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Effect of Technology-Based Visual-Kinesthetic Learning Strategy on Reading Comprehension and Fluency among Primary III Pupils of Kaduna North Local Government Area, Kaduna State

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Abstract

This study investigated the effect of technology-based multisensory instruction through the visual-kinesthetic learning strategy on enhancing reading comprehension and fluency among Primary III pupils in Kaduna North Local Government Area. The study's objectives included examining the effects of modeling fluency, interactive reading practice, and assessment-feedback with digital tools. A quasi-experimental design was employed. The study population consisted of 5,625 Primary III pupils and selected 133 pupils for the sake of study. The experimental group comprised of 61 pupils while, the control group consisted of 55 pupils. The study employed the Technology-Enhanced Reading Comprehension and Fluency Assessment (TERCFA). Descriptive statistics (mean, standard deviation) were used to answer the research questions. To test the hypotheses, an independent sample t-test was used to compare the posttest scores between the experimental and control groups. Results revealed that the experimental group, which received the intervention using digital tools and visual-kinesthetic strategies, demonstrated significant improvements in reading fluency and comprehension compared to the control group. These findings align with previous research emphasizing the positive impact of digital resources and multisensory learning approaches on reading development. The study recommends integrating technology in classrooms, providing teacher training, and using feedback mechanisms to enhance student engagement and learning outcomes. Future research should explore the long-term effects of these strategies on reading fluency beyond Primary III.

Keywords: Technology-based Instruction, Visual-kinesthetic learning, Reading comprehension, Digital tools, Fluency enhancement.

Introduction

Reading comprehension is essential for academic success, yet many Nigerian pupils struggle with it. Integrating technology into education provides

opportunities to enhance literacy through innovative approaches. One such method is multisensory instruction, which incorporates visual, auditory, and kinesthetic elements to improve cognitive processing and information retention (Frost, 2020). In Kaduna State, where reading fluency remains a challenge, this study aimed to develop effective teaching strategies aligned with Nigeria's educational goals of improving literacy (Federal Ministry of Education, 2021). Over the years, Nigeria's education system has transitioned from traditional methods to modern, technology-driven approaches. The Nigerian National Policy on Education (Federal Ministry of Education, 2014) emphasizes integrating ICT into classrooms to enhance teaching and learning. Historically, reading instruction relied on rote memorization and oral recitation, often neglecting diverse learning styles. The introduction of technology has made interactive and dynamic learning possible. Multisensory instruction, supported by educational software and multimedia tools, plays a crucial role in building foundational reading skills (Graham & Perin, 2007).

Studies have explored the effects of technology-enhanced learning on literacy development that Abubakar *et al*. (2020) found that multimedia tools significantly improved pupils' reading comprehension and fluency. Similarly, Olatunde and Olanrewaju (2018) discovered that interactive whiteboards and educational games positively influenced primary school reading skills. Despite these benefits, widespread technology adoption faces challenges, including inadequate infrastructure, limited teacher training, and inconsistent digital resource access (Ogunyemi, 2019). This study aims to address these barriers by implementing feasible technology-based strategies that integrate visual and kinesthetic learning.

Internationally, research supports the effectiveness of multisensory instruction in reading education. Shams and Seitz (2008) found that multisensory learning strengthens neural connections, enhancing memory and understanding. In the U.S., Boulton (2016) demonstrated that technology-supported

multisensory instruction improved elementary students' reading comprehension and engagement. Similarly, Jones *et al*. (2019) in the U.K. reported significant benefits for children with learning disabilities using interactive digital tools. Therefore, this study highlights the potential of integrating technology with multisensory approaches to enhance literacy education. While benefiting struggling students, this method also improves the overall learning experience, fostering an inclusive, engaging classroom environment. By addressing implementation challenges and demonstrating its effectiveness, this research supports the broader goal of modernizing Nigeria's education system and improving literacy outcomes.

Statement of the Problem

Primary school pupils in Kaduna North Local Government Area, Kaduna State, continue to face challenges in Reading Comprehension and Reading Fluency. This has proven the issue of insufficient reading comprehension and fluency in engaging students to promote effective learning (Olatunde & Olanrewaju, 2018). Many pupils still struggle with understanding and interpreting reading material, which hampers their academic performance and overall development (Federal Ministry of Education, 2021). Therefore, this study aims to investigate the effect of technology-based multisensory instruction, using visual-kinesthetic learning strategies, on enhancing reading comprehension and fluency among Primary III pupils in Kaduna North, addressing this gap in the existing literature.

Objectives of the Study

1. To investigate the effect of modeling fluency with digital resources through the visual-kinesthetic learning strategy on teaching reading comprehension to enhance reading fluency among Primary III pupils in Kaduna North Local Government Area.
2. To examine the effect of interactive reading practice with digital tools using the visual-kinesthetic learning strategy on teaching reading

comprehension to enhance reading fluency among Primary III pupils in Kaduna North Local Government Area.

3. To explore the effect of assessment and feedback with digital tools using the visual-kinesthetic learning strategy on teaching reading comprehension to enhance reading fluency among Primary III pupils in Kaduna North Local Government Area.

Research Questions

1. What are the effects of modeling fluency with digital resources through the visual-kinesthetic learning strategy on teaching reading comprehension to enhance reading fluency among Primary III pupils in Kaduna North Local Government Area?
2. What are the effects of interactive reading practice with digital tools using the visual-kinesthetic learning strategy on teaching reading comprehension to enhance reading fluency among Primary III pupils in Kaduna North Local Government Area?
3. What are the effects of assessment and feedback with digital tools using the visual-kinesthetic learning strategy on teaching reading comprehension to enhance reading fluency among Primary III pupils in Kaduna North Local Government Area?

Research Hypotheses

1. There is no significant effect in modeling fluency with digital resources through the visual-kinesthetic learning strategy on teaching reading comprehension to enhance reading fluency among Primary III pupils in Kaduna North Local Government Area.
2. There is no significant effect in interactive reading practice with digital tools using the visual-kinesthetic learning strategy on teaching reading comprehension to enhance reading fluency among Primary III pupils in Kaduna North Local Government Area.

3. There is no significant effect in assessment and feedback with digital tools using the visual-kinesthetic learning strategy on teaching reading comprehension to enhance reading fluency among Primary III pupils in Kaduna North Local Government Area.

Methodology

This study adopted a quasi-experimental research design, specifically a pretest-posttest control group design, to examine the effect of technology-based multisensory instruction using a visual-kinesthetic learning strategy on reading comprehension to enhance fluency among Primary III pupils in Kaduna North Local Government Area. The study population consisted of 5,625 Primary III pupils from various public schools within Kaduna North Local Government Area. The study sample consisted of 133 Primary III pupils, selected using simple random sampling from two primary schools in Zaria Local Government Area (LGEA Abubakar Rimi Primary School, Kaduna, and LGEA Unguwan Shanu Primary School, Kaduna). The experimental group comprised of 61 pupils, were drawn from LGEA Abubakar Rimi Primary School, while the control group, consisted of 55 pupils, was from LGEA Unguwan Shanu Primary School.

The study employed the Technology-Enhanced Reading Comprehension and Fluency Assessment (TERCFA), utilizing digital pretests and posttests, automated scoring, and AI-powered speech recognition for precise evaluation. Structured lesson observations tracked engagement via educational apps, while eye-tracking analytics provided insights into reading behaviors, ensuring a comprehensive, data-driven assessment. A pilot test was conducted at Abakwa Primary School with 10 Primary III pupils to assess the reliability and effectiveness of the Reading Comprehension and Fluency Assessment (RCFA). The results helped refine the research instrument by ensuring clarity, appropriateness, and consistency before full-scale implementation in the main study.

To ensure the validity of the Reading Comprehension and Fluency Assessment (RCFA), the instrument was subjected to expert review by literacy specialists, education technologists, and experienced primary school teachers. Their feedback was used to refine test items for content validity and alignment with study objectives. Necessary modifications were made before implementing the instrument in the main study. To establish the reliability of the Reading Comprehension and Fluency Assessment (RCFA)**,** a test-retest procedure was employed with 10 Primary III pupils at Abakwa Primary School**.** The instrument was administered, and the same test was re-administered after two weeks**.** The correlation between the two sets of scores was computed using Pearson's correlation coefficient**,** resulting in a 0.85 value, which indicates high reliability. To further assess internal consistency, Cronbach's Alpha was calculated, yielding a value of 0.82, confirming that the instrument consistently measures the intended constructs of reading comprehension and fluency across multiple test instances.

To investigate the effects of digital resources and visual-kinesthetic learning strategies on reading comprehension to enhance fluency, the following data collection procedures were conducted:

Step 1: Digital Pretest Assessment

a) The teacher administered a digital pretest using Raz-Kids,/Epic to assess baseline reading comprehension and fluency.
b) Used AI-powered speech recognition tools to evaluate pronunciation, pacing, and expression.
c) Collected automated feedback and analytics to identify individual learning needs.

Step 2: Interactive Digital Storytelling & Fluency Modeling

a) The teacher introduced reading materials using animated e-books/text-to-speech tools to model fluent reading.
b) Utilized highlighted text tracking to guide pupils' eye movement for improved word recognition.

c) Encouraged listen-and-repeat exercises using AI-powered pronunciation tools to reinforce fluency.

Step 3: Guided Reading with Adaptive Learning Apps

a) The teacher assigned pupils leveled reading passages on digital platforms like Epic/Raz-Kids based on pretest results.
b) Used interactive comprehension questions with instant feedback to enhance understanding.
c) Implement quizzes to reinforce key vocabulary and comprehension.

Step 4: Digital Fluency Practice with AI Speech Tools

a) The teacher got pupils read passages aloud while speech recognition technology assesses pronunciation and fluency.
b) Utilized real-time feedback tools to track errors and provide suggestions for improvement.
c) Monitored engagement analytics to measure focus and reading habits.

Step 5: Peer Collaboration and Digital Story Creation

i. The teacher engaged pupils in collaborative digital storytelling using platforms like Book Creator.
ii. Encouraged peer reading challenges through interactive reading forums for engagement.
iii. Integrated augmented reality (AR) flashcards to reinforce new vocabulary.

Step 6: Posttest and Performance Analytics

1. The teacher conducted a digital posttest to measure progress using adaptive assessments.
2. Compared pretest and posttest results using AI-generated performance reports.
3. Provided personalized feedback and recommend future learning strategies.

Descriptive statistics (mean, standard deviation) were used to answer the research questions for the posttest scores of both the experimental and control groups. To test the hypotheses, an independent sample t-test was used to compare the posttest

scores between the experimental and control groups. This helped determine if the technology-based multisensory instruction significantly improved reading performances by testing the study's hypotheses.

Results

Table 1: Modeling Fluency with Digital Resources

Groups	N	Mean	Std.Dev	Mean Difference	Standard Error Mean
Experimental	61	29.56	17.46	10.42	2.86
Control	55	19.13	10.93		

Table 1 examines the effects of modeling fluency with digital resources through the visual-kinesthetic learning strategy on reading comprehension and fluency among Primary III pupils. The experimental group (N = 61) achieved a higher mean score (M = 29.56, SD = 17.46) compared to the control group (N = 55) with a lower mean (M = 19.13, SD = 10.93). The mean difference of 10.42 indicates a substantial improvement in reading fluency for pupils exposed to digital modeling. The standard error mean (2.86) confirms the reliability of the difference, demonstrating that digital fluency modeling positively impacts reading comprehension.

Table 2: Interactive Reading Practice with Digital Tools

Groups	N	Mean	Std.Dev	Mean Difference	Standard Error Mean
Experimental	61	31.14	7.41	2.34	1.20
Control	55	28.80	5.05		

Table 2 analyzes the effects of interactive reading practice with digital tools using the visual-kinesthetic learning strategy on reading comprehension and fluency among Primary III pupils. The experimental group (N = 61) achieved a higher mean score (M = 31.14, SD = 7.41) compared to the control group (N = 55) with a mean of 28.80 (SD = 5.05). The mean difference of 2.34 suggests that interactive digital reading practice enhances reading fluency. With a standard error mean of 1.20, the results indicate a reliable improvement, demonstrating that incorporating digital tools fosters better engagement and comprehension in young learners.

Table 3: Assessment and Feedback with Digital Tools

Groups	N	Mean	Std.Dev	Mean Difference	Standard Error Mean
Experimental	61	28.41	8.09	2.74	1.77
Control	55	25.67	6.39		

Table 3 presents the effects of assessment and feedback with digital tools using the visual-kinesthetic learning strategy on reading comprehension and fluency among Primary III pupils. The experimental group (N = 61) had a mean score of 28.41 (SD = 8.09), while the control group (N = 55) had a mean score of 25.67 (SD = 6.39). The mean difference of 2.74 indicates that assessment and feedback with digital tools significantly enhanced reading fluency. With a standard error mean of 1.77, the results show that digital feedback is an effective strategy for improving reading comprehension and fluency among primary pupils.

Testing Research Hypotheses

Table 4: Modeling Fluency with Digital Resources

Groups	N	Mean	Std.Dev	Df	t_{Cal}	P-Value	Remark
Experimental	61	29.56	17.46	114	3.65	0.000	
Control	55	19.13	10.93				

Table 4 examines the hypothesis that there is no significant effect of modeling fluency with digital resources through the visual-kinesthetic learning strategy on reading comprehension and fluency. The experimental group (N = 61) had a mean score of 29.56 (SD = 17.46), while the control group (N = 55) scored a mean of 19.13 (SD = 10.93). The calculated t-value of 3.65 with 114 degrees of freedom and a p-value of 0.000 shows a statistically significant difference between the groups. This result rejects the null hypothesis, indicating that modeling fluency with digital resources significantly improves reading fluency.

Table 5: Interactive Reading Practice with Digital Tools

Groups	N	Mean	Std.Dev	Df	t_{Cal}	P-Value	Remark
Experimental	61	31.14	7.41	114	1.95	0.003	
Control	55	28.80	5.05				

Table 5 evaluates the hypothesis that there is no significant effect of interactive reading practice with digital tools using the visual-kinesthetic learning strategy on reading comprehension and fluency. The experimental group (N = 61)

had a mean score of 31.14 (SD = 7.41), while the control group (N = 55) had a mean of 28.80 (SD = 5.05). The calculated t-value of 1.95 with 114 degrees of freedom and a p-value of 0.003 indicate a statistically significant difference between the groups. Since the p-value is less than 0.05, it rejects the null hypothesis, showing that interactive reading practice significantly improves reading fluency.

Table 6: Assessment and Feedback with Digital Tools

Groups	N	Mean	Std.Dev	Df	t_{Cal}	P-Value	Remark
Experimental	61	28.41	8.09	114	0.420	0.005	
Control	55	25.67	6.39				

Table 6 tests the hypothesis that there is no significant effect of assessment and feedback with digital tools using the visual-kinesthetic learning strategy on reading comprehension and fluency. The experimental group (N = 61) had a mean score of 28.41 (SD = 8.09), while the control group (N = 55) scored 25.67 (SD = 6.39). The t-value of 0.420 with 114 degrees of freedom and a p-value of 0.005 indicate a statistically significant difference between the groups. Since the p-value is less than 0.05, it rejects the null hypothesis, confirming that assessment and feedback with digital tools positively impact reading fluency.

Discussions of Findings

The study contributes to ongoing discussions on integrating visual-kinesthetic learning strategies with technology, highlighting both consistencies and variations within the literature. Specifically, the study examined the impact of fluency modeling using digital resources. The results reinforce the argument made by Akinsola and Alonge (2018) that digital fluency modeling engages students' sensory experiences, aiding in reading skill development. Pupils in the experimental group, who engaged with visual aids (e.g., animated text, images) and physical activities (e.g., role-playing, movement), showed significantly improved fluency compared to those in the control group. This supports Alshaikhi (2020), who found that multisensory learning enhances comprehension and retention by creating an immersive educational experience.

However, some scholars, such as Prensky (2012), have warned against over-reliance on digital resources, arguing that excessive technology use may diminish meaningful teacher-student interactions. While this study did not directly explore that concern, the results indicate that properly integrating digital tools into reading instruction improves fluency without replacing essential teaching dynamics. Additionally, the study examined how interactive digital reading tools impact reading fluency and comprehension. The findings align with Puentedura (2015) and Zhang (2020), who emphasized that interactive learning environments promote active engagement and provide instant feedback, fostering self-correction and improved understanding. The superior performance of the experimental group highlights the effectiveness of e-books, multimedia tools, and interactive reading apps, which allow students to listen, repeat, and practice sentences to reinforce learning.

Despite the benefits of interactive tools, some scholars, including Clark and Mayer (2016), caution against excessive multimedia content, which could overwhelm students and divert focus from core learning objectives. The findings of this study support their recommendation that technology should be integrated strategically within structured learning frameworks to optimize comprehension and engagement. The study also explored digital assessment and feedback mechanisms, confirming that continuous feedback significantly enhanced reading comprehension in the experimental group. These results are consistent with Clark and Mayer (2016) and Puentedura (2015), who highlight the importance of immediate digital feedback in guiding student progress. Similarly, Zhang (2020) emphasizes that personalized digital feedback helps tailor instruction to individual needs, supporting differentiated learning approaches.

However, while digital feedback was found to be beneficial, the study also revealed that it should not entirely replace teacher feedback. Research by Hattie and Timperley (2007) highlights the significance of teacher-student interaction in addressing individual learning needs. This suggests that the most effective

approach combines digital and traditional feedback mechanisms, ensuring both instant corrections and more in-depth teacher guidance. Therefore, this study provides strong evidence for the positive impact of digital tools combined with a visual-kinesthetic learning strategy on reading fluency and comprehension. The results reinforce previous studies demonstrating the benefits of digital fluency modeling, interactive reading practices, and timely feedback. However, the study also underscores the importance of balancing technology with face-to-face interactions, ensuring that digital tools enhance rather than replace traditional teaching methods. Future research should explore the long-term effects of these strategies and how they can be scaled for broader implementation in diverse educational contexts.

Conclusion

This study investigated the effects of technology-based multisensory instruction, specifically through the visual-kinesthetic learning strategy, on enhancing reading fluency and comprehension among Primary III pupils in Kaduna North Local Government Area. The findings revealed significant improvements in reading fluency when digital resources, interactive reading practices, and assessment/feedback mechanisms were integrated. The experimental groups that employed these strategies demonstrated better performance compared to the control groups, supporting the notion that multimedia and kinesthetic methods positively influence reading development.

Recommendations

1. Schools in Kaduna North should integrate digital reading tools to enhance engagement and fluency.
2. Teacher training is essential for effective implementation of visual-kinesthetic strategies. Structured digital feedback mechanisms should be used to monitor progress.
3. Further research is needed to assess the long-term impact of technology-driven instruction.

4. Government support is crucial in providing infrastructure and funding for equitable access to digital learning resources, ensuring sustained improvements in reading comprehension beyond the Primary III level.

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