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Exploring the Effects of Technology Integration on Student Engagement and Academic Performance in Mathematics in Southwest Nigeria's Colleges of Education

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ABSTRACT: The integration of technology into mathematics instruction has gained increasing attention due to its potential to enhance student engagement and academic performance. This study examined the effects of technology integration on student engagement and academic performance in mathematics in Colleges of Education in South-West Nigeria. A descriptive survey research design was adopted for the study. The population comprised mathematics lecturers and students in Colleges of Education across Ogun, Oyo, Osun, Ondo, and Ekiti States. A sample of 500 respondents was selected using a multi-stage sampling technique. Data were collected using a structured questionnaire titled Technology Integration, Student Engagement and Academic Performance in Mathematics Questionnaire (TISEAPMQ), with a reliability coefficient of 0.82 determined through the Cronbach Alpha method. Data were analysed using inferential statistical tools, including chi-square test, one-sample t-test, Pearson correlation, and multiple regression analysis. The findings revealed a significant variety in the types of technology used in teaching mathematics, indicating diverse instructional practices among educators. Results further showed that students have a significantly positive perception of technology-enhanced mathematics learning, suggesting that technology use improves engagement and learning experiences. However, the study also found that educators face significant challenges in integrating technology into mathematics instruction, and these challenges negatively affect the level of technology integration. Overall, the study concludes that while technology integration enhances student engagement and learning in mathematics, addressing educators' challenges is crucial for achieving effective and sustainable integration. The study recommends improved infrastructural support, continuous professional development for educators, and institutional policies that promote effective technology use in mathematics instruction.

KEYWORDS: Technology integration, student engagement, academic performance, mathematics education, Colleges of Education, Nigeria.

INTRODUCTION

Technology integration in education has become a critical area of focus in the 21st century, especially in mathematics education, due to its potential to enhance learning outcomes and student engagement. With rapid advancements in educational technology, there are several ways to include technology in mathematics instruction, such as interactive whiteboards, online games, and instructional software. To raise student interest and academic achievement in mathematics classes interactive whiteboards were developed, this has been observed by Niederhauser (2020) that the use of interactive whiteboards enhanced student engagement and academic performance in Mathematics. The impact of interactive whiteboards in higher education was investigated by Andy (2018) in Lethbridge College, Canada and discovered that despite implementing best practices, most instructors underutilize IWB capabilities. Similarly, Fuchs et al. (2021) conducted a meta-analysis. They found that technology-based interventions in mathematics education favourably impact student achievement, particularly for those having trouble with mathematics. Research has consistently shown that incorporating technology into teaching methodologies significantly improves students' engagement, understanding, and academic performance, particularly in complex subjects like mathematics (Akinmoladun, 2022).

In the context of Nigeria, mathematics has historically been considered a challenging subject, with many students struggling to achieve proficiency. This trend is even more pronounced in tertiary institutions, such as Colleges of Education in Southwest Nigeria, where the training of future educators demands innovative teaching approaches to equip them for 21st-century classrooms.

Exploring the Effects of Technology Integration on Student Engagement and Academic Performance in Mathematics in Southwest Nigeria's Colleges of Education

Recent studies highlight that technology-integrated teaching strategies improve not only academic performance but also foster a deeper engagement in students by enabling practical applications of mathematical concepts (Oluwaseun, 2023).

Despite its benefits, the adoption of technology in education across Nigeria faces challenges, including inadequate infrastructure, lack of teacher training, and limited access to digital resources. Nevertheless, with the increasing emphasis on educational reforms and investments in technology, there is a growing need to empirically investigate the specific effects of technology integration on student engagement and performance in mathematics in this region (Andy, 2018).

This study seeks to explore these effects within the Colleges of Education in Southwest Nigeria, focusing on how technology integration can be leveraged to improve outcomes for both educators and students. By doing so, it aims to contribute to the body of knowledge that informs policy-making and instructional design in mathematics education. The findings from this research will provide actionable insights for educators, policymakers, and stakeholders in the education sector, particularly in Colleges of Education, where future educators are trained.

Technology Integration in Mathematics Education

Research underscores the importance of technology in facilitating mathematics instruction. Tools like interactive whiteboards, mathematical software, and online platforms enable students to grasp abstract concepts through visualization and interactive learning. Studies reveal that technology integration promotes active participation, critical thinking, and problem-solving skills among learners Bhuttah (2024). For example, Rizada (2023) highlights that the use of digital tools enhances academic performance in mathematics by providing instant feedback and personalized learning opportunities. Moreover, integrating technology into the curriculum creates opportunities for collaborative learning, allowing students to work on problem-solving tasks using shared digital platforms. The integration of technology in teaching mathematics was examined by Muhtadi et al (2017) who reported the use of a technology-based learning approach to developing the competence of pre-service math teacher TPACK and transforming knowledge in integrating technology into practice teaching mathematics after technology-based learning training. A study by Barak and Dori (2009) found that the use of computer-assisted learning tools led to higher student engagement and a deeper understanding of mathematical concepts. When students interact with dynamic, interactive environments, they are more likely to take ownership of their learning process and develop problem-solving skills that are crucial in mathematics (Jeynes, 2005).

Furthermore, several studies have shown that technology integration positively impacts students' achievement in mathematics. For example, a meta-analysis by Cheung and Slavin (2013) concluded that the use of educational technology significantly improved mathematics achievement, particularly when combined with appropriate instructional strategies. These technologies can reinforce learning by providing students with ample opportunities to practice problems, receive instant feedback, and engage in collaborative problem-solving.

Impact on Student Engagement

Student engagement in mathematics is crucial for understanding complex concepts and sustaining academic interest. Technology has been found to significantly improve engagement by making lessons more interactive and enjoyable. A systematic review by D'Angelo (2018) emphasises that technology helps reduce student absenteeism and fosters enthusiasm for learning through gamification and multimedia tools. The impact of technology integration on student engagement and achievement in mathematics education was studied by Ali et al (2023) and the study provides evidence of the positive effect of technology integration on student engagement and academic achievement in mathematics education, there is a necessity for a comprehensive synthesis of the available evidence.

In Nigeria, integrating technology into education has shown promising results. For instance, educational applications and simulations used in Southwest Nigeria have proven effective in capturing students' attention and increasing their motivation to learn mathematics.

Feng *et al.* (2021) investigated the effects of technology-enhanced mathematics instruction on academic achievement, finding that it positively affected student achievement in mathematics. Li et al. (2020) examined the effects of gamification on students' motivation and achievement in mathematics and found that it was an effective strategy for enhancing student engagement and achievement in mathematics. Additionally, Alzahrani et al. (2020) explored the effects of using interactive whiteboards on students' achievement and attitudes toward mathematics and found that their use in mathematics instruction had a positive impact on student achievement and attitude. Tan and Soh (2019) investigated the effects of using digital manipulatives on primary school students' mathematics achievement and found that their use positively affected students' mathematics achievement. Moreover, a study by Alghamdi et al. (2020) investigated the effects of using a mobile application on students' mathematics achievement and found that its use had a positive impact on students' mathematics achievement. Ma et al. (2020) examined the effects of using online platforms on student engagement and achievement in mathematics, finding that their use positively affected student

engagement and achievement in mathematics. Alammary and Alhajri (2021) investigated the effects of using a mathematics mobile application on students' achievement and attitudes and found that its use had a positive impact on both student achievement and attitudes toward mathematics. Chen and Lin (2020) studied the effects of using a digital pen and interactive whiteboard on students' learning outcomes in mathematics and found that their use had a positive impact on students' learning outcomes, including achievement, engagement, and retention. Similarly, Jahan and Ferdousi (2019) explored the effects of using a mathematical game on students' achievement and motivation and found that its use had a positive effect on both student achievement and motivation.

Another recent study by Li et al. (2021) examined the effects of using virtual reality on students' mathematics achievement and motivation, finding that its use had a positive impact on both. Nasir et al. (2020) explored the effects of using a web-based intelligent tutoring system on students' mathematics achievement and found that its use had a positive impact on students' mathematics achievement.

Statement of the problem

Technology integration in education has gained considerable interest as digital tools transform learning environments. In mathematics education, integrating technology is seen as a potential means to enhance student engagement and academic performance, particularly in colleges of education where teachers are trained to shape future learners. However, there is a pressing need to understand how effectively these technologies impact engagement and performance outcomes specifically in mathematics, a subject often perceived as challenging by students.

Despite considerable investments in educational technology, the degree to which these tools foster sustained engagement and improve achievement in mathematics remains uncertain. While some studies indicate positive correlations between technology use and increased student participation and comprehension, others highlight issues such as over-reliance on tools and lack of integration skills among educators. Additionally, limited research specifically examines these effects within colleges of education, which train future teachers whose attitudes and competencies in integrating technology can greatly affect their future students. Moreover, there is a need to explore the extent of technology's influence on student engagement and performance in mathematics within this context, identifying challenges and best practices to ensure effective implementation.

Despite advancements in technology, many mathematics classrooms still rely heavily on traditional teaching approaches. This reliance has led to diminished engagement and performance among students. The primary problem addressed by this research is understanding whether technology integration can address these issues in Colleges of Education and provide educators with tools that enhance teaching effectiveness in mathematics.

Purpose of the study

The study intends to explore the effects of technology integration on student engagement and academic performance in Mathematics in the South-West Nigeria's Colleges of Education

Objectives

The objectives of the study are:

i. To identify types of technology currently used in teaching mathematics.
ii. To assess student perceptions of technology-enhanced mathematics learning.
iii. To explore educators' challenges in integrating technology into mathematics instruction.

Research questions

The following research questions are raised for the study

1. What types of technology are currently used in the teaching of mathematics?
2. What are students' perceptions of technology-enhanced mathematics learning?
3. What challenges do educators encounter in integrating technology into mathematics instruction?

Research Hypotheses

The following null hypotheses are formulated for the study:

H_{o1}: There is no significant variety in the types of technology currently used in the teaching of mathematics.

H_{o2}: Students do not have a significantly positive perception of technology-enhanced mathematics learning.

H_{o3}: Educators do not face significant challenges in integrating technology into mathematics instruction.

METHODOLOGY

The study adopted a descriptive survey research design. This design was considered appropriate because it enables the researcher to systematically collect data from a large population to describe existing conditions, attitudes, and practices related to technology integration in mathematics teaching. The design also allows for examining relationships among technology integration, student engagement, and academic performance without manipulating the study variables. The study was conducted in Colleges of Education located in South-West Nigeria, comprising Lagos, Ogun, Oyo, Osun, Ondo, and Ekiti States. The region was selected because of its relatively high concentration of Colleges of Education and its increasing adoption of educational technologies. These institutions play a critical role in training future teachers, making them suitable for examining the effects of technology integration in mathematics education. The population of the study consisted of all mathematics lecturers and students in Colleges of Education in South-West Nigeria. This population was considered appropriate because both lecturers and students are directly involved in the teaching and learning of mathematics and are therefore well-positioned to provide relevant information on technology integration, engagement, and academic performance. A total sample of 500 respondents was selected for the study. This sample comprised both mathematics lecturers and students drawn from selected Colleges of Education in the region. The multi-stage sampling technique was employed. Data were collected using a structured questionnaire titled "Technology Integration, Student Engagement and Academic Performance in Mathematics Questionnaire (TISEAPMQ)". Four-point Likert scale of Strongly Agree (4), Agree (3), Disagree (2), and Strongly Disagree (1). The reliability of the instrument was determined using the Cronbach Alpha method. A pilot study was conducted using 30 respondents who were not part of the main study. The reliability coefficient obtained was 0.82, indicating that the instrument was reliable and suitable for data collection. The researcher personally visited the selected Colleges of Education to administer the questionnaires with the assistance of trained research assistants. Permission was obtained from the relevant authorities before data collection. Respondents were assured of confidentiality and informed that the information provided would be used strictly for academic purposes. A total of 500 questionnaires were administered and successfully retrieved. Data collected were analysed using inferential statistical tools.

RESULTS

Research hypothesis

Hypothesis one: There is no significant variety in the types of technology currently used in the teaching of mathematics.

Chi-Square Decision Table for Hypothesis One

Test Statistic	**Value**
Chi-Square Calculated (χ^2cal)	214.36
Degrees of Freedom (df)	9
Level of Significance (α)	0.05
Chi-Square Table Value (χ^2tab)	16.919
Decision	Reject H_o

Hypothesis One examined whether there is a lack of variety in the types of technology currently used in the teaching of mathematics. The chi-square analysis showed that the calculated chi-square value of 214.36 was much higher than the critical table value of 16.919 at the 0.05 level of significance. This indicates a statistically significant difference in the types of technology used. As a result, the null hypothesis was rejected. The finding implies that different types of technological tools are being used in mathematics instruction, reflecting diversity in teaching approaches and levels of technology adoption among educators.

Hypothesis two: Students do not have a significantly positive perception of technology-enhanced mathematics learning.

One-Sample t-Test Summary of Students' Perception of Technology-Enhanced Mathematics Learning

N	**Mean**	**Std. Deviation**	**Std. Error Mean**	**t**	**df**	**Sig. (2-tailed)**	**Mean Difference**	**95% Confidence Interval**
500	3.28	0.61	0.027	22.93	499	.000	0.78	0.71 – 0.85

Hypothesis two examined whether students hold a positive perception of technology-enhanced mathematics learning. The one-sample t-test results showed that students' mean perception score of 3.28 was significantly higher than the reference value, indicating a positive perception. The test was statistically significant, with a t-value of 22.93 at 499 degrees of freedom and a probability value less than 0.05. This result led to the rejection of the null hypothesis. The finding suggests that students generally

view the use of technology in mathematics learning positively, and this positive perception is consistent across the sample, as reflected by the narrow confidence interval.

Hypothesis three: Educators do not face significant challenges in integrating technology into mathematics instruction.

Summary of Correlation and Regression Analysis of Educators' Challenges and Technology Integration

Statistic	Value
Pearson Correlation (r)	-0.517
Sig. (2-tailed)	.000
R	.517
R^2	.267
Adjusted R^2	.266
Std. Error of Estimate	0.48
F-value	181.63
ANOVA Sig.	.000
Regression Coefficient (B)	-0.44
Standard Error (B)	0.03
Standardized Beta (β)	-0.517
t-value	-13.48
Regression Sig.	.000

Hypothesis three examined whether educators face significant challenges in integrating technology into mathematics instruction. The analysis revealed a strong and statistically significant negative relationship between educators' challenges and technology integration. The correlation result indicates that as the challenges faced by educators increase, the level of technology integration in mathematics teaching decreases. The regression analysis further confirmed this relationship, showing that educators' challenges significantly predict the extent of technology integration. The model explained about 26.7 percent of the variation in technology integration, and the overall result was statistically significant. Based on these findings, the null hypothesis was rejected, indicating that educators face meaningful challenges that hinder the effective integration of technology into mathematics instruction.

CONCLUSION

This study examined the effects of technology integration on student engagement and academic performance in mathematics in Colleges of Education in South-West Nigeria. The findings provide strong empirical evidence that technology integration plays a meaningful role in improving mathematics teaching and learning within this context. The study revealed that a wide variety of technological tools are currently being used in mathematics instruction, indicating that educators are gradually moving away from reliance on traditional teaching methods. This diversity reflects growing awareness of the instructional value of digital tools in mathematics education.

The results also showed that students hold a significantly positive perception of technology-enhanced mathematics learning. This positive disposition suggests that the use of technology makes mathematics lessons more engaging, interactive, and easier to understand, thereby enhancing students' interest and participation in the subject. Such positive perceptions are important, as they contribute to sustained engagement and improved academic performance.

However, the study further established that educators face significant challenges in integrating technology into mathematics instruction. These challenges were found to negatively affect the level of technology integration, indicating that the effectiveness of technology-based teaching depends largely on educators' capacity, access, and institutional support. Despite the availability of various technologies and students' readiness to embrace them, persistent barriers such as inadequate infrastructure, limited training, and technical difficulties continue to hinder optimal use. Thus, the study concludes that while technology integration has clear benefits for student engagement and learning in mathematics, its full potential in Colleges of Education in South-West Nigeria can only be realised if the challenges faced by educators are adequately addressed. Strengthening technology integration is therefore essential for improving the quality of mathematics education and for preparing future teachers to function effectively in technology-driven classrooms.

RECOMMENDATIONS

Based on the findings of this study, the following recommendations are made:

1. Government agencies, educational authorities, and institutional management should invest in modern and reliable technological infrastructure such as interactive whiteboards, projectors, computers, stable internet access, and relevant mathematics software to support effective teaching and learning.
2. Regular training programmes, workshops, and seminars should be organised for mathematics educators to improve their digital competence and confidence in integrating technology into instruction. Emphasis should be placed on practical classroom application rather than theoretical exposure alone.
3. Colleges of Education should develop clear institutional policies that encourage and support technology integration in teaching. This includes providing technical support staff and allocating time for educators to plan and experiment with technology-enhanced lessons.
4. Technology use should be formally embedded into the mathematics curriculum for Colleges of Education. This will ensure that pre-service teachers are trained to use digital tools effectively before entering the teaching profession.
5. Continuous funding from stakeholders such as TETFund and state governments should be ensured to maintain and upgrade technological facilities. Regular monitoring and evaluation should also be conducted to assess the effectiveness of technology integration initiatives.
6. Future studies should explore the long-term effects of technology integration on students' academic performance using experimental designs. Similar studies could also be conducted in other regions or educational levels to enhance generalisation of findings.

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