**Deepening Grade 1 Learners’ Ability to Visualize Missing Numbers in Addition and Subtraction Sentences Through Technology-Based Drills**

# ABSTRACT

The global trend highlights the need to adopt scalable, technology-driven solutions that bridge the gaps in early mathematics education. In the Philippines, similar challenges are evident, with a significant proportion of Grade 1 learners struggling to grasp fundamental arithmetic concepts. This study aimed to determine the impact of non-digital, technology based-drills on deepening Grade 1 learners’ ability to visualize missing numbers in addition and subtraction sentences. Conducted at San Rafael Integrated School during S.Y. 2024-2025, it focused on arithmetic visualization tasks over a five-day intervention. Anchored on John Dewey’s Constructivist Theory of “learning by doing”, the approached emphasized hands-on, experiential learning. Results showed both groups had low and nearly identical pre-test scores: control $(x̄=5.64, SD=2.74)$ and experimental $(x̄=5.65, SD= 2.25)$. After the intervention, the experimental group achieved significantly higher post test scores $(x̄=17.75, SD = 1.71)$ than the control group $(x̄=13.93, SD= 2.45)$, with a p value of $0.001$. The effect size using Cohen’s d was 2.17, indicating a large and meaningful educational impact. Based on the findings, the study recommends integrating structured, non digital tools in early math instruction and further exploring their long term effects.

**Keywords:** *Visualizing Missing Numbers, Constructivist Theory, Learning by Doing, Non-digital technology, Drills*

**INTRODUCTION**

Mathematics education serves as a cornerstone for developing problem-solving and critical thinking skills in young learners. However, these skills often rely on a strong foundation in basic operations, such as addition and subtraction (Jablonka, 2020). Interactive technology has emerged as a transformative tool in education, enhancing engagement and understanding among students (Bond & Bedenlier, 2019). Brewer (2016) found that technology-based instructional tools significantly improve learners' ability to visualize abstract mathematical concepts, such as missing numbers, by bridging the gap between theory and practice. Similarly, De Las Peñas et al. (2019) emphasized that non-digital simulations not only foster engagement but also create an immersive learning environment that supports the cognitive retention of fundamental math skills. Globally, this shift reflects a broader recognition of how innovative strategies, including gamified learning, can address the persistent challenges faced by early learners in mastering arithmetic (Ortiz et al., 2020). Despite these advancements, many young learners worldwide struggle with foundational mathematics skills, including visualizing and solving for missing numbers (Teahen, 2015). In developed countries like the United States, approximately 24% of Grade 1 students fail to demonstrate proficiency in basic addition and subtraction (Harper et al., 2019). This gap is even more pronounced in developing nations like India, where over 50% of students fall below minimum numeracy standards due to limited access to quality instructional resources and teacher training (Ortiz et al., 2020). Underdeveloped countries face a compounded challenge: With insufficient infrastructure, students remain dependent on rote learning methods that are often inadequate for fostering problem-solving skills (Johnson, 2014). This global trend highlights the need to adopt scalable, technology-driven solutions that bridge the gaps in early mathematics education. In the Philippines, similar challenges are evident, with a significant proportion of Grade 1 learners struggling to grasp fundamental arithmetic concepts (Magayon & Tan, 2016). A recent report by the Department of Education (DepEd) revealed that 60% of young learners face difficulty in visualizing and solving problems involving missing numbers in addition and subtraction sentences (Torres, 2020). This issue persists despite various national initiatives aimed at improving numeracy levels, primarily due to inadequate access to technology and insufficient teacher training (Gal et al., 2020). While urban schools have started adopting technology-based drills with notable success, rural areas lag due to resource constraints, leaving many students at a disadvantage (Ng'ambi et al., 2016). This disparity highlights the need for localized, technology-driven interventions that are both effective and accessible (McKenney & Reeves, 2018). Technology-based drills, the study's independent variable, present an opportunity to address these gaps by enabling learners to interact with mathematical problems dynamically and engagingly (Dwivedi et al., 2023). Studies by Morais et al. (2021) have shown that such drills enhance students' ability to visualize and understand mathematical relationships through repetitive and gamified exercises. Furthermore, tools such as learning materials or manipulatives enable students to engage actively with missing-number problems, thereby improving their ability to process and solve arithmetic operations effectively (Adu, E., 2022). This approach not only enhances comprehension but also caters to diverse learning styles, fostering inclusivity and deeper cognitive engagement (Dixit et al., 2024). Although the use of technology in mathematics education has been widely studied, most research has focused on general numeracy improvement rather than the specific skill of visualizing missing numbers (Venkatraman et al., 2019). Moreover, while existing studies highlight the potential of technology-based learning, there remains limited evidence of its sustained impact when applied to specific arithmetic challenges in Grade 1 learners (Escueta et al., 2017). This study addresses the gap uniquely by focusing on the cognitive skill of visualizing missing numbers, offering a novel approach to improving early numeracy outcomes. The social implications of improving foundational numeracy extend beyond academic performance (Geiger et al., 2015). Proficiency in basic arithmetic is a critical determinant of future academic success, career readiness, and overall cognitive development (Serdyukov, 2017). By leveraging technology-based drills, this study aims not only to enhance the mathematical skills of Grade 1 learners but also to align with national educational goals of fostering digital literacy (Ortiz, 2020). An important area that requires attention is enhancing learners' ability to visualize missing numbers in mathematical sentences. The ability to visualize these missing numbers is crucial for comprehending the connections between numbers and operations, which in turn leads to proficiency in solving complex problems as students advance in their education. Furthermore, this study aimed to investigate how the use of non-digital tools can enhance young learners' understanding of mathematical problems and their ability to visualize and solve missing number problems with greater confidence and accuracy**.**

**Statement of the Problem**

This quantitative action research aimed to investigate how the use of non-digital tools can enhance young learners' understanding of mathematical problems and their ability to visualize and solve missing number problems with greater confidence and accuracy. It sought to address the following questions:

1. What is the level of pre-test scores in terms of learners' ability to visualize missing numbers in addition and subtraction sentences between the control and experimental groups?
2. Is there a significant difference in the pre-test scores between the control and experimental groups in terms of learners' ability to visualize missing numbers in addition and subtraction sentences?
3. What is the level of post-test scores in terms of learners' ability to visualize missing numbers in addition and subtraction sentences between the control and experimental groups after the intervention?
4. Is there a significant difference in the post-test scores between the control and experimental groups in terms of learners' ability to visualize missing numbers in addition and subtraction sentences?
5. What is the effect size of the intervention in case of existing significant differences in the post-test scores between the control and experimental groups?

**Objective of the Study**

This study aimed to attain the following objectives:

1. To determine the level of pre-test scores in terms of Grade 1 learners' ability to visualize missing numbers in addition and subtraction sentences between the control and experimental groups.
2. To determine if there is a significant difference in the pre-test scores between the control and experimental groups regarding learners' ability to visualize missing numbers in addition and subtraction sentences.
3. To determine the level of post-test scores in terms of Grade 1 learners' ability to visualize missing numbers in addition and subtraction sentences between the control and experimental groups after the intervention.
4. To determine if there is a significant difference in the post-test scores between the control and experimental groups regarding learners' ability to visualize missing numbers in addition and subtraction sentences after the intervention.
5. To determine the effect size of the intervention in cases where a significant difference exists in the post-test scores between the control and experimental groups.

**Significance Study**

This action research will benefit the following;

**Students.** By utilizing technology-based drills, students are expected to develop faster and more accurate computation skills, particularly in identifying missing numbers in addition and subtraction sentences. This method can make learning math more engaging and enjoyable, thereby fostering both interest and competence in the subject. It also introduces young learners to the beneficial use of technology in their education.

**Teachers.** The research may provide teachers with practical insights into how integrating technology into their lessons can enhance Grade 1 learners' ability to understand and solve addition and subtraction sentences with missing numbers. Teachers can incorporate these technology-based drills into their instructional strategies, making math lessons more dynamic and addressing diverse learning needs. It also helps in tracking student progress more efficiently.

**Parents and Guardians.** This study can provide parents with a deeper understanding of how technology-based drills can enhance their children's ability to solve addition and subtraction problems, specifically in visualizing missing numbers. It emphasizes how technology can be an effective tool in enhancing cognitive skills and encourages parents to support and engage in their children's learning process by using similar activities at home.

**Educational Researchers.** This study will serve as a foundation for further research on the role of technology in developing mathematical problem-solving skills in early education. Future researchers can expand on the findings by exploring their application in other areas of math or different age groups. Additionally, it may open up avenues for more in-depth studies on the long-term impact of technology-based learning tools in education.

**Scope and Limitation of the Study**

This study examined the effectiveness of interactive non-digital tools in enhancing the foundational mathematics skills of Grade 1 students at San Rafael Integrated School during the 2024–2025 school year, with a specific focus on learning gains during the elaboration phase of the lesson. The research centered on key competencies, particularly *composing and decomposing a given number (e.g., 5 as 5 and 0; 4 and 1; 3 and 2; 2 and 3; 1 and 4; 0 and 5) (M1NS-IC-4)* and *visualizing and identifying missing numbers in addition and subtraction sentences using various strategies (M1AL-IIIj-10).* In this study, the elaboration phase was strategically emphasized as the instructional period where learners actively processed and deepened their understanding through structured visual and kinesthetic activities. The experimental group received instruction enriched with non-digital tools—such as flashcards, counters, blocks, and number charts—particularly during the elaboration segment of the lessons. In contrast, the control group received traditional instruction without these enhancements. Findings were measured by assessing student performance in hands-on, guided activities, confirming that learners demonstrated the most significant improvements when engaged in interactive, elaborative tasks designed to reinforce and extend mathematical thinking**.**

**Theoretical Framework**

This study is grounded in John Dewey’s Constructivist Theory, particularly the principle of “learning by doing,” which emphasizes active, hands-on engagement as key to meaningful learning (Dewey, 1916). Dewey believed that students learn best through practical experiences that encourage critical thinking, collaboration, and real-world problem-solving (Biesta, 2016; Fidan & Tuncel, 2019). In mathematics education, this approach helps learners connect abstract concepts—like missing numbers—to tangible experiences, enhancing understanding and retention (Brewer, 2016).

Aligned with this theory, the study uses both digital and non-digital tools—such as flashcards, blocks, counters, and gamified technology-based drills—to help Grade 1 learners visualize and solve addition and subtraction problems involving missing numbers (De Las Peñas et al., 2019; Miller et al., 2021). These tools promote active participation, immediate feedback, and iterative learning, allowing students to construct knowledge through exploration and reflection. By fostering independence and problem-solving skills, this approach prepares learners to apply mathematical thinking in real-world contexts, reflecting Dewey’s vision of learner-centered, meaningful education.

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| --- |
| **Dependent Variable**Math Performance of the learners **Independent Variable**Using Technology-based drills as a teaching method |

**Figure 1. Conceptual diagram of the study**

**REVIEW OF RELATED LITERATURE**

This chapter aims to provide a comprehensive review of relevant literature and studies that highlight the key factors influencing learners' understanding of mathematical concepts. By synthesizing existing literature, this chapter provides a deeper understanding, highlighting the following key areas: The Foundation of Early Math Skills, Challenges in Traditional Math Instruction, The Role of Technology in Math Education, Leveraging Technology-Based Drills for Accuracy, The Role of Gamified Tools in Improving Accuracy, and The Long-Term Benefits of Technology-Based Drills. By examining these aspects, this review aims to provide a comprehensive foundation for understanding how SBL impacts student learning and engagement in the science classroom.

**The Foundation of Early Math Skills**

Early math skills are crucial for lifelong cognitive development and academic success. Research shows that early proficiency in mathematics supports learning in other subjects and strengthens skills like memory, attention, and problem-solving (Clements & Sarama, 2020; Geary et al., 2017). Hands-on tools and play-based learning enhance brain development and foster creativity, executive function, and critical thinking (Vogt et al., 2020; Celik & Ozdemir, 2020).

Building math confidence early also encourages resilience, reduces anxiety, and promotes a positive attitude toward learning (Katz, 2016; Onoshakpokaiye, 2023). These foundational skills prepare students to tackle real-world challenges and make informed decisions (Sitopu et al., 2024). Ensuring equitable access to quality math instruction, especially for underserved communities, is vital for closing learning gaps and supporting long-term academic success (Bassok & Galdo, 2016; Jozsa et al., 2022).

**Challenges in Traditional Math Instruction**

Traditional math instruction often relies on rote memorization and passive learning, which limits students’ understanding and ability to apply concepts in real-world situations (Clements & Sarama, 2020; Li & Schoenfeld, 2019). These methods do little to foster critical thinking or problem-solving skills, especially in foundational arithmetic (Bicer, 2021).

Rigid, one-size-fits-all teaching approaches fail to address diverse learning styles and often leave struggling students behind (Khalaf et al., 2018; Geary et al., 2017). The pressure of standardized testing further reinforces surface-level learning, increasing math anxiety and reducing opportunities for exploration (Kasa et al., 2024).

Traditional classrooms often lack interactive and engaging elements like hands-on activities or storytelling, which are key to sparking curiosity and motivation (Broomhead et al., 2018; Walters et al., 2018). Teacher-centered methods also limit student participation and deeper conceptual understanding (Rao, 2020).

**The Role of Technology in Math Education**

Technology has transformed math education by providing interactive tools that enhance understanding and engagement (Verbruggen et al., 2021; Serin, 2023). These tools support active learning and real-world problem-solving (Haleem et al., 2022).

Non-digital tools like manipulatives and flashcards also play a crucial role by offering hands-on experiences that make abstract concepts more concrete (Smiderle et al., 2020; Bang et al., 2022). They support personalized learning, reduce anxiety, and promote mastery by allowing students to learn at their own pace (Umameh, 2020; Yang et al., 2018). With built-in feedback features, these tools help learners self-correct and build confidence (Lamb, 2017; Martinez, 2019).

In sum, non-digital tools remain essential in math instruction, offering adaptable, tactile, and engaging learning experiences that complement both traditional and tech-based methods (Abilova, 2024).

**Leveraging Technology-Based Drills for Accuracy**

Technology-based drills enhance mathematical accuracy by providing targeted, interactive practice with immediate feedback, helping students recognize and correct errors in real time (Manalaysay, 2021; Drigas et al., 2023). These drills adapt to individual skill levels, ensuring personalized learning and deeper understanding of arithmetic concepts (Bang et al., 2022; Yilmaz, 2017). Gamified elements further boost motivation, reduce anxiety, and support consistent, engaging practice that leads to long-term skill retention (Ramirez et al., 2018; Smiderle et al., 2020).

Similarly, non-digital gamified tools like math board games, flashcards, and puzzles improve accuracy by combining fun, hands-on learning with structured challenges (Verbruggen et al., 2021; Jimola & Adeleke, 2022). These tools offer immediate tactile feedback, support peer collaboration, and reduce pressure, making practice more effective and enjoyable—especially for young learners (Bang et al., 2022; Abilova, 2024). Both digital and non-digital gamified strategies foster active learning and precision in solving math problems.

**Enhancing Visualization of Missing Numbers Through the Elaboration Phase**

The elaboration phase is crucial for developing mathematical understanding, especially in teaching addition and subtraction with missing numbers (Almarode et al., 2019). It helps students connect prior knowledge to new concepts through visualization and guided problem-solving (Fuson, 2020; Pfister et al., 2015). Using tools like number lines, bar models, and ten-frames supports mental modeling and flexible thinking (Jitendra et al., 2019).

Interactive group work, visuals, and peer discussions during this phase enhance conceptual understanding and confidence, especially for learners with difficulties (Boonen et al., 2016; Hammer, 2018). Visual strategies like part-part-whole diagrams reduce reliance on memorization and promote adaptive reasoning (Fisher & Frey, 2016).

Incorporating digital tools and consistent visual scaffolds further strengthens learning and retention (Santillan et al., 2023). Overall, embedding visualization in elaboration fosters deeper comprehension, inclusivity, and creative problem-solving in early math instruction.

**The Long-Term Benefits of Technology-Based Drills**

Technology-based drills improve arithmetic accuracy and retention by offering personalized, interactive practice with real-time feedback (Manalaysay, 2021; Bang et al., 2022). These tools strengthen neural connections and help learners internalize math concepts through repetition and sensory engagement (Fuchs et al., 2016; Metsämuuronen, 2018).

By fostering automaticity in basic operations, drills free up cognitive resources for advanced problem-solving, supporting progression to higher-level math (Geary et al., 2017; Rosli & Lin, 2018). They also boost confidence and motivation, especially when paired with gamified features that make learning enjoyable (Bang et al., 2023; Mitsea et al., 2022).

Moreover, adaptive digital drills promote equity by catering to diverse learning needs, helping close achievement gaps and ensuring all students build strong foundational skills (Fuchs et al., 2016; Metsämuuronen, 2018).

 **METHODOLOGY**

**Research Locale**



**Figure 2: Map of San Rafael Integrated School**

The study was conducted at San Rafael Integrated School, located in San Rafael, Cateel, Davao Oriental. This school served a diverse student population, providing an ideal setting for implementing strategies aimed at improving student's ability to compose and decompose given numbers and to visualize and find the missing number in an addition or subtraction sentence using a variety of methods.

The research took place from February to April 2025, with a one-week intervention implemented to enhance these skills.

**Research Design**

This study employed a quasi-experimental design, a type of research method that involves an experimental group and a control group, although the groups were not randomly selected (Gopalan et al., 2020). According to Creswell (2018), quasi-experimental designs were often used in real-life settings where random assignment was not possible. This design was found helpful for comparing the effects of an intervention on one group while using the other group as a comparison.

**Respondents and Sampling Procedures**

The respondents for this study **were** Grade 1 learners from two sections at San Rafael Integrated School who **were enrolled** in Mathematics classes. These students **regularly participated** in Math lessons and **were included** only if they had obtained parental consent. A total of 49 students **were selected** as respondents and **divided** into sections. Among these sections, one **was assigned** as the experimental group, which **utilized** technology-based drills as a teaching method, and the other **was designated** as the control group, which **followed** the traditional teaching method. The assignment of experimental and control groups **was determined** through a coin toss.

**Research Instrument**

The study **utilized** a researcher-designed instrument to evaluate participants' learning outcomes before and after the intervention. The instrument **underwent** rigorous assessments of validity and reliability. Content validity **was established** through consultation with three experts, who **evaluated** the test questionnaire for alignment with outcomes, relevance to learning objectives, and the quality of each test item. The Aiken’s V coefficient **derived** from their ratings **was** 0.93, indicating a high level of validity. To confirm reliability, the instrument **was pilot-tested** in other schools, yielding a Cronbach's alpha coefficient of 0.786, indicating strong reliability. As a result, the 30-item test instrument **was deemed** both valid and reliable.

**Data Gathering Procedure**

This research followed a data-gathering procedure that comprised several steps to collect data from participants officially enrolled in Grade 1 at San Rafael Integrated School for the 2024–2025 school year. The researchers adhered to the following procedure:

1. Ethical clearance was obtained from the University Research Ethics Board to ensure compliance with ethical standards and to protect the rights and confidentiality of participants during data collection.
2. A permission letter was submitted to the School Principal of San Rafael Integrated School to obtain approval for conducting the research.
3. Upon approval, permission letters were submitted to the research adviser and parents detailing the nature and purpose of the study.
4. Pre-test questionnaires were administered to both the control and experimental groups.
5. The intervention was conducted as follows:
6. The control group received traditional instruction on visualizing missing numbers in addition and subtraction sentences.
7. The experimental group was provided with instruction using non-digital tools such as flashcards and other manipulatives.
8. Post-test questionnaires were administered to both groups to measure any improvements in visualizing missing numbers in addition and subtraction sentences.
9. Post-test data were collected, processed, and analyzed by totaling, tallying, encoding, and interpreting the results.

**Data Analysis**

 **Mean.** This statistical tool was used in the study to determine the pre-test and post-test scores of the experimental and control groups, thereby addressing the research questions: (1) What were the pre-test scores of the experimental and control groups? and (3) What were the post-test scores of the experimental and control groups? Hence, this tool was utilized in achieving Objectives 1 and 3.

**T-test.** Specifically, an independent samples t-test **was utilized** in this action research to determine the significant difference between the pre-test scores of the experimental and control groups (Objective 2) and to assess the extent to which Grade 1 learners **were able to visualize** missing numbers in addition and subtraction sentences in Mathematics. Thus, this statistical tool **addressed** Research Question 2 and **achieved** Objective 2.

**ANCOVA.** This tool **was used** to determine whether there **was** a significant difference between the post-test scores of the control and experimental groups. Thus, it **answered** Research Question 4 and **achieved** Objective 4.

**Cohen’s d.** This statistical measure **was used** to estimate effect size when comparing means, particularly in conjunction with t-tests or ANOVA. It **was utilized** to analyze Statement Number 5 of the research problem. This measure **represented** the difference between means relative to the pooled variance and **remained** constant regardless of sample size (Charlesworth Author Services, 2021).

**Ethical Considerations**

This research followed a structured data-gathering procedure to ensure the reliability and accuracy of the findings. During the study, ethical principles were strictly adhered to in order to protect the rights, safety, and well-being of all participants. The following ethical considerations guided the research process:

1. **Obtaining Informed Consent** – Before engaging student participants, written consent was secured from their parents or legal guardians. They were provided with clear and comprehensive details about the study’s objectives, procedures, potential risks, and benefits to ensure transparency and voluntary participation.
2. **Respecting Children's Assent** – Since the participants were young learners, they were given an age-appropriate and straightforward explanation of the study. Their willingness to participate was prioritized, and they were notcoerced or pressured into joining the program.
3. **Protecting Privacy and Confidentiality** – The identities and personal information of all participants were kept strictly confidential. Data were anonymized in reports, securely stored, and accessed only by authorized personnel to maintain privacy.
4. **Ensuring Safety and Well-being** – The study activities were designed to prevent any form of physical, emotional, or psychological harm. The tasks were age-appropriate, safe, and conducted in a positive and supportive environment.
5. **Right to Withdraw** – Participants and their guardians had the right to withdraw from the study at any point without facing any negative consequences. Their decision was respected, and they were not required to provide any justification for it.
6. **Voluntary Participation** – Participation in the study was entirely voluntary. No undue incentives, pressure, or penalties were imposed on students or their parents, ensuring their decision to participate was free and independent.
7. **Respecting Cultural and Individual Differences** – The study upheld inclusivity by considering participants’ diverse backgrounds, beliefs, and abilities. Activities were designed to be fair and culturally sensitive, fostering an environment of respect and equality.
8. **Equitable Treatment of Participants** – All students were treated fairly and equally throughout the study. No preferential treatment or bias was exhibited in any aspect of participation, assessment, or analysis.
9. **Honest and Reliable Data Reporting** – The research upheld academic integrity by ensuring that all collected data were accurately recorded and reported. No manipulation or misrepresentation of results occurred, preserving credibility and reliability.
10. **Proper Supervision and Guidance** – Qualified educators and researchers supervised all activities to ensure student safety and provided necessary assistance during the learning process. Support mechanisms were in place to address any concerns that arose.

**RESULTS AND DISCUSSION**

This chapter presents the detailed results and discussions derived from the gathered data based on the five statements of the problem. The participants were Grade 1 learners from two different sections categorized into mixed or mainstreamed classes. Each section included capable learners, average learners, and those who were struggling. The intervention used was a set of non-digital, technology-based drills designed to improve their ability to visualize missing number problems within addition and subtraction sentences.

The data gathering involved two Grade 1 sections. One group was assigned as the control group, comprising 28 learners, and the other as the experimental group, also with 21 learners. The intervention, which utilized non-digital technology-based drills (e.g., flashcards), lasted for one week, encompassing a total of 5 school days. Both groups underwent a pre-test before the intervention and a post-test afterward to measure any significant changes in their ability to visualize missing numbers in addition and subtraction sentences.

**Level of Pretest Scores**

Before the intervention was implemented, a pre-test consisting of 20 items was administered to both the control and experimental groups. Table 1 shows that both the control ($x̅ = 5.64, s = 2.74$, $grade = 67$) and experimental $(x̅ = 5.65, s = 2.25, grade = 67)$ groups demonstrated low performance in visualizing missing numbers in addition and subtraction sentences. These figures reflect a baseline level of understanding that suggests difficulty in internalizing previously taught arithmetic skills involving missing numbers.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Group | Total Score | Standard Deviation | Mean | Transmuted Grade | Remarks |
| Control | 20 | 2.74 | 5.64 | 67 | Did Not Meet Expectations |
| Experimental | 20 | 2.25 | 5.65 | 67 | Did Not Meet Expectations |

Table 1. Level of Pretest scores

These findings reveal a key limitation of the spiral curriculum—while concepts are revisited, they often lack reinforcement that promotes deep, lasting understanding (Clements & Sarama, 2020). Learners’ low pre-test scores show gaps in retention, especially with abstract concepts like missing numbers, due to passive, rote-based instruction (Li & Schoenfeld, 2019; Bicer, 2021). Research supports that re-teaching alone is ineffective unless learners actively reconstruct knowledge through varied, meaningful practice (Rittle-Johnson et al., 2019; Dockendorff & Zaccarelli, 2024).

Uniform, test-focused methods hinder conceptual learning and contribute to learning gaps (Kasa et al., 2024; Khalaf et al., 2018). In contrast, active, hands-on strategies—like non-digital drills—enhance retention and confidence by providing concrete experiences (Fuchs et al., 2016; Metsämuuronen, 2018). These results affirm Dewey’s constructivist principle that meaningful learning comes from doing, not memorizing (Geary et al., 2017).

**Difference in Pretest Scores**

Table 2 shows that there was no significant difference ($t = 0.010, p = 0.992$) in the pre-test scores between the control and experimental groups in terms of their ability to visualize missing numbers in addition and subtraction sentences. This result confirms that the two groups were equivalent at baseline, ensuring a fair basis for comparison after the intervention. The similarity in their pre-test scores suggests that any substantial improvement in the experimental group's post-test results can be attributed to the non-digital, technology-based drills rather than to prior differences in ability.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Group | Mean | Standard Deviation | t-value | p-value | Interpretation |
| Control | 5.64 | 2.74 | $$0.010$$ | 0.992 | There is no significant difference in the average pre-test score between the experimental and control groups.  |
| Experimental | 5.65 | 2.25 |

Table 2. The mean difference in pretest scores.

The pre-test results show that early math instruction often fails to support lasting understanding due to rote, uniform methods (Clements & Sarama, 2020). The control group received traditional, teacher-centered instruction, while the experimental group used interactive, technology-based drills. Post-test results revealed that the experimental group significantly outperformed the control group (mean score: 17.75 vs. 13.93), demonstrating that hands-on, visual, and engaging activities led to better understanding and retention of missing number concepts.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Group | Total Score | Standard Deviation | Mean | Transmuted Grade | Remarks |
| Control | 20 | 2.45 | 13.93 | 81 | Satisfactory |
| Experimental | 20 | 1.71 | 17.75 | 92 | Outstanding |

Table 3. Level of Posttest scores.

The significant improvement in the experimental group’s post-test scores highlights the effectiveness of non-digital, technology-based drills in enhancing math skills. Structured, tactile tools like flashcards and puzzles provided engaging, repetitive practice that improved accuracy, confidence, and understanding (Manalaysay, 2021; Bang et al., 2022; Jimola & Adeleke, 2022). These hands-on methods, supported by gamified elements, boosted motivation and reduced anxiety (Smiderle et al., 2020). Aligned with constructivist principles, the intervention promoted active learning and deeper retention (Martinez, 2019; Lamb, 2017).

**Difference of Posttest Scores**

Table 4 presents the test for significant differences in post-test scores between the control and experimental groups. It revealed a significant difference $(t = 6.001, p = 0.001)$ in the post-test scores between the two groups. This suggests that the intervention had a meaningful impact on learners' ability to visualize missing numbers in addition and subtraction sentences. The substantial difference in performance between the groups demonstrates that the intervention effectively enhanced learning outcomes beyond what traditional instruction alone could achieve. The statistically significant improvement confirms the value of using non-digital, structured, and engaging methods that are more aligned with the cognitive and developmental needs of young learners.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Group | Mean | Standard Deviation | t-value | p-value | Interpretation |
| Control | 13.93 | 2.45 | $$6.001$$ | 0.001 | There is a significant difference in the average pre-test score between the experimental and control groups.  |
| Experimental | 17.75 | 1.71 |

 Table 4. The mean difference in posttest score.

The experimental group’s significant improvement supports Serin’s (2023) view that adaptive, hands-on strategies enhance comprehension by addressing diverse learner needs. Unlike rigid traditional methods (Khalaf et al., 2018), the intervention allowed self-paced learning through tactile, gamified tools, boosting engagement and accuracy (Martinez-Maldonado, 2019; Abilova, 2024). These results affirm that interactive, non-digital strategies foster deeper understanding, autonomy, and confidence—reflecting constructivist principles and Dewey’s emphasis on experience-based learning (Bahari et al., 2021; Smiderle et al., 2020).

**Effect Size of the Intervention**

This result reveals that using non-digital and technology-based interventions has significantly improved learners' knowledge of visualizing missing numbers in addition and subtraction. Table 5 shows the degree of its effectiveness. It reveals that the intervention has a large effect $(Cohen's d = 1.757)$ on learning.

Table 5. Effect size of the intervention.

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| --- |
| **Independent Samples Effect Sizes** |
|  | Standardizer | Point Estimate | 95% Confidence Interval |
| Lower | Upper |
| Post Test | Cohen's d | 2.17499 | **1.757** | 1.074 | 2.426 |
| Hedges' correction | 2.21128 | 1.728 | 1.056 | 2.387 |
| Glass's delta | 2.44841 | 1.561 | .843 | 2.259 |

This considerable improvement underscores that the use of structured, non-digital technology-based drills went beyond achieving statistical significance—it made a practical difference in how students learned and applied mathematical concepts. The substantial improvement in the experimental group's performance supports research by Yilmaz (2017), who emphasized that structured, feedback-oriented learning helps students internalize core concepts more effectively. The hands-on, consistent practice provided by the intervention enabled learners to build accuracy and confidence in solving arithmetic problems.

Furthermore, Bahari et al. (2021) highlighted that interventions targeting specific gaps in understanding result in measurable learning gains. The improved performance (17.75; 92) of the experimental group reflects this principle, showing how well-structured instruction can lead to mastery. Rosli and Lin (2018) also noted that such interventions lay the foundation for more advanced mathematical thinking, making this approach not only effective for immediate outcomes but also beneficial for long-term academic development.

**The Implication to Mathematics Education**

The findings of this study suggest that early mathematics instruction should move beyond traditional approaches that rely heavily on rote memorization and repetition (Bicer, 2021). These conventional methods often yield short-term recall rather than a deep understanding (Kasa et al., 2024). Learners exposed to such teaching may remember steps but struggle to apply concepts in new or practical situations (Li & Schoenfeld, 2019). The pre-test scores in this study, despite previous exposure to the topic, illustrate this lack of retention (Clements & Sarama, 2020). Therefore, educators must explore instructional strategies that encourage active participation and concept mastery (Dockendorff & Zaccarelli, 2024).

This study also highlights the value of integrating hands-on, non-digital learning tools in foundational math instruction (Jimola & Adeleke, 2022). Physical tools such as flashcards, counters, and puzzles help make abstract number relationships more concrete (Yang et al., 2018). These tools can be tailored to different ability levels, making learning more accessible and inclusive (Umameh, 2020). When learners can touch and manipulate objects, their cognitive engagement improves (Lamb, 2017). The results of the intervention in this study confirm that structured, physical practice supports better learning outcomes than passive instruction (Smiderle et al., 2020).

Another key implication is the importance of motivation and emotional safety in learning mathematics (Ramirez et al., 2018). Learners who experience less pressure are more likely to engage consistently with challenging content (Drolet, 2021). Incorporating gamified tools and peer collaboration helps reduce math anxiety and makes learning feel enjoyable (Abilova, 2024). This environment also fosters a growth mindset, encouraging students to view mistakes as opportunities for learning (Crowley, 2018). The intervention in this study created an environment that led to significantly improved performance among learners (Bang et al., 2022).

The results affirm that early and targeted intervention can produce lasting academic benefits (Metsämuuronen, 2018). Frequent, focused drills improve fluency in basic operations, freeing up cognitive resources for more complex problem-solving (Manalaysay, 2021). These practices support long-term retention, even in a spiraled curriculum where topics reappear in later grades (Fuchs et al., 2016). This approach helps bridge gaps before they widen, ensuring that all learners build strong numeracy foundations (Rosli & Lin, 2018). Educators should, therefore, prioritize mastery-based, feedback-rich interventions to support mathematical development from the earliest stages (Bang et al., 2023).

The large effect size indicates that the intervention not only improved scores but also reshaped how students engaged with math (Yilmaz, 2017). Structured, non-digital tools allow learners to practice intentionally and with purpose (Rosli & Lin, 2018). This approach made math more accessible and less intimidating, supporting both emotional and cognitive development (Metsämuuronen, 2018). Frequent, meaningful practice builds fluency and readiness for advanced skills (Manalaysay, 2021). This confirms that Dewey's "learning by doing" philosophy is crucial in designing impactful and inclusive early math instruction (Bang et al., 2023).

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**SUMMARY, CONCLUSIONS AND RECOMMENDATIONS**

This chapter presents the summary of findings, conclusions drawn from the data analysis, and recommendations for future research and instructional practice.

**Summary**

This study investigated the effectiveness of using non-digital, technology-based drills to improve Grade 1 learners' ability to visualize missing numbers in addition and subtraction sentences. It aimed to determine the impact of such intervention on students' mathematical performance by comparing the outcomes of an experimental group and a control group. The research was conducted among Grade 1 students at San Rafael Integrated School during the 2024–2025 school year, focusing specifically on their ability to visualize and solve missing numbers in number sentences. The study was grounded in John Dewey's Constructivist Theory, particularly his principle of "learning by doing," which emphasizes that learners construct knowledge most effectively through hands-on, meaningful experiences.

This study employed a quasi-experimental research design to examine the effect of non-digital, technology-based drills on Grade 1 learners’ ability to visualize missing numbers in addition and subtraction sentences. Two intact classes from San Rafael Integrated School participated: the control group (40 learners) received traditional instruction, while the experimental group (39 learners) received the intervention. Both groups took a pre-test, followed by a week-long intervention for the experimental group, and then a post-test for both groups.

Results showed that both groups had similar pre-test scores, indicating no significant initial difference. However, the experimental group significantly outperformed the control group in the post-test, demonstrating the effectiveness of the intervention. The calculated effect size was large, confirming that the intervention had a strong and meaningful impact on learners' mathematical performance.

**Conclusions**

Based on the findings of the study, the following conclusions were drawn. The pre-test results showed that both the control and experimental groups performed at a similar and low level, indicating that learners had difficulty visualizing missing numbers despite prior exposure to the concept. This suggests a lack of retention and highlights the need for reinforcement strategies in mathematics instruction. There was no significant difference in the pre-test scores between the two groups, confirming that they had comparable baseline abilities. This establishes a fair ground for measuring the actual impact of the intervention on learners' performance.

The post-test results revealed that the experimental group outperformed the control group, demonstrating notable improvement in their ability to solve missing number problems. This suggests that the intervention enabled learners to understand better and apply mathematical concepts. A significant difference in post-test scores was found between the two groups, indicating that the intervention had a meaningful impact on learning outcomes. It affirms the effectiveness of using non-digital, technology-based drills in early mathematics instruction. The large effect size observed in the results indicates that the intervention not only improved learner performance but also had a strong influence on comprehension and skill development. This highlights the potential of hands-on, repetitive practice to foster a long-term understanding of mathematics.

**Recommendations**

Based on the results and conclusions of the study, the following are recommended. To address the poor retention of prior learning, teachers may regularly integrate reinforcement strategies, such as visual drills and guided practice, to help learners recall and apply previously taught math skills. Equitable access to interventions may be ensured for all learners, especially those with low baseline performance in key competencies. Teachers are encouraged to adopt non-digital, hands-on learning tools such as number cards, counters, and manipulatives to make abstract math concepts more engaging and concrete.

Furthermore, schools may implement structured remediation programs that incorporate activity-based learning to enhance learners' problem-solving and visualization skills, particularly in basic arithmetic. Finally, further studies may explore its long-term impact on learner retention and its potential application across different mathematical topics, grade levels, and learner profiles.

**Definition of Terms**

The following terms were defined conceptually and operationally.

**Addition.** Refers to the mathematical operation in which two or more numbers are combined to form a sum. It is one of the four basic arithmetic operations and is fundamental in early mathematical education as it lays the groundwork for more advanced concepts (Chin & Zakaria, 2015)

**Constructivist Theory.** It emphasizes that learners actively construct knowledge through hands-on experiences and meaningful interactions with their environment (Dewey, 1916).

**Control Group.** It refers to a group of subjects in an experiment that is not exposed to the treatment or intervention being tested. This group is used to compare results with the experimental group, helping to isolate the effect of the independent variable. In research, this group remains under normal conditions to provide a baseline for comparison (Taber, 2019).

**Experimental Group.** It is the group in an experiment that is exposed to the treatment or intervention. This group receives the independent variable, and the results from this group are compared to those of the control group to assess the treatment's effect (Rogers & Révész, 2019).

**Missing Numbers.** Refer to the absent elements within a numerical sequence or mathematical problem that follow a specific pattern or rule. Identifying missing numbers involves analyzing the given data to deduce the absent values, thereby enhancing problem-solving and critical-thinking skills (Aakash Institute, 2023).

**Posttest.** A test administered after a specific intervention or learning activity. The primary purpose is to assess the effects or outcomes of that intervention and to measure the learning that has occurred (Luetsch & Burrows, 2016).

**Pretest.** An assessment conducted before an intervention or instructional process to gauge the initial knowledge of participants in mathematics. It provides baseline data that can be compared to post-test results to measure change or effectiveness (Luetsch & Burrows, 2016).

**Subtraction.** It is a mathematical operation in which one quantity is taken away from another. In educational contexts, subtraction may refer to problem-solving tasks where learners practice this operation as part of their development of arithmetic skills (Ebby et al., 2020).

**Technology-based drills.** These refer to educational tools, such as flashcards and interactive exercises, that utilize technology to enhance learners' accuracy and proficiency through structured practice, active engagement, and immediate feedback (Brewer, 2016; Camp, 2018).

**Visualizing-** involves using visual tools and spatial training to identify gaps in data, enhance reasoning, and deepen understanding of mathematical concepts (Carden & Cline, 2015; Sorby & Veurink, 2018).

**Ethical Approval:**

As per international standards or university standards written ethical approval has been collected and preserved by the author(s).

**Consent**

Before engaging student participants, written consent was secured from their parents or legal guardians.

**Disclaimer (Artificial intelligence)**

Author(s) hereby declare that generative AI technologies such as Large Language Models, etc. have been used during the writing or editing of manuscripts. This explanation will include the name, version, model, and source of the generative AI technology and as well as all input prompts provided to the generative AI technology

Details of the AI usage are given below:

1. Chat GPT

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