhancing numeracy skills and offers a culturally relevant solution for addressing foundational learning gaps in mathematics.

Keywords: basic counting, effectiveness, finger counting, junior high school, "matahari" method

Introduction

The educational challenges in the Papua Pegunungan region are multifaceted and deeply entrenched, encompassing deficiencies in curriculum implementation, inadequate quality and availability of educators, limited infrastructure, and varying levels of student competency. These issues are further exacerbated by sociocultural constraints and unstable security conditions, which significantly diminish teacher morale and contribute to high rates of absenteeism in schools (Balai Guru Penggerak Provinsi Papua, 2023). During the COVID-19 pandemic, the transition to online learning was largely ineffective due to the minimal availability of supporting facilities and technological infrastructure, thereby intensifying educational disparities in the region (Paling & Sitorus, 2021). The resulting loss of instructional time has caused many students to fall behind across various subjects. Field data gathered through interviews and observations with a junior high school mathematics teacher in the region revealed that approximately 80% of students were unable to perform basic arithmetic operations such as addition, subtraction, multiplication, and division. Since foundational arithmetic skills serve as prerequisites for understanding more advanced mathematical concepts, such a deficiency significantly hinders students' academic progress (Zaini et al., 2021; Natsir et al., 2023).

Addressing the disparity in students' mastery of elementary mathematics requires the implementation of practical and accessible strategies to reinforce fundamental numeracy skills. One such approach is the utilization of finger-based counting techniques, which have demonstrated potential to stimulate student interest and create a more engaging learning environment (Ayurachmawati et al., 2021). This method, due to its simplicity and direct visual nature, enables students to better comprehend arithmetic procedures and is widely used by educators to teach operations such as addition, subtraction, multiplication, and division (Hendayanti et al., 2021; Bete, 2021; Panggarra & Trivena, 2021; Saputri et al., 2023). Students naturally resort to using their fingers when faced with difficulties in memorizing arithmetic facts or when they lack a conceptual understanding of operations. Research by Poletti et al. (2023) supports this practice, indicating that many early childhood educators recognize finger counting as an effective tool in fostering numerical cognition. Di Luca and Pesenti (2011) further emphasize the cognitive significance of finger-based representations in developing mental number frameworks critical for semantic number processing.

Additional studies highlight the positive affective and cognitive outcomes associated with finger-counting activities, including increased enthusiasm, improved self-confidence in mathematics learning, and enhanced peer collaboration (Melinda & Amaliah, 2021; Putra, 2022; Maja, 2024). From a pedagogical standpoint, fingers function as manipulatives that are both universally accessible and cognitively efficient. Although there are inherent limitations to finger counting particularly when dealing with large numbers or complex calculations these can be mitigated by structured strategies designed to reduce cognitive load (Multu et al., 2020). One such instructional innovation is the "MATAHARI" method (an acronym for *Matematika Hitung Jari* or Finger Arithmetic), which emphasizes repetitive practice and direct engagement. This approach, conceptually akin to "JARIMATIKA", integrates drill and practice techniques to cultivate procedural fluency and operational mastery in learners (Pramita, 2017; Kreilinger et al., 2022; Mutaquin et al., 2024; Bete, 2021).

The method's strength lies in its practicality and embodied nature, utilizing learners' own fingers to support kinesthetic and visual learning. This multisensory approach enables learners to internalize arithmetic concepts through repeated, meaningful practice, thereby facilitating long-term retention. Moreover, it fosters active participation and enhances learners' problem-solving confidence (Rombe et al., 2023; Lanya et al., 2020). Drawing on Vygotsky's Zone of Proximal Development (ZPD), the method aligns with the principle that students can perform complex tasks with guided support, gradually transitioning to independent proficiency. According to Bruner's enactive learning model, direct and tangible experiences such as those provided by the "MATAHARI" method are crucial for cognitive development and the assimilation of abstract concepts (Ndiung et al., 2021).

Despite its pedagogical advantages, finger-counting strategies remain underutilized in formal classroom settings, particularly within Jayawijaya Regency. Integrating the "MATAHARI" method within instructional practice offers a promising avenue to promote an interactive and enjoyable mathematics learning environment. The use of fingers, as always-available learning tools, minimizes dependency on rote memorization and aligns with students' natural problem-solving instincts, even in exam contexts.

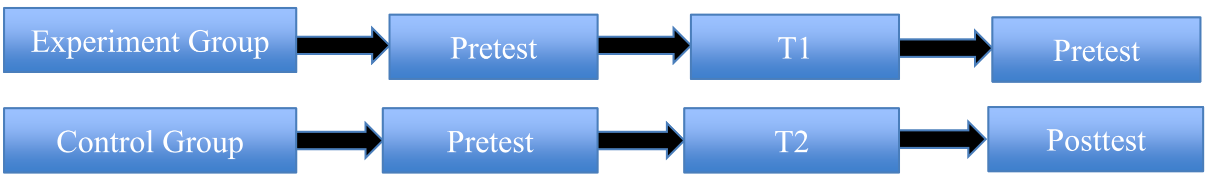
This study introduces a novel pedagogical intervention by integrating the finger-counting method with a structured drill-and-practice framework to enhance students' proficiency in basic arithmetic operations specifically addition, subtraction, multiplication, and division. The method is operationalized through a cooperative learning model that prioritizes active student engagement and allocates substantial time for repeated practice. During implementation, the teacher introduces the core concepts while demonstrating the finger-counting technique. Students are then organized into small groups, each facilitated by a teacher or tutor who guides them through sequential practice from basic to advanced operations until conceptual fluency is achieved. The effectiveness of this approach is assessed through post-intervention tests designed to evaluate students' computational abilities.

Based on preliminary discussions with mathematics teachers in Wamena, it was evident that a substantial number of junior high school students struggle with fundamental arithmetic and are often taught using memorization-based methods, which have proven to be ineffective. Consequently, this study aims to evaluate the effectiveness of the "MATAHARI" method in improving the basic mathematical competencies of seventh-grade students at Biji Sesawi Junior High School, Wamena. Additionally, the study seeks to explore students' and teachers' perceptions of the method, thereby providing insight into its pedagogical viability in similar educational contexts.

Methods

This study employed a quantitative approach using a quasi-experimental design to investigate the causal effect of the instructional intervention on students' basic arithmetic skills. Specifically, a nonequivalent pretest-posttest control group design was implemented, as depicted in Figure 1 (Kho et al., 2024). The research was conducted at Biji Sesawi Wamena Junior High School and involved seventh-grade students. The population consisted of three existing classes, from which participants were selected via purposive sampling. The selection criteria were based on the mathematics teacher's recommendation and students' consistent attendance in mathematics classes, yielding a total sample of 44 students. These were divided equally into two groups: 22 students in the experimental group (T_1) and 22 students in the control group (T_2).

The research procedure was carried out in three distinct phases. The preliminary phase involved classroom observations to understand the instructional context. The implementation phase included the following steps: (1) administration of a pretest to both the control and experimental groups; (2) implementation of the "MATAHARI" finger-counting method in the experimental group, which comprised: (a) a general introduction to the method; (b) formation of five small study groups each led by a peer tutor; (c) guided training for each student to apply finger-counting strategies to solve basic arithmetic problems; and (d) independent student practice using the "MATAHARI" method to reinforce their arithmetic skills. The final phase involved administering a posttest to both groups to evaluate the effectiveness of the intervention.



Note:
T1 = Experimental Group
T2 = Control Group

Figure 1. Nonequivalent pretest-posttest control group design

Data were collected through written assessments and a questionnaire. The test instrument comprised five open-ended items aimed at assessing students' competencies in basic arithmetic. Additionally, a 10-item Likert-scale questionnaire validated and tested for reliability was employed to gauge students' perceptions of the "MATAHARI" method. Statistical analysis was conducted using SPSS version 23 for Windows. Prior to hypothesis testing, the data were verified for normality and homogeneity assumptions. An independent samples t-test was employed to assess significant differences in posttest outcomes between the experimental and control groups. Furthermore, normalized gain (N-Gain) analysis was conducted to measure the effectiveness of the intervention. To support qualitative insights, implementation processes were systematically documented throughout the instructional sessions.

Results and Discussion

Students' mathematical learning outcomes were assessed through pretest and posttest instruments administered to both the experimental and control groups. The pretest was employed to establish the participants' baseline arithmetic proficiency prior to the implementation of the instructional interventions. Conversely, the posttest served to evaluate the effectiveness of the treatment on students' mathematics performance. A descriptive summary of the pretest and posttest scores for both groups are presented in Table 1.

Table 1. Descriptive statistics of pretest and posttest scores

Description	Experimental Group (n = 22)		Control Group (n = 22)	
	Pretest	**Posttest**	**Pretest**	**Posttest**
Mean	37.05	66.36	54.77	75.23
Standard Deviation	10.427	7.895	5.665	5.665
Variance	108.712	62.338	32.089	32.089
Minimal	20	45	45	65
Maximal	60	80	65	85

As shown in Table 1, the experimental group initially achieved a mean pretest score of 37.05 (SD = 10.427), with scores ranging from 20 to 60. Following the implementation of the MATAHARI method, their mean posttest score increased to 66.36 (SD = 7.895), with a score range of 45 to 80. In comparison, the control group recorded a higher pretest mean of 54.77 (SD = 5.665) and a posttest mean of 75.23 (SD = 5.665), with scores ranging from 65 to 85. The experimental group showed a mean score gain of 29.31, while the control group improved by 20.46 points. These findings suggest a relatively greater improvement in mathematical performance among students exposed to the MATAHARI method compared to those receiving conventional instruction.

Figure 2. Students engaged with the MATAHARI method

To further quantify learning gains, normalized gain (N-Gain) scores were computed and are summarized in Table 2.

Table 2. N-gain scores of experimental and control groups

Description	Experimental Group (n = 22)		Control Group (n = 22)	
	N-gain Score	N-gain (%)	N-gain Score	N-gain (%)
Mean	0.4630	46.3018	0.4587	45.8743
Minimal	0.31	31.25	0.36	36.36
Maximal	0.64	63.64	0.57	57.14

The data in Table 2, analyzed using SPSS 23 for Windows, reveals that the experimental group achieved a mean N-Gain score of 0.4630 (46.30%), whereas the control group obtained a slightly lower average N-Gain of 0.4587 (45.87%). Despite the marginal difference, the experimental group exhibited a slightly more substantial relative improvement in mathematics achievement.

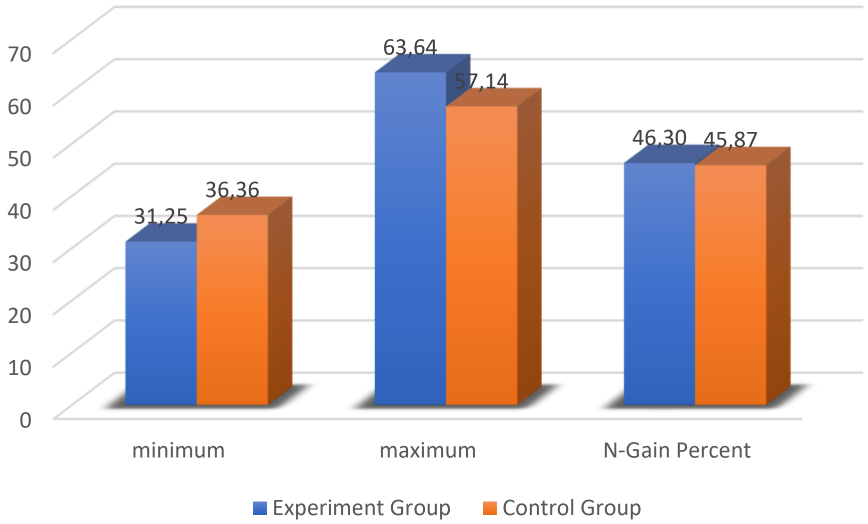


Figure 3. Comparative diagram of N-gain scores for experimental and control groups

Figure 3 depicts the N-Gain values for the mathematics outcomes of both the experimental and control groups. A further statistical description of the N-Gain scores, including measures of variability, is detailed in Table 3.

Table 3. Descriptive statistics of N-gain scores

	N	Mean	Std. Deviation	Std. Error Mean
N-Gain Experiment	22	46.3018	10.12483	2.15862
N-Gain Control	22	45.8743	6.23174	1.32861

Based on the N-Gain analysis, both instructional approaches were categorized as "less effective" in terms of improving students' basic mathematical abilities, including addition, subtraction, multiplication, and division. Nonetheless, the MATAHARI method incorporating the drill-and-practice strategy demonstrated slightly more potential for fostering improvement compared to traditional methods.

To test the statistical significance of these outcomes, assumptions of normality and homogeneity were first examined prior to conducting an independent samples t-test. The normality of the N-Gain distributions was verified using the Kolmogorov-Smirnov and Shapiro-Wilk tests, with the hypotheses structured as follows:

Ho: Data is normally distributed.
Ha: Data is not normally distributed.

A significance value higher than the specified alpha level ($\alpha > 0.05$) indicates the acceptance of the normality hypothesis, which suggests that the data is normally distributed. Conversely, a significance value lower than the specified alpha level ($\alpha < 0.05$) indicates the rejection of the normality hypothesis, which suggests that the data is not normally distributed. Table 4 shows the results of the normality test for N-Gain scores in the experimental and control classes.

Table 4. Normality test results for N-gain scores

N-Gain Score	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Experiment	.127	22	.200*	.943	22	.226
Control	.182	22	.057	.921	22	.081

According to the results presented in Table 4, the null hypothesis (H_0) is accepted, indicating that the data is normally distributed. This is because the significance values for the N-Gain scores in both the control and experimental groups exceed the alpha level determined by the Kolmogorov-Smirnov and Shapiro-Wilk tests.

The homogeneity test is used to determine whether the research subjects come from a population with homogeneous or heterogeneous variance. Levene's test is used with SPSS 23 for Windows to assess this. The following are the hypotheses for the homogeneity test:

Ho: The variances of the variable are equal or homogenous.
Ha: The variances of the variable are not equal or heterogeneous.

In the homogeneity test, the significance value is accepted if it is greater than the specified alpha level ($\alpha > 0.05$), and the null hypothesis is rejected if the significance value is less than the specified alpha level ($\alpha < 0.05$), indicating that the group variances are not homogeneous. Table 5 shows the results of the homogeneity test for N-Gain scores for the experimental and control groups.

Table 5. Levene's test for equality of variances

	Levene Statistic	df1	df2	Sig.
Based on Mean	2.926	1	41	.095
Based on Median	3.007	1	41	.090
Based on Median and with adjusted df	3.007	1	36.950	.091
Based on trimmed mean	2.897	1	41	.096

Table 5 shows that the established alpha level exceeds the significance value for the N-Gain scores in the mathematics results obtained from the pretest for both the experimental and control groups. Therefore, the null hypothesis (H_0) is accepted, indicating that the variances of each variable are identical or homogeneous. Therefore, the first hypothesis will be tested with a t-test, conducted using Windows SPSS 23.

Ho: $\mu A1 = \mu A2$ (There is no significant difference in students' mathematics outcomes between "MATAHARI" method with drill and practice concept).
Ha: $\mu A1 \neq \mu A2$ (There is a significant difference in students' mathematics outcomes between outcomes between "MATAHARI" method with drill and practice concept).

The null hypothesis (H_0) is rejected if the obtained significance value (p-value) is less than 0.05. The results of the t-test analysis for the posttest scores of mathematics outcomes are presented in Table 6.

Table 6. Independent samples t-test results

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Outcome	Equal variances assumed	1.661	.205	4.278	42	.000	8.864	2.072	13.045	4.683
	Equal variances not assumed			4.278	38.091	.000	8.864	2.072	13.057	4.670

The Independent Sample t-test produced a significance value of 0.000 and a value less than 0.05, as shown in Table 6. These results indicate that students in the experimental group taught the "MATAHARI" method with the drill and practice concept showed significantly better learning outcomes compared to students in the control group taught with conventional instruction. Therefore, it can be concluded that seventh-grade students at Biji Sesawi Wamena Junior High School taught the "MATAHARI" method with the drill and practice concept demonstrated significantly different mathematics results compared to the conventional teaching method.

Response From Students and Teachers

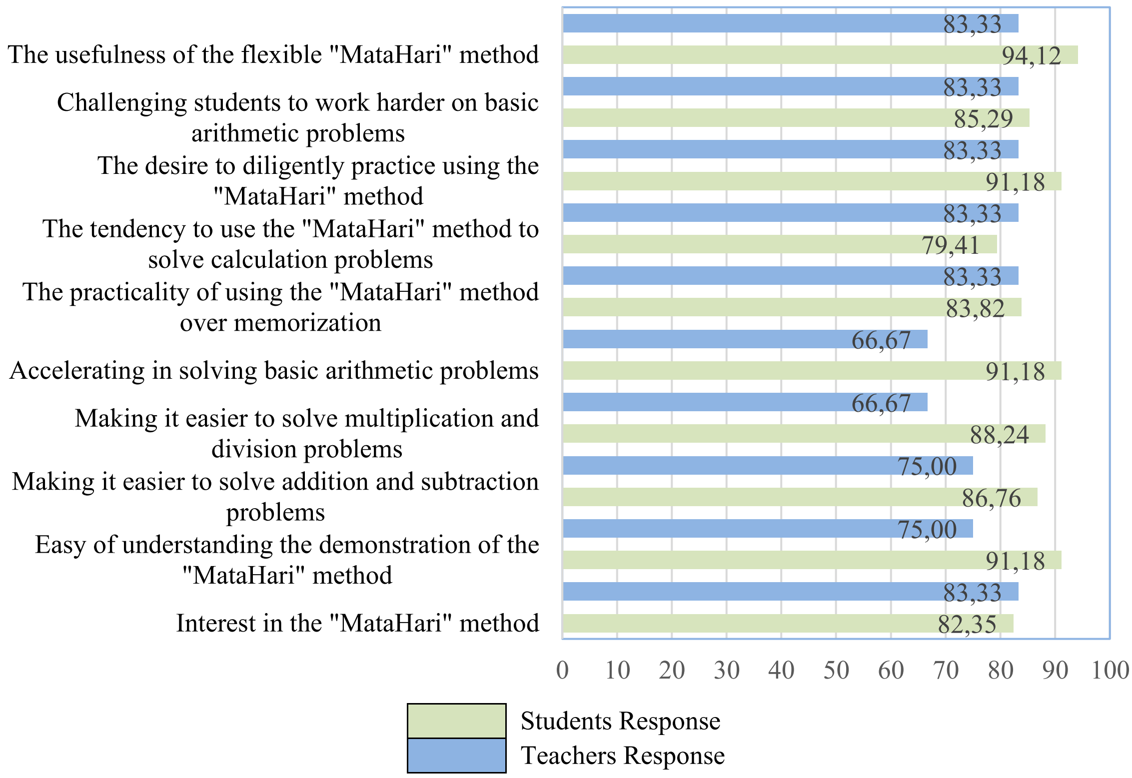


Figure 4. Student and teacher responses to the MATAHARI method

Based on the analysis of Figure 4, a high percentage of both students and teachers expressed a favorable perception of the "MATAHARI" method. Specifically, 82.35% of students and 83.33% of teachers reported an interest in this approach. Furthermore, 91.18% of students and 75% of teachers indicated that the method was easy to understand. Regarding its effectiveness in solving arithmetic operations, 86.76% of students and 75% of teachers stated that the "MATAHARI" method facilitated addition and subtraction, while 88.24% of students and 66.67% of teachers noted its utility in handling multiplication and division. Additionally, 91.18% of students and 66.67% of teachers believed that the method enhanced the speed of completing basic arithmetic tasks. The practicality of the method, as compared to traditional memorization techniques, was affirmed by 83.82% of students and 83.33% of teachers.

Moreover, the motivational aspect of the "MATAHARI" method was positively acknowledged, with 79.41% of students and 83.33% of teachers observing a greater inclination among students to apply the method in problem-solving. A strong desire to practice using this method was reported by 91.18% of students and 83.33% of teachers, while 85.29% of students and 83.33% of teachers indicated that it encouraged students to exert more effort in tackling basic mathematics problems. Notably, 94.12% of students and 83.33% of teachers recognized the method's flexibility as a significant benefit. Overall, an average positive response rate of 87.35% among students and 78.33% among teachers was recorded, demonstrating that the "matahari" method was well-received and perceived to enhance the basic arithmetic skills of seventh-grade students in the experimental class at Biji Sesawi Wamena Junior High School during mathematics instruction.

The analysis of research data indicates that the implementation of the "MATAHARI" method, which integrates drill and practice techniques, has demonstrated limited effectiveness in enhancing the mathematical learning outcomes of seventh-grade students at SMP Biji Sesawi Wamena. One contributing factor is the students' insufficient mastery of foundational arithmetic concepts, which often results in computational errors when attempting to apply these concepts in problem-solving contexts. Further investigation revealed that some students enrolled at the junior high school level had not previously undergone formal education at the elementary level, exacerbating their difficulties with basic numerical operations. Moreover, the drill and practice approach employed in this method demands extended instructional time to foster automaticity in finger-based counting strategies, yet the time allocated for classroom implementation remains constrained. Consequently, students exhibited rigidity in applying the finger math technique, further hindered by low intrinsic motivation and a lack of independent study habits, as learning activities are largely confined to the school environment. These findings are consistent with those of Saputri et al. (2023), who emphasized the necessity of continuous and consistent practice in the application of finger math strategies to improve students' basic computational fluency.

The baseline arithmetic proficiency of the seventh-grade cohort at SMP Biji Sesawi Wamena remains relatively low, as confirmed by observational data and teacher interviews conducted by the research team. Nevertheless, the introduction of the finger-counting strategy yielded observable improvements in students' fundamental calculation abilities. This is evidenced by the increase in the average test scores of the experimental group, which rose by 29.31 points, surpassing the 20.46-point gain observed in the control group. These outcomes are in alignment with the studies conducted by Frey et al. (2024) and Ndiung et al. (2021), who reported that finger-based numerical strategies can significantly enhance arithmetic learning and promote students' creative mathematical thinking more effectively than conventional instructional approaches.

The structured implementation of the "MATAHARI" method, combined with targeted guidance from teachers and tutors, facilitated gradual improvements in the arithmetic problem-solving abilities of lower-performing students. Each student had the opportunity to engage in hands-on practice of the "MATAHARI" method previously modeled by the teacher, which fostered active participation and increased enthusiasm for learning. These findings are congruent with those of Multu (2020) and Poletti et al. (2023), who highlighted the advantages of the finger-counting method, including its accessibility, practical utility, and ability to concretize abstract arithmetic concepts. These attributes are particularly beneficial for students who struggle with memory retention, experience high levels of mathematics anxiety, or possess limited confidence in their mathematical capabilities.

Furthermore, the study revealed that students taught using the "MATAHARI" method within a drill and practice framework exhibited higher levels of classroom engagement compared to their peers in traditional learning settings. The structured environment allowed students to practice basic arithmetic operations addition, subtraction, multiplication, and division under the guidance of a tutor, with each student given opportunities to demonstrate their understanding using the "MATAHARI" strategy. This instructional approach not only reinforced arithmetic skills but also promoted peer collaboration and tutor-assisted scaffolding.

The integration of the "MATAHARI" method during mathematics instruction cultivated a dynamic and enjoyable learning atmosphere. Its emphasis on active student involvement contributed to a more meaningful learning experience and allowed educators to gain deeper insights into the cognitive profiles of their students. Compared to conventional pedagogical techniques, the "MATAHARI" method fostered a more engaging and supportive learning environment, as reflected in heightened student enthusiasm and participation during instructional activities. This is substantiated by the positive response rate of 87.35% from students in the experimental class and 78.33% from the mathematics teacher, indicating strong receptivity toward the method. These results corroborate the findings of Rombe et al. (2023) and Ayurachmawati et al. (2021), who demonstrated that finger math techniques are both accessible and effective, serving as a viable alternative instructional strategy to support students' arithmetic development, stimulate their interest, and enhance their overall engagement in mathematics learning.

Conclusion

The results of this study reveal that the implementation of the "MATAHARI" approach characterized by the integration of drill and practice techniques demonstrated limited effectiveness in enhancing the arithmetic learning outcomes of seventh-grade students at SMP Biji Sesawi Wamena. Specifically, the method did not yield a statistically significant improvement in students' mastery of basic arithmetic operations, indicating that repetitive practice alone may not be sufficient to address foundational mathematical challenges in this context. However, observational data suggest that students in the experimental group, who received additional support through peer tutors, exhibited higher levels of learning motivation compared to their counterparts in the control group. This finding underscores the potential motivational benefits of collaborative and supportive learning environments when applied in conjunction with structured mathematical interventions.

Given the scope and limitations of this research particularly constraints related to time and the absence of a longitudinal implementation the findings suggest the need for further investigation into more integrative and contextually relevant instructional strategies. Future studies are recommended to explore alternative pedagogical models, such as those rooted in ethnomathematics or Realistic Mathematics Education (RME), with specific attention to culturally responsive practices like finger counting mathematics. Researchers are also encouraged to develop structured teaching manuals or practical guidelines to support the application of such methods in diverse classroom settings. A longitudinal or mixed-methods design may provide deeper insights into the sustained impact of these interventions on students' cognitive and affective mathematical development.

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Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies have been covered completely by the authors.

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