

Impact of Digital Learning Tools on Students' Motivation and Academic Performance in Physics among Senior Secondary School in Katsina Zonal Education Quality Assurance

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Abstract

This study examines the impact of digital learning tools on students' motivation and academic performance in physics among senior secondary school in Katsina zonal education quality assurance, Katsina state, Nigeria. It established four objectives and research questions, and tested four hypotheses at a significance level of 0.05. A sample of 113 students was selected from a population of 17,572 SSII students, consisting of 10,258 male and 7,314 female students from public schools in the Katsina Zonal Education Quality Assurance. The research used a quasi-experimental design with instruments such as the Physics Performance Test (PPT) and Physics Motivation Questionnaire, which had validity and reliability coefficients of 0.897 and 0.753, respectively. Descriptive statistics (mean and standard deviation) were used to analyze the research questions, while inferential statistics (independent t-test and Regression Analysis) tested the hypotheses at $\alpha = 0.05$. The results showed a significant difference in performance between students taught physics via Digital learning tools and those taught with the traditional method. The study recommends the government should provide computer, projectors, and internet access in schools to support digital learning and teachers should combine normal classroom teaching with digital method to help students learn better.

Keywords: Academic performance, Digital learning tools, Motivation. Physics, Gender

Introduction

The rapid advancement of information and communication technologies (ICT) has significantly transformed the educational landscape worldwide. Digital learning tools ranging from interactive multimedia, educational software, online platforms, to mobile learning applications are now integrated into classrooms to enhance teaching and learning. These technologies offer new opportunities to deliver content, support differentiated instruction, and provide engaging and interactive learning experiences (Ghavifekr & Rosdy, 2015).

Digital learning tools refer to technology-based resources used to enhance teaching and learning. These include educational software, mobile learning apps, virtual simulations, learning management systems (LMS), video tutorials, and interactive whiteboards. These tools aim to facilitate learner-centered environments, promote collaboration, and provide multimedia content to support diverse learning needs (Ghavifekr & Rosdy, 2015). The adoption of these tools is rooted in the belief that technology can bridge gaps in accessibility, enhance engagement, and improve instructional delivery.

According to Thoms et al. (2023), digital technologies bridge the gap between human perception and physical reality, enabling students to explore phenomena that are otherwise inaccessible due to scale, speed, or invisibility such as atomic interactions or electromagnetic radiation. This capability is particularly vital in physics, where traditional teaching methods often fall short in conveying complex ideas effectively.

One of the most critical variables in student learning is motivation. More recent evidence showing reciprocal links between task interest, self-efficacy, and performance (Nuutila et al. (2020)). Traditional instructional methods, often teacher-centered, may fail to sustain students' interest, especially in a digital generation that is accustomed to interactive and multimedia-rich environments. Digital learning tools have been shown to enhance student motivation by providing interactive and immersive experiences, with augmented reality applications in particular helping students connect abstract concepts to physical reality (Thoms, Lee, & Chung, 2023).

Student motivation refers to the internal drive or external stimuli that influence a learner's engagement, persistence, and effort in academic activities. Motivation remains a critical factor in student learning. According to Nuutila et al. (2020), task interest, self-efficacy, and performance are interrelated and

reciprocally influential, underscoring the importance of strategies that sustain learners' motivation.

In educational settings, motivation is critical as it significantly affects students' willingness to learn, effort levels, and academic success.

Motivation is a critical factor in academic success, particularly in subjects like physics that demand abstract reasoning and problem-solving skills. Nuutila et al. (2020) found reciprocal relationships between interest, self-efficacy, and performance, suggesting that motivated students are more likely to engage deeply with content and achieve better outcomes. Digital tools can enhance motivation by making learning more interactive and personalized. For example, video-based instruction has been shown to improve retention and engagement (Noetel et al., 2021). Similarly, platforms that allow students to create and share content such as explanatory videos or digital posters foster a sense of ownership and creativity (Kulgemeyer & Peters, 2016).

Furthermore, academic performance remains a central goal in educational systems, and educators are continuously exploring innovative instructional strategies to improve it. Studies suggest that digital learning tools can support academic success by providing immediate feedback, enabling self-paced learning, and promoting critical thinking skills (Ifinedo, 2017; Noetel et al., 2021). However, the effectiveness of these tools in real classroom settings particularly in developing countries has not been conclusively established Noetel et al. (2021) Systematic review showing video-based learning significantly improves student outcomes.

Previous research has indicated that the use of digital learning tools for educational purposes can lead to improved students motivation, and academic performance. For example, a study highlighted that incorporating digital learning tools into academic courses can enhanced students' interest and learning outcomes when used effectively (Ghavifekr and Rosdy, 2015). Additionally, Ifinedo (2017) explored the use of blogs and learning management systems and reported a significant increase in student motivation and performance. Several studies have explored the impact of digital learning tools on students' academic performance. For instance, research conducted by Al-Qahtani and Higgins (2013) compared traditional, blended, and e-learning methods, concluding that digital environments significantly improved academic Performance. Yusuf and Al-Banawi (2013) discovered that students

exposed to e-learning tools demonstrated higher levels of self-directed learning and better test scores than those in conventional classrooms.

In the context of secondary education, students are expected to master foundational knowledge while also developing motivation, autonomy, and problem-solving skills. Given the increasing presence of technology in students' lives, it becomes imperative to investigate how digital tools can be leveraged to support these educational goals. This study, therefore, seeks to examine the impact of digital learning tools on students' motivation and academic performance in secondary schools.

Statement of the Problem

Despite widespread adoption of digital learning tools in educational settings, there is limited empirical evidence on their actual impact on students' motivation and academic performance, particularly within the Nigerian secondary school context. While some educators assume these tools enhance engagement and understanding, others argue that without proper implementation and teacher training, they may become distractions or underutilized resources (Ifinedo, 2017).

Many schools invest in digital infrastructure without a clear strategy for integration into the curriculum. Moreover, few studies have systematically examined how these tools influence students' internal drive to learn or their academic outcomes. Given the growing emphasis on 21st-century learning, it is essential to evaluate whether digital learning tools truly contribute to meaningful educational improvement. Hence, this study aims to address this gap by assessing the impact of digital learning tools on student motivation and academic performance in physics among senior secondary school in Katsina zonal education quality assurance.

Objectives of the Study

The main aim of this study is to examine the impact of digital learning tools on students' motivation and academic performance. The specific objectives are to:

1. determine the effect of digital learning tools on students' academic performance.

2. examine the impact of digital learning tools on students' motivation toward learning.
3. find out the impact of digital learning tools on academic performance of male and female students in physics.
4. identify the impact of digital learning tools on motivation scores of male and female students in physics.

Research Questions

This study will be guided by the following research questions:

1. what is the difference between the means performance scores of students taught physics using digital learning tools and those taught with traditional methods?
2. what is the difference between the mean motivation score of the students taught physics using digital learning tools and those taught using traditional Method?
3. What is the difference between the mean Performance scores of male and female students taught physics using digital learning tools?
4. What is the difference between the mean rank motivation score of Male and Female Students taught physics using digital learning tools?

1.5 Research Hypotheses

The following null hypotheses will be tested in the study:

H0₁: There is no significant difference between the mean performance score of students taught physics using digital learning tools and those taught using traditional methods.

H0₂: There is no significant difference between the mean motivation score of students taught physics using digital learning tools and those taught using traditional Method

H0₃: There is no significant difference between the mean performance scores of male and female students taught physics using digital learning tools.

H0₄: There is no significant difference between the mean rank interest score of Male and Female Students taught physics using digital learning tools.

Methodology

This study adopts a quasi-experimental research design using a pre-test, post-test non-equivalent control group design. This approach allows for the comparison of academic performance and motivation between students taught with digital learning tools (experimental group) and those taught with traditional methods (control group), while controlling for initial differences through pre-testing.

The study employed the quasi-experimental research design which has to do with pre-test, post-test and post posttest non-equivalent control group. This is because random assignment of subject to the experimental and control group was not allowed for the study. Instead, intact classes were used for the treatments to experimental and control groups. Pre-test was initially administered to the students in the two groups to determine the equivalency of the subjects being studied in terms of performance and interest in Physics before the treatment. The posttest was also conducted for the experimental and control groups to determine the impact of the treatment on the performance and motivation of the subjects in Physics.

The study population consisted of all 17,572 (10,258 male and 7,314 female) SSII students in the Katsina Zonal Education Quality Assurance area. The Katsina Zonal Education Quality Assurance area comprises three local government areas in Katsina State. Three methods were used to select a sample for the study, viz: the cluster, purposive and simple random sampling methods. Schools were grouped into three clusters based on local government areas, and one school from each cluster was randomly selected through balloting. This ensured the study was not limited to just one local government area, resulting in three schools being chosen. Two of these schools were purposively and randomly assigned to the experimental and control groups and labeled School A and School B for ethical reasons, purposive sampling to select schools equipped with digital learning facilities while Simple random sampling to assign students into experimental and control groups to ensure comparability. One intact SSII class was chosen from each of the groups using the simple random sampling technique, resulting in a total of 113 SSII students from the selected schools.

The experimental group was taught using a digital learning tools over a six-week period. Students used smartphones and were given internet access to engage with instructional content delivered through platforms such as Google Classroom, YouTube, WhatsApp, and Quizizz. Each lesson began with a short video explaining the topic, followed by interactive activities, quizzes, and collaborative discussions. The researcher provided a structured schedule, continuous feedback, and guidance on planning and evaluating tasks. Eight reflective learning rules were introduced to encourage respectful and active participation. Meanwhile, the control group was taught the same content using the conventional lecture method, following a predefined lesson plan. Both groups received instruction for the same duration.

Data were collected using two instruments, viz: the Physics Performance Test (PPT) and the Physics Motivation Questionnaire (PMQ). The PPT, a 30-item multiple-choice test based on modified Bloom's taxonomy, evaluated students' performance levels before and after the intervention. The PMQ, designed for Senior Secondary School II (SS II) students, measured Motivation toward physics using a four-point Likert scale, with responses rated as Strongly Agree (4), Agree (3), Disagree (2), and Strongly Disagree (1). Both instruments underwent validation by two experts and reliability testing. For the Physics Performance Test (PPT), a test-retest method was applied during the pilot testing to establish the reliability of instrument PPT. Pearson Product Moment Correlation (PPMC) statistical tool was used to calculate the reliability coefficient of the instrument and a value of (0.851) was obtained. While a split-half method was used for the Physics Motivation Questionnaire (PMQ) and Cronbach Alpha statistical tool was used to analyze the result and a reliability coefficient of (0.783) was obtained from the result of pilot test of the Physics Motivation Questionnaire. Descriptive statistics, such as mean and standard deviation, were employed to summarize data, with the mean reflecting average responses and the standard deviation indicating variability. Hypothesis one was tested using an independence t-test, while Hypothesis two was tested using the Mann-Whitney U-test. Hypothesis three and four were analyze using Analysis of Covariant (ANCOVA).

Results

a. Performance of the students taught Physics using Digital Learning Tools and those taught using lecture method

Table 1: Mean and Standard Deviation of Physics Performance Posttest Score for Experimental and Control Groups

Variable	Group	N	Mean	Std. Dev.	Mean difference
Posttest	Digital Learning Tools	45	26.27	1.839	6.296
	Traditional Method	68	19.97	3.138	

Table 1 shows that the mean performance scores of the experimental group (i.e. students taught using Digital Learning Tools) ($M = 26.27$, $SD = 1.839$) and that of control group (students taught using Traditional Method) ($M = 19.97$, $SD = 3.138$) differs by 6.296 in favor of the students taught using Digital Learning Tools. Hence the students taught using Digital Learning Tools outperformed their counterparts taught using Traditional Method. To determine whether this difference is significant or not, the scores of the two groups were subjected to analysis of t-test independence. The result is presented in Table 2.

Table 2: Summary of independence t-test Result on Performance in Physics between Experimental and Control Groups

Group	N	Mean	Std. Dev.	Df	t-value	p-value	Remark
Digital Learning Tools	45	26.27	1.839	111	12.138	0.000	Sig.
Traditional Method	68	19.97	3.138				

* Significant at $\alpha \leq 0.05$

Table 2 indicates that the difference between the mean performance scores of the students taught using Digital Learning Tools and those taught using traditional Method is significant. ($t = 12.138$, $sig. = .000$) at $p < .05$. Hence, H_0 is rejected implying that there exists statistically significant difference between Experimental Group (i.e. students taught using Digital Learning Tools) and the Control Group (i.e. students taught using traditional Method) in favor of the students taught using Digital Learning Tools.

b. Students' Motivation taught physics using Digital Learning Tools and those taught using Traditional Method

Table 3: Mean Ranks of students' motivation Scores in Physics for the Experimental and Control Groups

Group	N	Mean Rank	Sum of Ranks	Mean Ranks Diff.
Motivation Digital Learning Tools	45	82.81	3726.50	
Traditional Method	68	39.92	2714.50	42.89
Total	113			

Table 3 showed that the difference between the mean motivation score of students taught physics using digital learning tools ($N = 45$, $MR = 82.81$) and those taught using traditional Method ($N = 68$, $MR = 39.92$) is 42.89 in favor of the students taught physics using digital learning tools. Hence, the students taught physics using digital learning tools exhibited higher motivation in physics than their counterparts taught using traditional Method. To determine whether this difference is significant or not, motivation scores of the two groups were subjected to the Mann Whitney U-test. The result is shown in Table 4.

Table 4: Mann Whitney U-Test for Comparison of Mean Ranks of motivation toward Physics Scores for Experimental and Control Groups

Group	N	Mean Rank	Sum of Ranks	U-value	p-value	Remark
Experimental Group	45	82.81	3726.50			
Control Group	68	39.92	2714.50			
Total	113			$Z = -6.818$	0.000	Significant

The Mann-Whitney U test result in Table 4 shows that the difference between the mean ranks of the Experimental and Control Groups is significant, $Z = -6.818$, $p < 0.05$. Hence, H_0 is rejected, implying that there exists statistically significant difference in motivation towards physics between Experimental Group (i.e. students taught using digital learning tools) and the Control Group (i.e. students taught using traditional Method) in favor of the students taught using digital learning tools.

c. Performance of the Male and Female students taught Physics using Digital Learning Tools and those taught using lecture method

Table 5: Mean and Standard Deviation of Male and Female Performance Score

Variable	Group	N	Mean	Std. Dev.	Mean difference
Posttest	Male	22	26.09	1.797	0.34
	Female	23	26.43	1.903	

Table 5 shows that the mean performance scores of the male students taught using Digital Learning Tools ($M = 26.09$, $SD = 1.797$) and that of Female ($M = 26.43$, $SD = 1.903$) differs by 0.34. Hence the students taught using digital learning tools are gender friendly. To determine whether this difference is significant or not, the scores of the two groups were subjected to analysis of Covariant ANCOVA. The result is presented in Table 6.

Table 6: Summary of ANCOVA Result on Performance in Physics between Male and Control Female students

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Squared	Eta
Corrected Model	6.603 ^a	2	3.302	.975	.385	.044	
Intercept	2438.754	1	2438.754	720.325	.000	.945	
Pretest	5.274	1	5.274	1.558	.219	.036	
Gender	1.039	1	1.039	.307	.582	.007	
Error	142.197	42	3.386				
Total	31196.000	45					
Corrected Total	148.800	44					

a. R Squared = .044 (Adjusted R Squared = -.001)

Table 6 indicates that the difference between the mean performance scores of the students taught using WhatsApp and those taught using Lecture Method is significant. $(1, 2) = 0.307$ $p \geq .05$. Hence, H_{04} is retained implying that there no statistically significant difference between male and female.

d. Male and female Students' Motivation taught physics using Digital Learning Tools

Table 7: Mean Ranks of male and female students' motivation Scores in Physics for the Experimental

	Gender	N	Mean Rank	Sum of Ranks	Mean Ranks Diff.
Motivation	Male	22	24.32	535.00	2.58
	Female	23	21.74	500.00	
	Total	45			

Table 7 showed that the difference between the mean rank of motivation score of male students taught physics is ($N = 22$, $MR = 24.32$) and that of male students ($N = 23$, $MR = 21.74$) is 2.58 in favor of the male students. Hence, the male students taught physics using digital learning tools exhibited higher motivation in physics than female. To determine whether this difference is significant or not, motivation scores of the two scores were subjected to the Mann Whitney U-test. The result is shown in Table 8.

Table 8: Mann Whitney U-Test for Comparison of Mean Ranks of male and female student's motivation toward Physics Scores for Experimental

Group	N	Mean Rank	Sum of Ranks	U-value	p-value	Remark
Male	22	24.32	535.00			
Female	23	21.74	500.00	$Z = -0.660$	0.510	Not Significant
Total	45					

The Mann-Whitney U test result in Table 8 shows that the difference between the mean ranks of the Male and Female students is not significant, $Z = -0.660$, $p \geq 0.05$. Hence, H_0 is retained, implying that there no statistically significant difference in motivation towards physics between male and female students.

Discussion

This study set out to investigate how digital learning tools affect students' motivation and academic performance in physics among senior secondary school students in Katsina. The findings show that students taught with digital learning tools performed significantly better than those taught with the traditional lecture method. This outcome suggests that digital platforms can provide richer, more engaging experiences that help learners grasp difficult physics concepts more effectively. This finding echoes earlier research by Ghavifekr and Rosdy (2015), who highlighted how technology integration enhances teaching and learning, as well as Al-Qahtani and Higgins (2013), who demonstrated that blended and e-learning approaches significantly boost students' academic achievement.

Another key finding was the higher motivation levels observed among students who engaged with digital tools compared to their peers in traditional classrooms. This result supports Ryan and Deci's (2000) self-determination theory, which emphasizes motivation as a driving force behind learning and persistence. It also resonates with the work of Noetel et al. (2021), who showed that video-based instruction can significantly enhance student

engagement and retention, and Ifinedo (2017), who reported that digital platforms such as blogs and learning management systems strengthen both motivation and academic outcomes.

Interestingly, the study also revealed that digital learning tools are gender-friendly. No significant difference was found between male and female students' performance or motivation. This result suggests that technology provides an inclusive environment that supports learning equally across genders. The finding is consistent with Yusuf and Al-Banawi (2013), who found that e-learning fosters self-directed learning without gender bias. Similarly, Nuutila et al. (2020) emphasized that motivation, interest, and performance are interrelated factors that remain consistent across different student groups.

Finally, the positive relationship identified between students' motivation and their performance reinforces the idea that motivated learners are more likely to excel academically. Digital tools seem to provide the conditions necessary for both motivation and performance to flourish, as supported by Kulgemeyer and Peters (2016), who highlighted how digital platforms foster creativity, ownership, and deeper engagement in learning.

Conclusion

The study concludes that digital learning tools significantly improve students' academic performance and motivation in physics compared to traditional teaching methods. These tools not only make learning more interactive and engaging but also create an inclusive environment where both male and female students benefit equally. Furthermore, the strong link between motivation and performance underscores the importance of cultivating student interest through innovative digital strategies. Overall, the study affirms that digital learning tools are effective in promoting better learning outcomes in physics and should be embraced in secondary education.

Recommendations

1. Teachers should incorporate digital tools into their teaching practices to make physics lessons more engaging and effective.

2. Governments and educational stakeholders should ensure schools are equipped with essential facilities such as projectors, computers, internet connectivity, and digital applications.
3. Regular training should be provided to teachers on how to effectively integrate digital tools into classroom teaching.
4. Schools should guarantee that both male and female students have equal opportunities to access and use digital resources.
5. Educational policymakers should prioritize ICT-driven instruction in secondary schools to meet the demands of 21st-century learning.

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