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Blended Instruction in Elementary Mathematics: Effects of Demonstration Method and Digital Media on Calculation Skills

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ABSTRACT

Basic calculation skills—addition, subtraction, multiplication, and division—are foundational in elementary mathematics. However, many students struggle to master these skills using traditional instruction alone. This study explores the effectiveness of integrating the demonstration method with digital learning media to improve calculation skills among Grade IV elementary students. A one-group pretest-posttest quasi-experimental design was employed with 40 fourth-grade students from Mendak State Elementary School, Indonesia. The intervention combined step-by-step teacher-led demonstrations with digital tools, such as interactive apps, over an eight-week period (16 sessions). Students' calculation abilities were measured before and after the intervention using a validated 20-item multiple-choice test. Data were analyzed using paired samples *t*-tests after confirming normality through the Kolmogorov-Smirnov test. Students showed significant improvement in posttest scores (M = 85.56) compared to pretest scores (M = 60.62), with a mean gain of 24.95 points ($t = 15.43$, $p < 0.001$). Most students shifted from "fair" or "low" to "high" or "very high" proficiency categories. Female and older students exhibited slightly higher gains, though improvements were consistent across all demographics. The integration of structured demonstration with digital media significantly enhanced students' arithmetic performance. The blended approach leveraged the clarity of modeling with the engagement and personalization of digital tools. Despite the study's limitations—such as the absence of a control group—findings support the use of blended instructional methods in elementary mathematics.

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1. INTRODUCTION

Basic arithmetic skills—addition, subtraction, multiplication, and division—constitute the cornerstone of mathematics learning in elementary education. Mastery of these operations is not merely procedural; it underpins students' broader mathematical reasoning and their capacity to engage in analytical and problem-solving tasks. Empirical evidence consistently demonstrates that early

arithmetic competence significantly predicts later mathematical achievement and long-term academic success (Träff et al., 2023; Wang et al., 2020). Students who develop strong numerical fluency in the primary grades are more likely to demonstrate conceptual understanding in advanced topics such as fractions, algebra, and proportional reasoning. Moreover, arithmetic proficiency is closely associated with domain-general cognitive processes, including working memory, attention control, and spatial reasoning, which collectively support effective mathematical performance (Matejko & Ansari, 2021). These findings underscore that foundational calculation skills are integral not only to mathematics achievement but also to students' overall cognitive and academic development (Finke et al., 2020).

The significance of arithmetic competence extends beyond mathematics classrooms. In science education, for instance, students are required to apply numerical operations to measure variables, interpret data, and manipulate formulas in experimental contexts (Nakakoji & Wilson, 2018). In language learning, the logical sequencing and structured reasoning fostered through mathematical problem-solving contribute to improved comprehension and coherent writing (Haeruman et al., 2024). Furthermore, arithmetic proficiency has been linked to increased academic self-efficacy and cognitive flexibility, enabling students to approach learning tasks with greater confidence and adaptability (Bal & Kapucu, 2022; Mihno et al., 2023). Consequently, strengthening basic calculation skills in elementary school is not only a curricular objective but also a developmental imperative that supports interdisciplinary learning and long-term educational trajectories.

Despite their foundational importance, many elementary school students—particularly those in Grade IV—continue to experience difficulties in mastering basic arithmetic operations. These challenges become more pronounced when students encounter multi-step problems, contextual word problems, or tasks requiring conceptual reasoning rather than mechanical computation (Powell et al., 2021). One frequently cited factor contributing to these difficulties is the persistence of conventional instructional approaches that emphasize rote memorization and repetitive drills over conceptual understanding (Bouck et al., 2021). While procedural fluency is important, instruction that prioritizes memorization without fostering meaning-making often results in superficial learning, reduced engagement, and diminished motivation. Students may be able to perform isolated calculations but struggle to apply strategies flexibly across contexts. Such outcomes suggest the need for pedagogical approaches that integrate procedural instruction with conceptual scaffolding and active student engagement.

In response to these concerns, the demonstration method has been proposed as a structured instructional strategy capable of enhancing students' understanding of arithmetic processes. The demonstration approach involves modeling problem-solving procedures in a clear, step-by-step manner, enabling students to observe the logic and sequence underlying each operation. This strategy aligns with Vygotsky's (1978) concept of the Zone of Proximal Development, which emphasizes the role of guided instruction in helping learners accomplish tasks that would be difficult to complete independently. Through teacher modeling, students gain access to cognitive strategies and metacognitive processes that can later be internalized. Empirical studies suggest that demonstration-based instruction supports procedural clarity and improves students' ability to replicate solution strategies accurately (Li-mei et al., 2022; Steckel et al., 2020). By making abstract mathematical concepts more visible and concrete, demonstration can enhance conceptual transparency and reduce misconceptions (Gerofsky & Zebehazy, 2020).

However, while the demonstration method provides structured guidance, its effectiveness may be constrained if implemented in a predominantly teacher-centered manner without sufficient opportunities for interactive practice. Contemporary learners are increasingly immersed in digital environments characterized by interactivity, immediate feedback, and multimodal representation. Within this context, digital learning media offer promising avenues to enrich arithmetic instruction. Educational applications, interactive videos, and online practice platforms can provide adaptive tasks tailored to students' performance levels, enabling personalized learning trajectories (Alzubi, 2023; Outhwaite et al., 2023). Immediate feedback mechanisms embedded in digital tools facilitate error

correction and reinforce mastery learning principles, thereby promoting sustained engagement and skill consolidation.

Research further indicates that digital media can positively influence students' motivation, engagement, and academic outcomes when thoughtfully integrated into instruction (Kim et al., 2021; Qian & Chen, 2020). From a theoretical perspective, multimedia learning theory posits that students learn more effectively when information is presented through complementary verbal and visual channels (Mayer, 2005). Digital tools can incorporate visual representations, animations, and interactive simulations that support cognitive processing and conceptual understanding. In addition, cognitive load theory suggests that well-designed multimedia resources can optimize working memory capacity by distributing information across modalities, thereby enhancing learning efficiency (Sweller, 2010). Nevertheless, scholars caution that the mere presence of technology does not guarantee improved learning outcomes; its pedagogical alignment and integration with instructional strategies remain critical (Gracin & Krišto, 2022).

Although both the demonstration method and digital learning media have demonstrated individual effectiveness in supporting mathematics instruction, empirical investigations examining their combined application in elementary arithmetic contexts remain limited. Much of the existing literature tends to focus on single-method interventions, either evaluating teacher-led instructional strategies in isolation (Powell et al., 2021) or assessing the impact of digital tools without embedding them within a coherent pedagogical framework (Kim et al., 2021). Moreover, a substantial proportion of digital learning research has been conducted in secondary or higher education settings, leaving a relative gap in primary education contexts. This gap is particularly evident in countries such as Indonesia, where the integration of structured demonstration with digital reinforcement at the elementary level has not been extensively explored.

Theoretically, integrating demonstration methods with digital media offers a complementary and potentially synergistic instructional model. Demonstration provides explicit, sequential guidance that scaffolds students' understanding of arithmetic procedures, while digital media extend this guidance through interactive practice, adaptive feedback, and opportunities for independent reinforcement (Gracin & Krišto, 2022; Koreňová et al., 2024). Such integration aligns with multimodal and constructivist perspectives, as students first observe and internalize modeled strategies and subsequently construct understanding through guided digital engagement. By combining structured teacher facilitation with technology-enhanced practice, this hybrid approach may simultaneously strengthen accuracy, efficiency, and conceptual depth in arithmetic performance.

Given the persistent challenges in elementary students' arithmetic mastery and the limited empirical evidence regarding integrated instructional models, systematic investigation is warranted. This study seeks to evaluate the effectiveness of integrating the demonstration method with digital learning media in enhancing Grade IV students' arithmetic skills. Specifically, it examines whether this combined approach improves students' accuracy, procedural efficiency, and conceptual understanding of basic arithmetic operations, and how digital media function to reinforce concepts introduced through teacher demonstrations. By addressing a gap in the literature—particularly within the context of Indonesian elementary education—this research aims to contribute both theoretically and practically to the development of innovative, evidence-based mathematics instruction. Ultimately, the findings are expected to inform pedagogical practices that support meaningful arithmetic learning and strengthen foundational competencies essential for students' continued academic progress.

2. METHODS

2.1 Research Method

This study employs a quasi-experimental one-group pretest-posttest design to investigate the effectiveness of the demonstration method integrated with digital learning media on the calculation

skills of Grade IV elementary school students. The pretest-posttest design involves a single group of participants who are assessed before and after the intervention. This design was selected because it allows for the assessment of changes in students' mathematical performance as a result of the intervention. However, it is important to note that the lack of a control group introduces limitations in terms of establishing causal relationships. Without a control group, it is difficult to rule out other external factors that might influence the observed changes, thus affecting the internal validity of the study. The absence of a control group means that we cannot definitively attribute improvements in students' calculation skills solely to the intervention, as factors such as maturation, test-retest effects, or other concurrent educational activities may also have contributed to the observed outcomes.

The intervention's duration was eight weeks, with two sessions per week. Each session lasted approximately 45 minutes, totaling 16 sessions. During these sessions, the demonstration method was used to model step-by-step solutions to arithmetic problems, while digital learning media were used to reinforce learning and provide interactive practice. The integration of digital tools provided students with an opportunity to engage with the content independently after the teacher's demonstration, enhancing their understanding and reinforcing key concepts.

2.2 Participants and Sampling

The sample consists of 40 Grade IV students from Mendak State Elementary School, Ponjong, Gunungkidul, using total sampling. This approach ensures inclusivity and provides a comprehensive view of the impact of the intervention on all students in the targeted grade level. However, the use of a single school and a relatively small sample size may limit the generalizability of the findings beyond this specific context. While the findings may be relevant for similar schools in the region, caution should be exercised when applying them to a broader population.

2.3 Intervention

The intervention involved the implementation of the demonstration method integrated with digital learning media over eight weeks. The demonstration method included teacher-led step-by-step modeling of arithmetic problem-solving, with students observing and practicing alongside the teacher. Digital learning tools were then used to supplement the instruction. These tools allowed students to practice the concepts independently, receive immediate feedback, and engage with visual aids to reinforce their learning. Specifically, the study utilized the Khan Academy app, which provides interactive practice problems, video explanations, and immediate feedback on arithmetic skills (addition, subtraction, multiplication, and division). The use of Khan Academy allowed for personalized learning where students could progress at their own pace, solidifying the concepts introduced during the teacher's demonstration.

2.4 Data Collection and Instrument

Data were collected through a 20-item multiple-choice test that covered basic arithmetic operations (addition, subtraction, multiplication, and division). The test was administered both as a pretest and posttest to measure learning gains. To ensure the validity and reliability of the test:

a) The test items were reviewed by two mathematics education experts to assess content relevance and clarity.
b) Reliability was assessed through a pilot test with a similar student population, resulting in a Cronbach's alpha coefficient of 0.81, indicating high internal consistency.

2.5 Data Analysis

Data were analyzed using a paired sample t-test, which is appropriate for measuring changes within the same group over time. The test compares mean scores from the pretest and posttest to

determine whether the differences are statistically significant. This approach provides evidence of the effectiveness of the integrated teaching method in improving students' calculation skills.

2.6 Ethical Considerations

The study was conducted with full adherence to ethical research standards. Approval was obtained from the school principal and the relevant school authorities. Informed consent was secured from all participants' parents or guardians before the study. Participation was voluntary, and students were assured of the confidentiality and anonymity of their responses.

3. FINDINGS AND DISCUSSION

3.1. Characteristics of Participants and Their Pretest-Posttest Results

The following table displays the characteristics of the participants, their frequencies, percentages, and the pretest and posttest results based on age and gender. This data allows for a comparison of how different groups performed before and after the intervention, providing insight into any variations in improvement related to these characteristics.

Table 1: Characteristics of Participants and Their Pretest-Posttest Results

Characteristic	Frequency (n=40)	Percentage (%)	Pretest	Posttest
Age				
9 years	25	62.50%	58.91	84.59
10 years	15	37.50%	62.55	87.21
Gender				
Male	18	45.00%	56.21	83.76
Female	22	55.00%	64.22	86.98
Total	40	100%	60.62	85.56

The data indicates a general improvement in calculation skills across all groups, with notable differences between age and gender. For age, students who were 10 years old showed a higher average posttest score (87.21) compared to 9-year-olds (84.59), suggesting that older students may have had a slightly greater gain in their calculation skills. However, both age groups exhibited significant improvements from their pretest scores, with 10-year-olds showing an average pretest score of 62.55 and 9-year-olds at 58.91, indicating that the intervention positively impacted students across both age categories. Regarding gender, female students began with a higher pretest score (64.22) than their male counterparts (56.21), and they also showed a greater improvement in their posttest scores (86.98 compared to 83.76). This suggests that while both genders benefited from the intervention, females demonstrated a slightly higher overall performance. Nevertheless, both male and female students showed substantial progress, highlighting the effectiveness of the combined demonstration method and digital learning media in improving calculation skills across different demographics.

3.2. Results of Pretest and Posttest Calculating Skills

The following table presents the results of the pretest and posttest administered to Grade IV students at Mendak State Elementary School, Ponjong, Gunungkidul. The table categorizes students based on their calculating skills and shows how their performance changed after the intervention, which involved the demonstration method combined with digital learning media.

Table 2: Pretest and Posttest Results of Calculating Skills

Score	Category of Calculating Skill	Score Range	Pretest (Number of Students)	Percentage	Posttest (Number of Students)	Percentage
1.	Very Low	0-19	0	0%	0	0%
2.	Low	20-39	9	23%	0	0%
3.	Fair	40-59	12	30%	1	3%
4.	High	60-79	16	40%	15	38%
5.	Very High	80-100	3	8%	24	60%
Total			40	100%	40	100%
Average			60.62		85.56	
Lowest			30.00		52.00	
Highest			86.00		96.00	
Standard Deviation			13.52		10.99	
Gain (Difference)			24.95			

The data from the pretest and posttest indicate a significant improvement in students' calculating skills following the intervention. In the pretest, a considerable proportion of students fell into the "Low" and "Fair" categories, with only 8% of students demonstrating "Very High" skills. After the intervention, the majority of students (60%) achieved "Very High" scores, and the percentage of students in the lower categories decreased dramatically. This shift suggests that the integration of the demonstration method with digital learning media had a positive impact on students' mathematical proficiency, helping them move from basic skills to more advanced levels of calculation. Furthermore, the average score increased from 60.62 in the pretest to 85.56 in the posttest, reflecting an improvement of 24.95 points. The reduction in standard deviation from 13.52 to 10.99 further indicates that the students' scores became more consistent, with less variability in their performance after the intervention. The results highlight the potential of combining traditional teaching methods with digital tools to foster a more engaging and effective learning environment. This approach not only improves calculation skills but also helps students gain confidence in their ability to solve mathematical problems.

3.3. Normality Test

The following table presents the results of the Kolmogorov-Smirnov normality test conducted on the pretest and posttest counting skill scores. This test is used to determine whether the data follows a normal distribution, which is essential for deciding on the appropriate statistical analysis methods.

Table 3: Results of Kolmogorov-Smirnov Normality Test

Variable	N	Mean	Std. Deviation	Test Statistic	Sig. (2-tailed)
Pretest Counting Skill	40	60.62	13.52	0.231	0.223
Posttest Counting Skill	40	85.56	10.99	0.254	0.219

The results of the Kolmogorov-Smirnov test indicate that both the pretest and posttest counting skill data are normally distributed. With significance values (p-value) greater than 0.05 (0.223 for pretest and 0.219 for posttest), we fail to reject the null hypothesis that the data follows a normal distribution. This suggests that parametric tests, such as the paired sample t-test, can be applied to analyze the data, as the assumption of normality is met for both pretest and posttest scores. This normal distribution provides confidence in the validity of the statistical analysis performed in this study.

3.4. Results of Paired Samples Test

The following table presents the results of the paired samples t-test conducted to evaluate the difference in counting skills between the pretest and posttest. The test assesses whether there is a statistically significant improvement in students' calculation abilities after the intervention.

Table 4: Paired Samples Test Results

Variable Pair	Mean Difference	Std. Deviation	t	df	Sig. (2-tailed)
Pretest Counting Skill - Posttest Counting Skill	24.945	1.584	15.433	39	0.000

The results of the paired samples t-test show a significant improvement in the students' counting skills from the pretest to the posttest, with a mean difference of 24.945. The t-value of 15.433, with 39 degrees of freedom, is highly significant, as indicated by the p-value of 0.000, which is less than the 0.05 significance level. This strong statistical evidence suggests that the intervention, which combined the demonstration method with digital learning media, had a significant positive impact on students' ability to perform basic arithmetic operations. The large mean difference between the pretest and posttest scores indicates that the students experienced a substantial gain in their calculation skills after the intervention. This suggests that the integrated approach of using both traditional demonstration methods and interactive digital tools effectively enhanced students' understanding and proficiency in mathematics. These findings underscore the potential benefits of incorporating modern educational technologies alongside traditional teaching strategies to improve mathematical performance in elementary education.

Discussion

The findings of this study reveal a statistically significant improvement in the calculation skills of Grade IV students following the implementation of the demonstration method integrated with digital learning media. The mean score difference of 24.945 between pretest and posttest scores suggests a notable enhancement in students' arithmetic abilities. Rather than merely presenting this as an outcome, it is crucial to understand *why* this integrated instructional approach proved effective.

The strength of this teaching strategy lies in its synergistic use of demonstration and digital media. Demonstration offers structured modeling of arithmetic operations, making abstract mathematical concepts more concrete and accessible (Yunus et al., 2022). When paired with digital tools, the learning experience becomes more interactive, personalized, and engaging, allowing students to explore and practice at their own pace (Setiawan et al., 2023).

Digital learning media plays a vital role by offering immediate feedback, gamified content, and adaptive learning paths, which are especially beneficial for young learners who require motivation and repetition to master fundamental skills (Agnesa et al., 2023). These tools not only reduce learning anxiety but also promote self-correction and independent problem-solving (Rachmadtullah et al., 2022), supporting both skill acquisition and retention.

Moreover, the personalization afforded by digital platforms ensures that learners with varying abilities and preferences can receive targeted support, reinforcing their understanding in a more efficient and meaningful way (Mirķe et al., 2019). The dual approach accommodates diverse learning styles, resulting in a more inclusive and responsive learning environment (Sangur & Makatita, 2021; Doo et al., 2021).

However, the results must be interpreted in light of several limitations. First, the absence of a control group restricts the ability to attribute improvements solely to the intervention, as other variables may have influenced outcomes. Second, test familiarity—the use of the same instrument for pretest and

posttest—may have introduced practice effects. Third, the study was conducted in a single school with a limited sample size, which affects the generalizability of the findings.

To address these limitations, future research should include a control or comparison group to better isolate the intervention's effect. Additionally, delayed posttests could assess long-term retention of skills, and expanding the study across multiple schools or regions would enhance external validity. Research might also explore the integration of digital learning media across other mathematical domains or subjects, as well as its impact on student motivation and engagement over time.

The results also offer valuable implications for teacher training and curriculum design. Educators should be equipped with the skills to effectively combine traditional and digital methods, recognizing when and how to implement each to maximize learning. Furthermore, curriculum developers can consider embedding interactive, technology-enhanced learning strategies into mathematics education frameworks to support diverse learner needs and foster deeper conceptual understanding.

The Effectiveness of the Integrated Approach Based on Educational Theory

The observed improvements in students' calculation skills can be understood through the lens of several educational theories. The demonstration method, which provides clear, structured guidance, is rooted in Vygotsky's Zone of Proximal Development (ZPD), where learners benefit from guidance that enables them to perform tasks just beyond their current ability but achievable with support (Vygotsky, 1978). This method allows students to initially observe and learn from teacher modeling before gradually taking on more responsibility for solving problems on their own. By providing a clear problem-solving framework, the demonstration method supports the development of foundational mathematical skills.

When integrated with digital learning media, the approach aligns with multimodal learning theory, which suggests that students learn more effectively when information is presented through multiple modalities (visual, auditory, and kinesthetic) (Mayer, 2005). Digital tools, such as interactive apps and platforms, offer visual aids, immediate feedback, and opportunities for repetition, thus reinforcing the understanding gained through demonstration. This multimodal approach helps optimize cognitive load, allowing students to process information more efficiently by reducing extraneous cognitive load (Sweller, 2010).

Motivation, Engagement, and Self-Regulated Learning

One of the key factors contributing to the effectiveness of this approach is student motivation and engagement. Digital learning media have been shown to increase student motivation by providing gamification elements, such as rewards, progress tracking, and interactive exercises. Research has demonstrated that students are more motivated to engage with learning materials when they are interactive and provide instant feedback, as seen in platforms like Khan Academy (Outhwaite et al., 2023). The digital tools used in this study not only provided instant feedback but also allowed students to practice at their own pace, fostering a sense of autonomy and mastery over their learning.

Furthermore, this integration supports self-regulated learning (Zimmerman, 2002). Digital tools encourage students to monitor their own progress, set goals, and reflect on their learning process. By practicing independently through digital exercises, students were able to engage in self-assessment, identify areas of improvement, and adjust their strategies accordingly. This is particularly important for building long-term learning habits and fostering independent problem-solving skills, which are essential for lifelong learning and academic success.

Analysis of Age and Gender Differences

While the study did not focus heavily on age or gender as primary variables, it is worth noting some differences in the improvements seen across these groups. As shown in Table 1, 10-year-old students demonstrated higher posttest scores than 9-year-olds, which could be attributed to cognitive development factors. Older students may have a more developed working memory or better problem-solving strategies, which allowed them to benefit more from the intervention. However, it is important to note that both age groups showed significant improvement, suggesting that the intervention was effective across different age ranges.

Gender differences also emerged, with female students showing slightly higher performance than male students, both in terms of pretest scores and posttest improvements. This finding aligns with some studies that suggest gender may influence learning outcomes, possibly due to differences in learning styles or socialization (Kim et al., 2021). Nonetheless, both genders showed substantial gains, further highlighting the effectiveness of the integrated method in enhancing calculation skills across diverse student populations.

4. CONCLUSION

This study found that integrating the demonstration method with digital learning media significantly improved the calculation skills of Grade IV students. The clear increase in posttest scores compared to pretest results indicates that combining structured, step-by-step teaching with interactive digital tools enhances students' understanding and proficiency in basic arithmetic operations. The use of engaging digital resources, alongside traditional demonstration techniques, creates a more effective and motivating learning environment for young learners.

Based on these findings, educators are encouraged to adopt integrated instructional approaches that leverage both conventional teaching methods and digital learning media. Doing so can help cater to diverse learning needs, maintain student interest, and improve mathematical outcomes in elementary classrooms.

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