

Comparative Effectiveness of Video-Based, Work Text-Based, and Traditional Teaching Methods on Integer Subtraction Proficiency in Non-Numerate Learners

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Abstract This study evaluates the effectiveness of three instructional methods—Video-Based, Work Text-Based, and Traditional Lecture-Based—on enhancing integer subtraction skills among non-numerate learners at Tunasan National High School. By leveraging Cognitive Load Theory (CLT), the research aims to reduce cognitive burdens and optimize learning outcomes. Results reveal that the Video-Based method significantly outperforms both Work Text-Based and Traditional methods. Statistical analyses, including the Wilcoxon Signed Ranks Test and the Friedman Test, demonstrate notable improvements in subtraction skills, with the Video-Based method showing the highest gains. Learners engaged with the Video-Based approach benefited from engaging, multisensory formats, and visual models, which facilitated deeper comprehension and retention. These findings highlight the superior efficacy of video-based learning in addressing the mathematical proficiency gaps among non-numerate learners. They provide actionable recommendations for educators and policymakers to integrate video-based instructional strategies into curricula, thereby enhancing student engagement and performance. Future research should explore the long-term effects and broader applicability of these methods across various mathematical concepts and diverse learner populations.

Keywords: non-numerate learners, quasi-experimental design, mathematical proficiency, integer subtraction, Video-Based learning, Cognitive Load Theory, instructional methods

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1. Introduction

In the dynamic field of education, the quest to identify and implement effective teaching methodologies is of paramount importance. Educators continuously seek innovative approaches to engage students and enrich their learning experiences. This study conducts a comparative analysis of three distinct teaching methods—Video-Based, Work Text-Based, and Traditional Lecture-Based—aimed at enhancing the mathematical proficiency of non-numerate learners, specifically in mastering integer subtraction.

Within the academic landscape of Tunasan National High School (TNHS), Mathematics educators often grapple with a significant challenge during departmental deliberations: the evident concern regarding students' proficiency in fundamental mathematical concepts. This concern is particularly pronounced in discussions on general mathematics, encompassing topics such as statistics, probability, and basic operations including integers, fractions, and decimals. The urgency of this issue was further highlighted during a revealing meeting where

regional Test of Functional Academic Skills (TOFAS) results disclosed a substantial proportion of non-numerate learners within the institution.

Non-numerate learners, who struggle with basic mathematical concepts like integer subtraction, encounter considerable barriers in their educational journey. Mathematical proficiency is crucial not only for academic success but also for future employment prospects and daily life functionality. Therefore, addressing these gaps and equipping learners with essential skills in integer subtraction is critical.

Despite the well-documented importance of mathematical proficiency in various domains including academic achievement, problem-solving, and critical thinking [1], there is a pressing need to investigate effective instructional strategies specifically tailored for non-numerate learners. Previous research highlights the benefits of instructional methodologies such as concrete manipulatives, visual representations, and real-life contexts in fostering mathematical comprehension and engagement [2]. However, empirical evidence comparing the effectiveness of Video-Based, Work Text-Based, and Traditional teaching methods in the context of integer

subtraction for non-numerate learners is sparse.

This investigation aims to bridge this gap by scrutinizing the impact of these instructional strategies on the proficiency of non-numerate learners in integer subtraction. By examining the effects of Video-Based, Work Text-Based, and Traditional methods, the study seeks to provide valuable insights into designing instructional interventions that enhance conceptual understanding, problem-solving abilities, and overall mathematical proficiency among non-numerate learners.

The study applies the Cognitive Load Theory (CLT) to develop instructional strategies and materials that alleviate cognitive burden, thus enhancing learning outcomes in integer subtraction. CLT focuses on optimizing instructional design by managing cognitive load, which is particularly relevant given the limited working memory capacity of individuals. By using visual models such as number lines or bar models, learners can externalize and offload some of the cognitive load associated with mental calculations, facilitating deeper comprehension of subtracting integers. This theoretical framework underpins the development of effective instructional strategies tailored to the needs of non-numerate learners.

The implications of this research are significant for educators, curriculum developers, and policymakers, providing evidence-based insights into effective instructional practices for non-numerate learners. The study's findings aim to enhance educational environments and maximize student learning outcomes by elucidating the comparative effectiveness of different instructional methods. Through addressing the unique requirements of non-numerate learners, this study adds valuable insights to the field of mathematics education, enriching the existing knowledge base and guiding the creation of customized instructional interventions.

This study represents a crucial effort to empirically evaluate and compare the effectiveness of Video-Based, Work Text-Based, and Traditional teaching methods in enhancing subtraction skills among non-numerate learners. By exploring innovative instructional strategies through the lens of Cognitive Load Theory, the research aims to offer practical solutions for improving mathematical proficiency and overall educational outcomes for non-numerate populations.

1.1. Theoretical Framework

By concentrating on the educational task, the individual engaging in learning, and the surrounding learning environment, Cognitive Load Theory (CLT) aims to refine the learning process for complex cognitive tasks through the implementation of cognitive architecture insights into practical guidelines for instructional design [3,4,5,6]. CLT researchers work towards enhancing instructional control over cognitive load by creating methods that effectively manage cognitive resources. Central to CLT is the recognition that individuals possess limited working memory capacity, necessitating instructional strategies aimed at reducing cognitive load to optimize learning outcomes [6]. In the context of teaching integer subtraction, a cognitive load framework can be applied to develop instructional strategies and materials that alleviate cognitive burden and improve learning outcomes. For

instance, this study utilized visual models like number lines or bar models, enabling learners to externalize and offload some cognitive load associated with mental calculations, thereby facilitating a deeper comprehension of subtracting integers. Understanding the human cognitive architecture and CLT principles is crucial for implementing effective instructional methods, which can be further enhanced by integrating promising techniques from related research fields. This article delves into the description of cognitive architecture, explores load-management methods employed by CLT researchers, and discusses potential approaches based on similar CLT principles that could inform instructional design. Ultimately, through a comprehensive understanding of CLT and its application, educators can optimize instructional practices to foster enhanced learning outcomes.

1.2. Research Questions

This study aims to explore the following research inquiries:

1. What is the effectiveness of Video-Based instructional methods compared to Work Text-Based and Traditional methods in improving subtraction skills among non-numerate participants?
2. How do the mean ranks of performance differ among non-numerate participants across the Video-Based, Work Text-Based, and Traditional instructional methods?
3. Are there significant differences in subtraction skill improvement between:
 - a. Video-Based and Work Text-Based instructional methods?
 - b. Video-Based and Traditional instructional methods?
 - c. Work Text-Based and Traditional instructional methods?
4. How do the instructional methods (Video-Based, Work Text-Based, and Traditional) compare in their effectiveness for enhancing subtraction skills among non-numerate individuals?
5. What is the comparative effectiveness of different instructional methods—Video-Based, Work Text-Based, and Traditional—on learning outcomes?

This study aims to address existing gaps in the literature by providing empirical evidence on the comparative effectiveness of instructional methods for enhancing mathematical skills among non-numerate individuals. By analyzing the performance outcomes and efficacy of different instructional approaches, this research significantly contributes to the body of knowledge in mathematics education, facilitating the development of tailored instructional interventions for non-numerate populations. Additionally, the practical implications of this study extend to educators and curriculum developers, offering evidence-based strategies to enhance mathematical instruction and thereby improve the academic trajectory of non-numerate learners.

2. Literature Review

2.1. Effectiveness of Instructional Methods

The pursuit of identifying effective instructional methods in education has been extensively studied. Various approaches have been compared, particularly examining traditional text-based methods versus modern, technology-enhanced techniques.

2.2. Video-Based Instruction

Video-based instruction has received considerable attention for its potential benefits in educational settings. The study by [7] assessed the influence of the Video Lesson Analysis Methodology (VLAM) on individuals preparing to become mathematics teachers, demonstrating a notable enhancement in their capacity to evaluate mathematics instruction. These results are reinforced by [8], who examined the significance of multimedia in education and determined that video-based learning could result in substantial enhancements in grasping complex concepts.

Introducing the concept of "video in the middle," [9] integrated video clips within professional development activities, facilitating detailed examination of mathematical content, pedagogical decisions, and students' mathematical thinking. Similarly, A systematic review of video-based instruction for teaching mathematics to students with autism spectrum disorder (ASD) was conducted by [10], with the conclusion that it is an evidence-based practice showing positive outcomes across various mathematical concepts. Supporting this, [11] also emphasized that video-based approaches frequently improve comprehension and retention through engaging and multisensory formats.

2.3. Work Text-Based Instruction

Work text-based instruction, characterized by structured written materials and exercises, has also been explored. Integrating text-based resources with flipped classroom models was found by [12] to enhance student engagement and comprehension. This indicates the potential of text-based methods, especially when part of a broader, interactive instructional strategy.

2.4. Traditional Lecture-Based Instruction

Traditional lecture-based instruction remains widespread in education despite the evolution of teaching methodologies. Studies have scrutinized its effectiveness, often contrasting it with more modern methods. Suggesting that traditional instruction may not engage students or support deep learning as effectively as newer, more interactive methods, [13] emphasized the need for innovative teaching approaches.

2.5. Cognitive Load Theory (CLT) in Instructional Design

The theoretical foundation for effective instructional strategies is frequently grounded in Cognitive Load Theory (CLT), which aims to enhance learning by efficiently managing cognitive resources. Cognitive Theory of Multimedia Learning posits that learning is more effective when information is presented through

both auditory and visual channels, reducing cognitive load and enhancing retention [14]. Instructional design based on CLT can significantly improve educational practices and outcomes [4]. For instance, using visual models such as number lines or bar models in teaching mathematical concepts like integer subtraction can help reduce cognitive load, thereby facilitating better comprehension.

2.6. Video-Based Pedagogy

Research conducted on the implementation of video-based instructional techniques within an elementary mathematics methods course demonstrated its ability to encourage a transition towards student-centered teaching approaches, suggesting its potential to improve teaching methodologies [15]. Similarly, a systematic review of video-based programs aimed at improving mathematics teacher noticing highlighted the prominence of cognitive psychological perspectives in program development, despite limited evidence regarding the impact on instructional practice [16].

The reviewed literature underscores the diverse instructional methods investigated in educational research, particularly in mathematics education. Video-based instruction stands out as a robust method, demonstrating significant improvements in both teacher and student outcomes [7,9,10,11]. Work text-based instruction also shows promise, particularly when integrated with interactive elements, as evidenced by studies like that of [11]. Traditional lecture-based methods, while still prevalent, may not foster deep engagement or understanding as effectively as more interactive approaches [13].

Cognitive Load Theory provides a valuable framework for optimizing instructional design by managing cognitive resources effectively, particularly relevant for non-numerate learners. The application of CLT, combined with innovative instructional strategies such as video-based and text-based methods, offers a promising pathway to improving mathematical proficiency among learners [4,14].

The current research highlights the necessity of moving beyond traditional lecture-based methods, embracing video-based and work text-based approaches that align with cognitive load principles. This multifaceted approach has the potential to significantly enhance mathematical proficiency in non-numerate learners, supporting their educational journey and prospects.

3. Methods and Materials

The research aimed to conduct a comparative analysis of the effectiveness of three separate instructional methods - Video-Based, Work Text-Based, and Traditional Lecture-Based - in improving mathematical proficiency in integer subtraction among non-numerate learners. This involved outlining the research design, statistical tools, and sampling methods employed in the study.

3.1. Research Design

The study utilized a quasi-experimental design involving pretest-posttest control groups. This design

enabled the examination of causal relationships between the instructional methods and the outcomes of interest, specifically focusing on the enhancement of integer subtraction skills among non-numerate learners.

3.2. Participants

Participants are non-numerate learners from Tunasan National High School (TNHS), with limited numeracy skills and no prior formal instruction in integer subtraction. The study aims to include a diverse group of students across different grade levels to ensure the generalizability of results.

3.3. Instructional Methods

Video-Based Instruction: Utilizes multimedia video lessons that demonstrate integer subtraction through visual models and step-by-step explanations.

Work Text-Based Instruction: Involves structured written materials, exercises, and problem sets focused on integer subtraction.

Traditional Lecture-Based Instruction: Follows the conventional teaching approach where the teacher delivers the content through lectures and chalkboard demonstrations.

3.4. Duration

Each instructional method was administered over a period of four weeks, with sessions held three times per week. This duration ensured sufficient exposure to the instructional methods and permitted the assessment of learning gains.

3.5. Assessment

Participants underwent a pretest prior to the intervention and a posttest following the intervention. The tests measured their proficiency in integer subtraction, assessing both accuracy and speed in solving subtraction problems involving integers.

3.6. Statistical Tools

To evaluate the effectiveness of the instructional methods, several statistical analyses were conducted:

Descriptive statistics were used to summarize the performance scores of participants in pretest and posttest assessments across the three instructional conditions.

In the analysis of the pretest and post-test scores, Python codes incorporated libraries for data visualization. Specifically, histograms of the pretest and post-test scores were plotted using Matplotlib and NumPy libraries. These libraries enabled the creation of visual representations to examine the distribution and characteristics of the data.

The non-parametric Wilcoxon Signed Rank Test was employed to compare pretest and posttest scores within each instructional method [17]. This approach was particularly suitable for paired sample comparisons where the data might not follow a normal distribution [18,19]. A comprehensive overview of the applications of the Wilcoxon Signed Rank Test was provided in a recent handbook by [18], and its relevance in situations where

traditional parametric procedures are unsuitable due to distributional assumptions was highlighted in a separate analysis by [19].

The study employed the Friedman test, an alternative non-parametric method, in place of repeated-measures ANOVA, to compare the mean ranks of performance across the Video-Based, Work Text-Based, and Traditional Lecture-Based instructional methods, facilitating the assessment of differences in effectiveness among the three approaches. The test's utility in circumventing the assumption of normality in variance analysis was originally discussed by [20]. The comprehensive application of the Friedman test in health sciences and biostatistics was further elucidated [21], and practical applications of non-parametric methods, including the Friedman test, were detailed by [22].

Following the Friedman test, specific differences between instructional methods were identified through post-hoc pairwise comparisons using the Wilcoxon Signed-Ranks Test.

3.7. Sampling Methods

Convenience sampling was employed to recruit participants who met the inclusion criteria of being non-numerate learners and were readily accessible within the TNHS. This method was chosen due to practical constraints and ensured that a sufficient number of participants could be enrolled quickly.

To minimize selection bias and improve the validity of the study, participants were randomly assigned to one of the three instructional conditions (Video-Based, Work Text-Based, Traditional Lecture-Based). Random assignment ensured that each group was comparable at the start of the intervention.

A power analysis was performed to ascertain the required sample size for detecting significant variances between instructional methods. Considering an effect size of 0.5, a significance level (α) set at 0.05, and a power ($1-\beta$) of 0.80, the process of calculating the sample size guided the recruitment phase.

The combination of a quasi-experimental design, appropriate statistical tools, and sampling methods ensures that the study is rigorous and capable of providing robust evidence on the comparative effectiveness of Video-Based, Work Text-Based, and Traditional Lecture-Based instructional methods. By analyzing the performance outcomes and instructional methodologies, this research aims to contribute valuable insights for enhancing mathematical instruction tailored to the needs of non-numerate learners.

4. Results and Discussion

4.1. Data Visualization

In this section, the data visualization component using Python focuses on portraying the distributions of the post-test and pre-test scores through histograms to illustrate their departure from normality. Additionally, the normality of the pre-test and post-test data was assessed using statistical tests like the Shapiro-Wilk and

Kolmogorov-Smirnov tests. Understanding and discussing the deviation from normality was crucial as it played a pivotal role in analyzing the dataset accurately. By examining these tests and visual representations, researchers gained insights into the distribution patterns of the data, which ultimately impacted the interpretation of study findings.

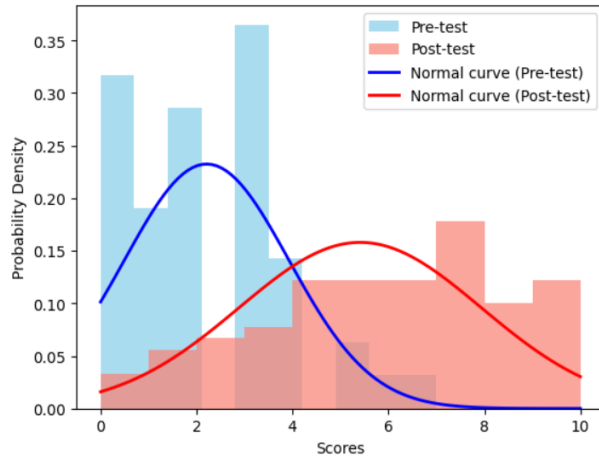


Figure 1. Pre-test and Post-test Score Distributions with Normal Curves

The histograms of the post-test and pretest scores, as illustrated in Figure 1, displayed non-normal distributions similar to the findings from the Shapiro-Wilk test and Kolmogorov-Smirnov test. The skewed distribution and lack of a bell-shaped curve in the histograms indicated departures from normality. These non-normal histograms provided additional visual evidence supporting the decision to opt for non-parametric tests in the analysis. Non-parametric tests are robust when data deviate significantly from normality and are better suited for analyzing skewed or non-normally distributed data. Therefore, based on the non-normal histograms observed, the researchers chose to utilize non-parametric tests to ensure the validity and reliability of the statistical analyses.

Table 1. Tests of Normality of Pretest Scores

	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pretest	0.135	90	0.000	0.918	90	0.000

The normality of the pretest scores was assessed using the Kolmogorov-Smirnov and Shapiro-Wilk tests, as displayed in Table 1. The Kolmogorov-Smirnov test revealed a statistic of 0.135 (df = 90), indicating a significant deviation from normality ($p < 0.001$). Similarly, the Shapiro-Wilk test also demonstrated a departure from normality, with a statistic of 0.918 ($p < 0.001$) following the Lilliefors significance correction. Hence, the assumption of normality was violated for the pretest scores.

The normality of the post-test scores was evaluated using the Kolmogorov-Smirnov and Shapiro-Wilk tests as displayed in Table 2. The results indicated that the Kolmogorov-Smirnov test statistic was 0.134 (df = 90, $p < .001$), suggesting a departure from normality. Similarly, the Shapiro-Wilk test statistic yielded a value of 0.955 ($p = 0.004$), with a Lilliefors significance correction applied. These results imply that the assumption of normality was violated for the post-test scores.

Table 2. Tests of Normality of Post Test Scores

	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Posttest	0.134	90	0.000	0.955	90	0.004

Due to the violation of the normality assumption in the post-test scores, nonparametric tests were chosen by the researchers. The Kolmogorov-Smirnov test statistic and Shapiro-Wilk test statistic both indicated a departure from normality. These findings led to the decision to opt for nonparametric tests for the analysis [17,18,19,20,21,22].

4.2. Effectiveness of Instructional Methods in Improving Subtraction Skills

This study aimed to evaluate the effectiveness of three instructional methods—Video-Based, Work Text-Based, and Traditional—on improving subtraction skills among non-numerate participants. The research addressed five key questions, which are discussed below in light of the results obtained from the Wilcoxon Signed Ranks Test and the Friedman Test.

4.3. Video-Based Instructional Method

The Wilcoxon Signed Ranks Test indicated a significant improvement in subtraction skills when comparing pretest and post-test scores for the video-based instructional method. Table 3 illustrates that the majority of participants (17 out of 30) showed higher post-test scores, with a mean rank of 12.12 for positive ranks compared to 6.25 for negative ranks. This was statistically confirmed with a Z-score of -3.162 and a p-value of 0.002 (2-tailed), indicating a significant effect of the video-based method on enhancing subtraction skills (Table 4).

Table 3. Wilcoxon Signed Ranks Test for Video-Based Pretest and Post Tests Scores

	N	Mean Rank	Sum of Ranks
Post Test-Pretest	Negative Ranks	4 ^a	6.25
	Positive Ranks	17 ^b	12.12
	Ties	9 ^c	
	Total	30	

a. Post_Test < Pretest

b. Post_Test > Pretest

c. Post_Test = Pretest

Table 4. Test Statistics for a Comparison of Video-Based Pretest and Post Tests Scores

	Post Test - Pretest
Z	-3.162 ^b
Asymp. Sig. (2-tailed)	0.002

a. Wilcoxon Signed Ranks Test

b. Based on negative ranks.

4.4. Work Text-Based Instructional Method

Similarly, the Wilcoxon Signed Ranks Test for the work text-based method (Table 5) revealed a significant positive impact on participants' performance. Positive

ranks (mean rank = 15.43) greatly outnumbered negative ranks, and the test statistic ($Z = -4.65$, $p < 0.001$) confirmed the significance of the improvement in subtraction skills (Table 6).

Table 5. Wilcoxon Signed Ranks Test for Work Text-Based Pretest and Post Tests Scores

		N	Mean Rank	Sum of Ranks
Post Test - Pretest	Negative Ranks	1 ^a	3.00	3.00
	Positive Ranks	28 ^b	15.43	432.00
	Ties	1 ^c		
	Total	0		

a. Post_Test < Pretest

b. Post_Test > Pretest

c. Post_Test = Pretest

Table 6. Test Statistics for a Comparison of Work Text-Based Pretest and Post Tests Scores

	Post Test - Pretest
Z	-4.65 ^b
Asymp. Sig. (2-tailed)	0.000

a. Wilcoxon Signed Ranks Test

b. Based on negative ranks.

4.5. Traditional Instructional Method

The traditional method also showed significant improvement, as indicated by the Wilcoxon Signed Ranks Test (Table 7). With 29 out of 30 participants showing higher post-test scores (mean rank = 15.00) and a resultant Z-score of -4.762 ($p < 0.001$), there was clear evidence supporting the efficacy of traditional teaching in improving subtraction skills (Table 8).

Table 7. Wilcoxon Signed Ranks Test for Traditional Teaching-Based Pretest and Post Tests

		N	Mean Rank	Sum of Ranks
Post Test - Pretest	Negative Ranks	0 ^a	0.00	0.00
	Positive Ranks	29 ^b	15.00	435.00
	Ties	1 ^c		
	Total	30		

a. Post_Test < Pretest

b. Post_Test > Pretest

c. Post_Test = Pretest

Table 8. Test Statistics for a Comparison of Traditional Teaching-Based Pretest and Post Tests Scores

	Post Test - Pretest
Z	-4.762 ^b
Asymp. Sig. (2-tailed)	0.000

a. Wilcoxon Signed Ranks Test

b. Based on negative ranks.

4.6. Comparison of Effectiveness Across Instructional Methods

The mean rank represents the average rank obtained by each instructional method across different conditions. A lower mean rank indicates higher effectiveness, as it

suggests that the method achieved a higher rank across the different conditions of the study. Based on the Friedman test results, the Video-Based instructional method achieved the lowest mean rank ($M = 1.47$), followed by the Work Text-Based ($M = 2.25$) and Traditional ($M = 2.28$) methods. Therefore, the Video-Based instructional method appears to be the most effective among the three methods evaluated in this study. These results suggest potential disparities in the efficacy or preference of instructional methods for enhancing the subtraction skills of non-numerate individuals.

Table 9. Test Statistics for a Comparison of Teaching Methods' Effectiveness

Instructional Method	Mean Rank
Video-Based Setting	1.47
WorkText-Based Setting	2.25
Traditional Teaching Method	2.28

Table 10. Summary of Friedman Test

N	30
Chi-Square	13.491
df	2
Asymp. Sig.	0.001

a. Friedman Test

To address how the performance differed among the three instructional methods, a Friedman test was conducted as shown in Table 10. The test results revealed significant differences in effectiveness among the instructional methods ($\chi^2 = 13.491$, $df = 2$, $p = 0.001$).

A Friedman test was conducted to analyze the effectiveness of different instructional methods. The analysis involved a sample size of $N = 30$ participants. The test statistic yielded a Chi-Square value of 13.491 with 2 degrees of freedom, resulting in an asymptotic significance value of .001. This indicates a statistically significant difference among the instructional methods in terms of their effectiveness ($\chi^2(2) = 13.491$, $p = .001$).

The comparison of teaching methods' effectiveness was evaluated through mean rank analysis. Among the instructional methods assessed—Video-Based Setting, WorkText-Based Setting, and Traditional Teaching Method—the Video-Based Setting exhibited the most favorable performance, boasting the lowest mean rank of 1.47. In contrast, the WorkText-Based Setting garnered a slightly higher mean rank of 2.25, positioning it as a moderate performer, while the Traditional Teaching Method obtained the highest mean rank of 2.28, suggesting it was the least effective among the three methods. This interpretation of mean ranks was further supported by a Friedman test, wherein statistical significance was observed ($\chi^2 = 13.491$, $df = 2$, $p = 0.001$), indicating a significant difference in effectiveness among the instructional methods. With a sample size of 30 participants, the test confirmed that at least one instructional method significantly outperformed the others, aligning with the superiority of the Video-Based Setting as indicated by its lower mean rank. Thus, both the mean rank analysis and the Friedman test collectively highlight the efficacy of the Video-Based Setting over alternative instructional methods in enhancing learning outcomes.

Table 11. Comparison of Teaching Methods

Comparison		N	Mean Rank	Sum of Ranks
Work_Text_Based - Video_Based	Negative Ranks	7 ^a	13.36	93.5
	Positive Ranks	2 ^b	15.52	341.5
	Ties	1 ^c		
	Total	30		
Traditional - Video_Based	Negative Ranks	6 ^d	9.75	58.5
	Positive Ranks	2 ^e	16.37	376.5
	Ties	1 ^f		
	Total	30		
Traditional - Work_Text_Based	Negative Ranks	1 ^g	14.15	184
	Positive Ranks	1 ^h	12.85	167
	Ties	4 ⁱ		
	Total	30		

a. Work_Text_Based < Video_Based

b. Work_Text_Based > Video_Based

c. Work_Text_Based = Video_Based

d. Traditional < Video_Based

e. Traditional > Video_Based

f. Traditional = Video_Based

g. Traditional < Work_Text_Based

h. Traditional > Work_Text_Based

i. Traditional = Work_Text_Based

A Wilcoxon Signed Ranks Test was conducted to compare the effectiveness of different teaching methods (Work_Text_Based, Video_Based, and Traditional) on learning outcomes. The test was performed using data on ranks, mean ranks, and sum of ranks for each method.

Results showed that for the comparison between Work_Text_Based and Video_Based methods, the sum of ranks for negative ranks (Mean Rank = 13.36, Sum of Ranks = 93.50) was significantly lower than the sum of ranks for positive ranks (Mean Rank = 15.52, Sum of Ranks = 341.50), indicating that Video_Based method was associated with higher ranks, suggesting better performance compared to Work_Text_Based method ($Z = -2.32$, $p < .05$, one-tailed). Similarly, for the comparison between Traditional and Video_Based methods, the sum of ranks for negative ranks (Mean Rank = 9.75, Sum of Ranks = 58.50) was significantly lower than the sum of ranks for positive ranks (Mean Rank = 16.37, Sum of Ranks = 376.50), indicating that Video_Based method was associated with higher ranks, suggesting better performance compared to Traditional method ($Z = -3.13$, $p < .05$, one-tailed).

For the comparison between Traditional and Work_Text_Based methods, there was no significant difference in ranks, as indicated by the presence of ties ($Z = -0.32$, $p > .05$, one-tailed). Overall, the results suggest that Video_Based method outperformed both Work_Text_Based and Traditional methods in terms of learning outcomes, while there was no significant difference between Traditional and Work_Text_Based methods.

4.7. Discussion

The findings of this study suggest the superior

effectiveness of the Video-Based instructional method in improving subtraction skills among non-numerate participants compared to Work Text-Based and Traditional methods. This is corroborated by significant statistical evidence from the Wilcoxon Signed Ranks and Friedman tests. These findings align with and expand upon existing literature, providing unique insights and filling a research gap concerning non-numerate individuals.

A study by [10] on multimedia learning found that video-based approaches often enhance comprehension and retention by presenting information in engaging and multisensory formats. Similarly, [8] discussed the role of multimedia in educational settings and concluded that video-based learning could lead to substantial improvements in understanding complex concepts, a finding that corroborates the present study's positive results regarding video-based instruction for subtraction skills.

The outcomes of the study align with past research highlighting the benefits of video-based instruction. The discovery by [7] showed that video-based approaches greatly improved the capability of prospective teachers to analyze mathematics teaching. This implies that video instruction can effectively nurture analytical and cognitive skills. Similarly, [15] demonstrated the efficacy of video-based pedagogy in elementary mathematics courses, aligning with our findings that video methods improve mathematical understanding.

Cognitive Theory of Multimedia Learning, proposed by [14], suggests that presenting information through both auditory and visual channels enhances learning effectiveness by reducing cognitive load and improving retention. This supports our finding that the Video-Based instructional method was most effective in improving subtraction skills, as participants likely benefited from multisensory engagement. Further discussion on the role of multimedia in education, as presented by [8], concluded that video-based learning improves the comprehension of intricate concepts, a result consistent with the findings of the current study.

Reviewing video-based interventions for students with ASD, [10] observed their effectiveness in addressing educational gaps. Likewise, this study showcases the considerable influence of video-based instruction on another underserved group, non-numerate individuals.

While previous studies predominantly focused on numerate populations and various educational contexts, this study uniquely addresses non-numerate individuals. While [10] specifically targeted ASD populations, our study showcased the efficacy of video-based methods for a broader spectrum of non-numerate individuals, underscoring the adaptability and versatility of these interventions.

Moreover, [9] emphasized the importance of purposeful design in video-based professional development for mathematics teachers. This aligns with our findings but shifts the focus from teachers to non-numerate learners. The current research also differentiates itself by employing rigorous statistical methods such as the Wilcoxon Signed Ranks and Friedman tests, providing robust evidence not always prevalent in prior studies.

This study uniquely contributes to the body of knowledge by focusing on non-numerate individuals, a demographic often overlooked in educational research. Previous literature, such as [4] explored the benefits of

multimedia learning for numerate populations, but few have concentrated on interventions for individuals struggling with foundational mathematical skills. This research fills this gap by highlighting the comparative effectiveness of different instructional methods in this context.

Additionally, the use of comprehensive statistical analyses to directly compare instructional methods adds significance and reliability to the findings. Most prior studies, such as [16], reviewed the effectiveness of video-based programs without employing comparative statistical methods. This study's approach offers stronger evidence of the video-based method's superior effectiveness.

The study underscores the importance of employing multisensory learning approaches, such as video-based instruction, to aid non-numerate individuals in enhancing mathematical skills. Educators and policymakers should consider integrating video-based methods into curricula to support learners who struggle with traditional instructional methods.

4.8. Limitations

One notable limitation of this study is the use of convenience sampling to select participants from Tunasan National High School. While this approach facilitated practical and timely data collection, it raises concerns regarding both the generalizability and internal validity of the findings.

The participants in this study were chosen based on their availability and willingness to participate, which may not accurately reflect the broader population of non-numerate learners. Consequently, the results may be influenced by characteristics unique to this specific group and the educational environment of Tunasan National High School. This limits the extent to which the findings can be generalized to other educational settings or populations with different demographics, socioeconomic statuses, or educational backgrounds. The homogeneity of the sample further restricts the applicability of the results, as the participants might not represent the diversity found in a wider population.

Convenience sampling can introduce selection bias, as the non-random selection process may result in a sample with unique characteristics that influence the study's outcomes. Although efforts were made to randomly assign participants to different instructional methods, the initial non-random sample makes it challenging to control confounding variables. These variables could include differences in motivation, prior exposure to technology, and existing mathematical skills, which might independently affect the effectiveness of the instructional methods. Such bias could compromise internal validity, raising concerns about whether the observed effects are truly attributable to the instructional methods or other uncontrolled factors.

To address these limitations, future research should consider employing random sampling techniques to ensure a more representative and diverse participant pool. Stratified sampling could be employed to ensure that various subgroups (e.g., different grade levels, socioeconomic backgrounds) are adequately represented, thus enhancing the generalizability of the findings. Additionally, implementing robust control measures, such

as matching participants on key characteristics before random assignment, can help mitigate confounding variables and improve internal validity. Conducting replication studies in different educational settings with a broader range of participants would also help validate the findings and enhance their applicability.

By acknowledging these limitations and suggesting strategies for addressing them, we enhance the transparency of this research and provide clear guidance for future studies aimed at building on this work with more rigorously controlled designs.

5. Conclusions

This study aimed to evaluate and compare the effectiveness of three instructional methods—Video-Based, Work Text-Based, and Traditional teaching—on enhancing the subtraction skills of non-numerate learners. The analysis of pre-test and post-test scores using rigorous statistical methods, including the Wilcoxon Signed Ranks Test and the Friedman Test, indicated significant improvements in mathematical proficiency across all three instructional methods. However, the comparative analysis revealed that the Video-Based instructional method was the most effective, followed by Work Text-Based and Traditional methods.

The findings reinforce the benefits of video-based instruction as highlighted in the existing literature and extend these benefits to non-numerate individuals. Video-based learning, which offers engaging, interactive, and dynamic educational experiences, significantly outperformed the other methods. This aligns with Cognitive Load Theory, which suggests that managing cognitive load through visual and engaging content enhances learning outcomes. The Work Text-Based method also showed substantial benefits, supporting previous research on the effectiveness of structured textual resources in facilitating learning at the learner's own pace.

Traditional teaching methods, while effective, did not match the performance gains observed with the video-based intervention. This suggests that modern, multimedia-based approaches may provide more engaging and personalized learning experiences compared to traditional lecture-based instruction.

These results have meaningful implications for educators, curriculum developers, and policymakers, highlighting the importance of selecting appropriate instructional strategies tailored to the needs of non-numerate learners. Integrating video-based learning into instructional frameworks can optimize educational outcomes, enhancing student engagement, understanding, and performance in mathematics. Future research should explore the long-term effects of these instructional methods and investigate their applicability across different mathematical concepts and diverse learner populations.

In conclusion, the Video-Based instructional method has proven to be a highly effective strategy for improving mathematical proficiency in subtraction among non-numerate learners. Implementing such evidence-based strategies can make a meaningful difference in educational practices, ultimately enhancing student engagement, understanding, and performance in mathematics.

6. Implications to Research and Practice

The findings of this study have several important implications for educators, curriculum developers, policymakers, and researchers in the field of mathematics education, particularly for enhancing the mathematical proficiency of non-numerate learners through effective instructional methodologies.

6.1. Educational Practices and Curriculum Design

The results underscore the potential of Video-Based instructional methods to significantly enhance mathematical proficiency among non-numerate learners. Educators should consider integrating video-based learning tools into their instructional practices, leveraging the dynamic and interactive nature of video content to engage students and enhance their understanding of complex concepts such as integer subtraction. The use of visual aids and multimedia resources can mitigate cognitive overload and provide clear, contextualized examples that are instrumental for conceptual understanding, as highlighted by Cognitive Load Theory (Sweller, Ayres, & Kalyuga, 2011).

Additionally, curriculum developers should design educational materials that incorporate Video-Based instructional strategies, ensuring that these resources are accessible and tailored to the specific needs of non-numerate learners. This approach can help bridge the gap in mathematical proficiency and provide learners with a more engaging and effective learning experience.

6.2. Teacher Training and Professional Development

The study's results emphasize the necessity for continuous professional development opportunities that provide educators with the skills and knowledge necessary for the effective implementation of Video-Based instructional methods. Training programs should focus on enhancing teachers' ability to create and utilize video content to support mathematical instruction, providing them with the tools to design lessons that are both engaging and educationally effective.

Educators should also be trained in the application of Cognitive Load Theory principles to ensure that instructional materials are designed in a way that minimizes unnecessary cognitive load and maximizes learning efficiency. Such training can empower teachers to better support non-numerate learners and improve their overall mathematics teaching practices.

6.3. Policy and Funding

Policymakers should recognize the value of integrating Video-Based instructional methods into educational strategies and provide the necessary funding and resources to support this transition. Investment in technology infrastructure, such as classroom multimedia systems and online learning platforms, is critical to facilitate the widespread adoption of video-based learning. Additionally,

funding should be allocated for the development of high-quality video content that aligns with curriculum standards and addresses the specific needs of non-numerate learners.

Policy initiatives should also promote the adoption of evidence-based instructional strategies, encouraging schools and educational institutions to implement video-based methods and other innovative teaching practices that have been empirically shown to enhance learning outcomes.

6.4. Future Research

The study opens several avenues for future research. Researchers should investigate the long-term effects of Video-Based instructional methods on mathematical proficiency and explore their applicability across diverse mathematical concepts and learner populations. Comparative studies that examine the effectiveness of different video-based instructional designs and content types can provide further insights into optimizing these methods for various educational contexts.

Furthermore, research should explore the integration of other innovative instructional strategies, such as flipped classrooms and blended learning models, which combine video-based content with traditional and work text-based methods. The exploration of hybrid approaches can provide a more comprehensive understanding of how different instructional strategies can be synergistically combined to enhance learning outcomes for non-numerate learners.

The implications of this study are far-reaching, providing a solid foundation for transforming educational practices, professional development, policy-making, and future research in mathematics education. By adopting Video-Based instructional methods and ensuring their effective implementation, educators and policymakers can significantly enhance the learning experiences and mathematical proficiency of non-numerate learners, ultimately contributing to their academic success and long-term educational and career opportunities.

7. Recommendations

The results of this comparative study highlight significant implications for educational practices, curriculum design, teacher training, policy, and future research in the field of mathematics education, particularly for non-numerate learners.

7.1. Educational Practices and Curriculum Design

Given the superior effectiveness of Video-Based instructional methods demonstrated by this study, it is strongly recommended that educators integrate video lessons into their teaching practices. These lessons should include dynamic and interactive content that fosters engagement and simplifies complex mathematical concepts like integer subtraction. Cognitive Load Theory supports the use of multimedia resources to manage cognitive load effectively, enhancing conceptual understanding.

Curriculum developers should incorporate video-based strategies and create aligned instructional materials tailored to the needs of non-numerate learners. These resources should be accessible, and their design should aim to provide

contextualized, clear examples that facilitate deeper understanding and retention of mathematical concepts.

7.2. Teacher Training and Professional Development

The study underscores the need for professional development programs that equip educators with the necessary skills to effectively implement Video-Based instructional methods. Training programs should include workshops and resources on creating and leveraging video content in mathematical instruction, focusing on best practices for integrating multimedia into the classroom.

Teachers should also be trained in cognitive load management strategies to ensure instructional materials are designed to enhance learning efficiency. Incorporating principles from Cognitive Load Theory into teacher training can empower educators to better support non-numerate learners and thereby improve overall mathematics teaching practices.

7.3. Policy and Funding

Policymakers should prioritize the integration of Video-Based instructional methods into education systems. This involves providing adequate funding for technology infrastructure, including multimedia classroom setups and online learning platforms. Furthermore, there should be financial support for developing high-quality video content that aligns with curriculum standards and meets the specific needs of non-numerate learners.

Policy initiatives should promote the adoption of evidence-based instructional strategies, mandating the use of empirically validated methods such as video-based learning to improve educational outcomes. Ensuring that schools have the required resources to implement these strategies efficiently is crucial.

7.4. Future Research

Future research should delve into the long-term impacts of Video-Based instructional methods on mathematical proficiency and explore their efficacy across varied mathematical topics and learner demographics. Studies should compare different video-based instructional designs to identify the most effective approaches for enhancing learning outcomes.

Additional research should investigate hybrid instructional models, such as flipped classrooms and blended learning environments, which combine video-based content with traditional and text-based methods. Understanding how these hybrid approaches can synergistically improve educational outcomes for non-numerate learners will provide deeper insights into optimal instructional strategies.

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