

Influence of Digital Technology Integration on Performance, Interest and Engagement in Biology among Secondary School Students in Edu, Kwara State, Nigeria

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Abstract

This study investigated the influence of digital technology integration on performance, interest and Engagement in Biology among secondary school students in Edu Local Government Area of Kwara State, Nigeria. A descriptive survey research design was adopted, and a sample of 150 senior secondary school students was selected from public secondary schools in the study area using a convenience sampling technique. Data were collected through a structured questionnaire validated by experts in Science Education and Educational Measurement. Descriptive statistics, including frequencies and percentages, were used to answer the research questions, while chi-square (χ^2) statistics were employed to test the hypotheses at the 0.05 level of significance. Findings revealed that digital technology integration positively influenced students' learning outcomes in Biology. A majority of the respondents reported improved understanding of complex biological concepts, increased classroom attention, enhanced motivation, and greater interest in Biology when digital tools such as videos, animations, simulations, and online resources were utilized. The results further indicated that digital technology integration had a significant effect on students' academic performance ($\chi^2=12.90$, $p < 0.05$), interest in Biology ($\chi^2=15.84$, $p < 0.05$), and engagement in Biology learning ($\chi^2=18.72$, $p < 0.05$). Despite these positive outcomes, inadequate digital infrastructure and limited access to technological resources were identified as major challenges to effective implementation. The study concluded that digital technology integration significantly enhances Biology teaching and learning by improving students' academic performance, interest, and engagement. It recommended increased investment in digital infrastructure, teacher training, and the provision of technology-supported learning resources to improve science education outcomes in secondary schools.

Keywords: Digital Technology Integration, Biology, Academic Performance, Interest & Engagement.

Introduction

The twenty-first century has witnessed unprecedented advances in digital technologies, resulting in profound transformations across numerous sectors, particularly education. The integration of digital technologies into teaching and learning has become a global priority because of its potential to enhance instructional effectiveness, increase learner engagement, and improve educational outcomes. Digital technology integration in education refers to the deliberate and pedagogically informed use of technological tools and resources—such as computers, multimedia applications, internet-based resources, virtual laboratories, educational software, mobile devices, simulations, and learning management systems—to support and enrich teaching and learning processes. As educational systems continue to evolve in response to the demands of a digitally driven world, technology is increasingly recognized as an indispensable component of contemporary education. Modern educational systems acknowledge the critical role of technology in preparing learners to thrive in a knowledge-based and digitally interconnected society. According to UNESCO (2023), digital technologies represent one of the most transformative innovations in modern education, offering opportunities for personalized learning, collaborative knowledge construction, and expanded access to educational resources. However, the effectiveness of technology integration depends largely on the quality of implementation, teachers' technological competencies, the availability of adequate infrastructure, and learners' digital readiness (GEM Report, 2023). The growing recognition of technology's educational value has contributed to the emergence of technology-enhanced learning environments, which have transformed traditional approaches to teaching and learning. This transformation has encouraged a shift from teacher-centred instructional practices toward more interactive and learner-centred pedagogies that promote collaboration, critical thinking, creativity, and self-directed learning. Empirical evidence from diverse educational contexts indicates that, when effectively implemented, digital technologies significantly enrich learning experiences by providing students with immediate access to information, interactive content, and personalized learning opportunities. Consequently, digital



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technology has become a central component of educational reform initiatives aimed at improving the quality, accessibility, and effectiveness of teaching and learning worldwide (Usman, Oyeronke, & Hussaini, 2024). Beyond the provision of technological devices in schools, effective digital technology integration requires the systematic incorporation of technology into curriculum delivery, classroom instruction, assessment practices, and learning activities. Recent studies by Maričić and Lavicza (2024) and Umar, Soladoye, Tunde, Frankling, Adekunle, Peter, and Gafar (2024) revealed that technology-enhanced learning environments promote active learning by enabling students to interact with content through multimedia presentations, simulations, animations, virtual experiments, and collaborative digital platforms. These studies further reported that emerging technologies facilitate deeper cognitive engagement and foster the development of creativity, critical thinking, and problem-solving skills. In science education, particularly, digital technologies provide visual and interactive representations of abstract concepts that are often difficult to explain using conventional instructional methods. As a result, educators across the globe are increasingly adopting technology-supported pedagogies to enhance students' understanding and participation in science-related subjects.

Within the domain of science education, Biology occupies a particularly important position because of its relevance to numerous professional and societal needs. At the secondary school level, Biology provides foundational knowledge required for careers in medicine, nursing, pharmacy, agriculture, environmental science, biotechnology, and other health-related professions. Furthermore, it contributes significantly to scientific literacy by enabling learners to understand the structure and functions of living organisms, ecological relationships, genetic inheritance, environmental sustainability, and public health issues. Despite its importance, students' academic performance in Biology remains a major concern in many developing countries, including Nigeria. Several studies have attributed students' poor achievement in Biology to factors such as inadequate instructional materials, ineffective teaching methods, insufficient laboratory facilities, low student motivation, and limited opportunities for active participation during classroom instruction (Aina & Sofowora, 2023; Oyelekan et al., 2022). Given these persistent challenges, researchers and educators have increasingly explored innovative instructional approaches capable of improving students' learning outcomes in Biology. Academic performance refers to the extent to which students successfully achieve learning objectives as measured through tests, examinations, assignments, classroom participation, and other assessment indicators. Educational researchers argue that technology-supported learning environments can improve academic performance by enhancing students' comprehension, retention, and application of knowledge. Through multimedia resources, simulations, animations, and interactive learning activities, students are exposed to richer learning experiences that facilitate deeper cognitive processing. In Biology education, where many concepts are abstract and difficult to visualize through conventional instructional methods, digital technologies provide opportunities for students to observe biological processes virtually and engage more meaningfully with scientific content. A recent quasi-experimental study conducted by Falebita and Asimolowo (2025; 2026) found that students exposed to interactive multimedia Biology instruction demonstrated significantly higher academic achievement than those taught using conventional instructional approaches. Similarly, Adeleye (2023) reported that multimedia-assisted instruction significantly improved Biology students' academic performance compared with traditional lecture methods. These findings suggest that effective digital technology integration can substantially enhance students' academic outcomes. While academic performance remains a crucial pointer of educational success, it is equally important to consider students' interest in learning, as interest often serves as a catalyst for sustained engagement and achievement. Interest refers to a learner's psychological inclination, enthusiasm, and willingness to engage in learning activities. Educational researchers have consistently emphasized that students who demonstrate higher levels of interest in a subject are more likely to participate actively in classroom activities, devote time to independent study, and achieve better academic outcomes. Digital technologies can stimulate students' interest by making lessons more interactive, engaging, and relevant to their everyday experiences. Features such as animations, educational games, virtual reality, simulations, and multimedia presentations can capture students' attention and increase their enthusiasm for learning scientific concepts. Recent research on educational technology suggests that technology-supported instruction enhances learners' motivation and fosters positive attitudes toward learning by creating dynamic and student-centred learning environments (Himendra, 2024). Further related to students' interest is the concept of student engagement, which represents another critical determinant of successful learning outcomes. Student engagement encompasses students' behavioural, emotional, and cognitive involvement in learning activities. Engaged students actively participate in classroom discussions, complete learning tasks, collaborate with peers,



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and demonstrate persistence in overcoming academic challenges. Educational psychologists have consistently argued that students who exhibit high levels of engagement are more likely to demonstrate stronger intrinsic motivation, participate actively in learning activities, and achieve superior academic outcomes. Digital technologies possess considerable potential to enhance engagement by creating dynamic learning environments characterized by interactivity, collaboration, immediate feedback, and learner autonomy (Mirjana & Zsolt, 2024). Nevertheless, the extent to which these technologies influence students' engagement and academic performance may depend on factors such as accessibility, digital competence, instructional quality, and institutional support. Understanding the relationship between digital technology integration, students' academic performance, interest, and engagement is therefore essential for informing educational policies and instructional practices aimed at improving Biology learning outcomes in contemporary secondary schools.

Statement of the Problem

Despite the documented benefits of digital technology integration, many secondary schools in developing countries continue to face significant implementation challenges. In Nigeria, the integration of digital technologies into classroom instruction remains constrained by inadequate ICT infrastructure, unreliable electricity supply, limited internet connectivity, insufficient funding, and inadequate teacher training (UNESCO, 2023). Although educational policies advocate the incorporation of technology into teaching and learning processes, implementation remains uneven across urban and rural schools. Recent studies indicate that while students increasingly utilize digital technologies for learning purposes, access to quality digital learning resources and effective technology-supported instruction remains limited in many schools. These challenges may hinder the realization of the full educational benefits associated with digital technology integration. Within Kwara State, particularly in Edu Local Government Area, empirical evidence regarding the impact of digital technology integration on students' academic performance, interest, and engagement in Biology remains limited. While previous studies have examined technology integration in broader educational contexts, few have specifically investigated its influence on Biology learning outcomes among secondary school students in Edu LGA. Given the increasing emphasis on digital transformation in education and the strategic importance of Biology in science education, there is a need to examine how digital technology integration influences students' academic performance, interest, and engagement in Biology. It is against this background that this study investigates the impact of digital technology integration on Biology teaching and learning among secondary school students in Edu Local Government Area, Kwara State, Nigeria.

Research Questions

1. What is the impact of digital technology integration on students' academic performance in Biology?
2. What is the influence of digital technology integration on students' interest in learning Biology?
3. What is the influence of digital technology integration on students' engagement in Biology learning?

Research Hypotheses

H₀₁: Digital technology integration has no significant impact on students' academic performance in Biology.

H₀₂: Digital technology integration has no significant influence on students' interest in learning Biology.

H₀₃: Digital technology integration has no significant influence on students' engagement in Biology learning.

Literature Review

Concept of Digital Technology in Education

Digital technology refers to electronic tools, systems, devices, and resources that generate, process, store, and transmit information. In educational contexts, digital technologies include computers, tablets, smartphones, internet resources, learning management systems, simulations, virtual laboratories, and multimedia applications. According to UNESCO (2023), digital technologies facilitate equitable access to education and enhance teaching effectiveness through personalized and interactive learning experiences. Similarly, the European Commission's DigCompEdu Framework emphasizes that digital competence has become an essential component of effective teaching and learning in contemporary educational systems.

Digital Technology and Biology Education

Biology education benefits significantly from digital technologies because many biological concepts involve microscopic structures, dynamic processes, and complex interactions that are difficult to visualize through conventional methods. Recent studies indicate that digital simulations and virtual laboratories enhance students' conceptual understanding and

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scientific reasoning. Bond et al. (2024) found that technology-supported science instruction significantly improves learner engagement and achievement. Likewise, Hennessy et al. (2023) reported that digital pedagogies increase student participation and collaborative learning in science classrooms. Virtual learning environments enable students to observe biological phenomena, conduct simulated experiments, and access multimedia resources that support deeper understanding. Research by Redecker and Punie (2023) further demonstrates that technology-enhanced science instruction promotes inquiry-based learning and critical thinking.

Empirical Review

Several studies have reported positive outcomes associated with digital technology integration in science education. Aina (2023) found that secondary school students exposed to digital instructional materials performed significantly better in Biology than those taught using traditional methods. Similarly, Adeyemi and Olatunji (2024) reported that multimedia-supported instruction improved retention and motivation among Biology students in Nigerian secondary schools. Internationally, OECD (2023) observed that effective educational technology integration contributes to improved learning outcomes when supported by adequate teacher training and infrastructure. However, studies also reveal persistent barriers such as inadequate funding, insufficient digital competence among teachers, unreliable electricity supply, and limited internet connectivity.

Challenges of Digital Technology Integration

Despite its benefits, several factors hinder successful technology integration in Nigerian schools:

1. Inadequate funding for ICT infrastructure.
2. Limited access to computers and internet facilities.
3. Poor electricity supply.
4. Insufficient teacher training and digital literacy.
5. Resistance to pedagogical change.
6. Weak institutional support and policy implementation.

These constraints continue to limit the realization of the full educational benefits of digital technologies.

Theoretical Framework

Technology Acceptance Model (TAM)

This study is anchored on the **Technology Acceptance Model (TAM)** developed by Davis (1989) and subsequently extended by Venkatesh and Davis (2000). The model posits that individuals' adoption of technology is influenced primarily by:

1. Perceived Usefulness (PU): The degree to which users believe technology enhances performance.
2. Perceived Ease of Use (PEOU): The degree to which technology is perceived as easy to use.

In the context of Biology education, students and teachers are more likely to adopt digital technologies when they perceive such technologies as useful for improving learning outcomes and easy to operate. The positive responses reported by students regarding improved understanding, engagement, and performance support the assumptions of TAM.

Constructivist Learning Theory

The study is also supported by Constructivist Learning Theory, particularly the works of Piaget and Vygotsky. Constructivism argues that learners actively construct knowledge through interaction with their environment. Digital technologies facilitate collaborative learning, inquiry-based exploration, and experiential learning, thereby supporting knowledge construction in Biology education. The combination of TAM and Constructivism provides a robust theoretical foundation for explaining both technology adoption and its educational outcomes.

Research Methodology

This study adopted a descriptive survey research design to investigate the impact of digital technology integration on Biology teaching and learning among secondary school students in Edu Local Government Area, Kwara State. The population of the study comprised senior secondary school students in selected public secondary schools within the study area. A sample size of 150 students was selected using a convenience sampling technique to ensure that respondents who had been exposed to digital technology in Biology instruction were adequately represented. Data for the study were collected through a structured questionnaire designed by the researcher based on the objectives of the study and the research questions. The questionnaire consisted of two sections. Section A elicited demographic information such as gender, age,

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class level, and religion, while Section B contained items measuring students' perceptions of the impact of digital technology on academic performance, interest, and engagement in Biology learning. The instrument was structured on a four-point Likert scale of Strongly Agree (SA), Agree (A), Disagree (D), and Strongly Disagree (SD). Prior to administration, the questionnaire was subjected to face and content validation by experts in Science Education and Educational Measurement to ensure its appropriateness and relevance to the study objectives. Data were collected directly from the respondents with the assistance of school authorities and class teachers. The completed questionnaires were coded and analyzed using descriptive and inferential statistics. Frequency counts and percentages were used to answer the research questions, while the chi-square (χ^2) statistical technique was employed to test the hypotheses at a 0.05 level of significance. The results were presented in tables and interpreted in line with the objectives of the study.

Presentation of Results

Research Question One: What is the impact of digital technology integration on students' academic performance in Biology in secondary schools in Edu Local Government Area, Kwara State?

Table 1: Students' Responses on the Impact of Digital Technology Integration on Academic Performance in Biology (N = 150)

S/N	Item	SA (%)	A (%)	D (%)	SD (%)
1	I learn Biology better when digital tools (videos, animations, simulations) are used	40.0	30.7	22.7	6.7
2	Digital technology makes Biology lessons more interesting	38.0	41.3	20.0	0.7
3	I understand complex Biology concepts better through visual aids	46.7	35.3	13.3	4.7
4	I prefer using apps or online resources to study Biology	40.7	32.0	26.7	0.7
5	Digital tools used in Biology increase my interest in science subjects	38.7	33.3	26.0	2.0
6	My academic performance in Biology has improved since digital tools were introduced	33.3	31.3	20.0	15.3
7	I pay more attention in Biology class when digital tools are used	26.7	40.0	22.0	11.3
8	My school provides enough digital resources for learning Biology	23.3	27.3	30.0	19.3

The findings revealed that digital technology integration has a positive impact on students' academic performance in Biology in secondary schools in Edu Local Government Area, Kwara State. The results showed that 70.7% of the respondents agreed that they learn Biology better when digital tools such as videos, animations, and simulations are used, while only 29.4% disagreed. Similarly, 82.0% of the respondents agreed that visual aids help them understand complex Biology concepts more effectively, indicating that digital resources facilitate conceptual understanding and knowledge retention. The findings further revealed that 79.3% of the students agreed that digital technology makes Biology lessons more interesting, while 72.7% indicated a preference for using digital applications and online resources for studying Biology. Additionally, 72.0% of the respondents agreed that digital tools increase their interest in science subjects, suggesting that technology-enhanced instruction contributes to positive learning attitudes. Most importantly, 64.6% of the respondents agreed that their academic performance in Biology had improved since the introduction of digital tools, whereas 35.3% disagreed. Furthermore, 66.7% of the students reported paying greater attention during Biology lessons when digital technologies were used, indicating that technology integration enhances concentration and classroom participation. However, responses regarding the availability of digital resources showed that only 50.6% agreed that their schools provide adequate digital facilities for learning Biology, while 49.3% disagreed. This finding suggests that inadequate technological infrastructure remains a challenge to the effective integration of digital technology in Biology instruction. In conclusion, the results indicate that digital technology integration positively impacts students' academic performance in Biology by improving understanding of difficult concepts, enhancing classroom attention, increasing interest in learning, and supporting better academic outcomes.

Research Question Two: What is the influence of digital technology integration on students' interest in learning Biology in secondary schools in Edu Local Government Area, Kwara State?

Table 2: Students' Responses on the Influence of Digital Technology Integration on Interest in Learning Biology (N = 150)

S/N	Item	SA (%)	A (%)	D (%)	SD (%)
1	Digital technology makes Biology lessons more interesting	38.0	41.3	20.0	0.7
2	Digital tools increase my interest in science subjects	38.7	33.3	26.0	2.0



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3	I would like more Biology classes to include the use of digital technology	45.3	33.3	20.0	1.3
4	I feel motivated to study Biology when I use educational websites or platforms	44.7	23.3	21.3	10.7

The findings indicate that digital technology integration has a positive influence on students' interest in learning Biology in secondary schools in Edu Local Government Area, Kwara State. The results revealed that 79.3% of the respondents agreed that digital technology makes Biology lessons more interesting, while only 20.7% expressed contrary opinions. Similarly, 72.0% of the students agreed that digital tools increase their interest in science subjects, suggesting that technology-enhanced instruction stimulates curiosity and enthusiasm for learning. The findings further showed that 78.6% of the respondents expressed a desire for more Biology lessons to incorporate digital technology, indicating a strong preference for technology-supported learning environments. In addition, 68.0% of the students agreed that educational websites and online learning platforms motivate them to study Biology, whereas 32.0% disagreed. In conclusion, the findings suggest that digital technology integration significantly enhances students' interest in Biology by making lessons more appealing, increasing motivation to learn, stimulating enthusiasm for science-related subjects, and encouraging positive attitudes toward Biology instruction.

Research Question Three: What is the influence of digital technology integration on students' engagement in Biology learning in secondary schools in Edu Local Government Area, Kwara State?

Table 3: Students' Responses on the Influence of Digital Technology Integration on Engagement in Biology Learning (N = 150)

S/N	Item	SA (%)	A (%)	D (%)	SD (%)
1	I pay more attention in Biology class when digital tools are used	26.7	40.0	22.0	11.3
2	The use of digital tools encourages me to study Biology outside the classroom	41.3	38.7	16.7	3.3
3	I prefer using apps or online resources to study Biology	40.7	32.0	26.7	0.7
4	I would like more Biology classes to include the use of digital technology	45.3	33.3	20.0	1.3

The findings revealed that digital technology integration positively influences students' engagement in Biology learning. A majority of the respondents (66.7%) agreed that they pay more attention during Biology lessons when digital tools are utilized, while only 33.3% expressed disagreement. Similarly, 80.0% of the respondents agreed that digital tools encourage them to study Biology beyond classroom activities, indicating that technology promotes independent learning and sustained academic engagement. Furthermore, 72.7% of the students indicated a preference for using applications and online resources when studying Biology, suggesting that digital platforms provide convenient and engaging learning opportunities. The results also showed that 78.6% of the respondents desired greater integration of digital technology into Biology lessons, reflecting students' positive perception of technology-enhanced instruction. In conclusion, the findings suggest that digital technology integration significantly enhances students' engagement in Biology learning by increasing attention during lessons, promoting independent study habits, encouraging the use of digital learning resources, and fostering positive attitudes toward technology-supported instruction. These findings imply that greater access to digital learning tools may contribute to improved participation and active involvement in Biology education among secondary school students in Edu Local Government Area, Kwara State.

Testing of Hypotheses

H₀₁: Digital technology integration has no significant effect on students' academic performance in Biology in Edu Local Government Area, Kwara State.

Table 4: Chi-square Analysis of the Effect of Digital Technology Integration on Students' Academic Performance in Biology

Variable	N	χ^2 Calculated	df	χ^2 Critical	p-value	Decision
Digital Technology Integration and Academic Performance	150	12.90	1	3.841	0.001	Reject H ₀₁

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The calculated Chi-square value of 12.90 exceeded the critical value of 3.841 at the 0.05 significance level. The null hypothesis was therefore rejected. This implies that digital technology integration has a statistically significant effect on students' academic performance in Biology in Edu Local Government Area, Kwara State.

H₀₂: Digital technology integration has no significant influence on students' interest in learning Biology in Edu Local Government Area, Kwara State.

Table 4: Chi-square Analysis of the Influence of Digital Technology Integration on Students' Interest in Biology

Variable	N	χ^2 Calculated	df	χ^2 Critical	p-value	Decision
Digital Technology Integration and Interest in Biology	150	15.84	1	3.841	0.000	Reject H ₀₂

The calculated Chi-square value (15.84) was greater than the critical value (3.841), indicating a statistically significant influence of digital technology on students' interest in Biology. Consequently, the null hypothesis was rejected.

H₀₃: Digital technology integration has no significant influence on students' engagement in Biology learning in Edu Local Government Area, Kwara State.

Table 5: Chi-square Analysis of the Influence of Digital Technology Integration on Students' Engagement in Biology Learning

Variable	N	χ^2 Calculated	df	χ^2 Critical	p-value	Decision
Digital Technology Integration and Student Engagement	150	18.72	1	3.841	0.000	Reject H ₀₃

The calculated Chi-square value of 18.72 was greater than the critical value of 3.841 at the 0.05 significance level. The null hypothesis was rejected, indicating that digital technology integration significantly influences students' engagement in Biology learning.

Discussion of Findings

The findings of this study revealed that digital technology integration has a positive and significant impact on students' academic performance in Biology in secondary schools in Edu Local Government Area, Kwara State. The majority of the respondents agreed that the use of digital tools such as videos, animations, simulations, and online resources improved their understanding of Biology concepts and enhanced their learning experiences. Students also reported that digital technologies made Biology lessons more interesting and contributed to improved academic performance. Furthermore, the hypothesis testing showed a significant relationship between digital technology integration and students' academic performance ($\chi^2 = 12.90$, $p < 0.05$), leading to the rejection of the null hypothesis. These findings support the assertion that technology-enhanced learning environments facilitate deeper understanding and retention of scientific concepts through visual and interactive instructional approaches. The result is consistent with the findings of Aina (2023), Falebita and Asimolowo (2025), and Adeyemi and Olatunji (2024), who reported that digital instructional materials and multimedia-supported teaching significantly improved students' achievement in Biology and other science subjects. The study further revealed that digital technology integration positively influenced students' interest in learning Biology. Most of the respondents indicated that digital technologies made Biology lessons more interesting, increased their enthusiasm for science-related subjects, motivated them to study Biology, and encouraged them to desire more technology-supported Biology lessons. The chi-square analysis also revealed a statistically significant influence of digital technology integration on students' interest in Biology learning ($\chi^2 = 15.84$, $p < 0.05$). This finding suggests that digital technologies possess motivational characteristics capable of stimulating learners' curiosity and positive attitudes toward Biology. The finding agrees with the work of Himendra (2024), who observed that technology-supported instruction promotes learner motivation and positive attitudes toward learning, as well as Dada et al. (2024), who found that ICT resources enhanced students' interest in Biology. The findings also established that digital technology integration significantly enhances students' engagement in Biology learning. Students reported increased attention during lessons, greater participation in learning activities, increased use of digital learning resources, and stronger commitment to studying Biology beyond classroom hours. A large proportion of respondents expressed a preference for learning through digital applications and online resources. The hypothesis test further confirmed a significant influence of digital technology integration on students' engagement in Biology learning ($\chi^2 = 18.72$, $p < 0.05$). These findings indicate that digital technologies create interactive learning environments that promote active participation, independent learning, and sustained academic engagement. This finding corroborates the views of Bond et al. (2024), Hennessy et al. (2023), and Mirjana and Zsolt (2024), who reported



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that technology-supported learning environments enhance student engagement through collaboration, interactivity, and immediate feedback mechanisms. However, despite the positive outcomes associated with digital technology integration, the findings revealed concerns regarding the availability of adequate digital facilities in schools. Nearly half of the respondents indicated that their schools lacked sufficient digital resources for effective Biology instruction. This suggests that inadequate technological infrastructure remains a major challenge to the successful implementation of technology-supported learning in secondary schools. The finding aligns with previous studies that identified poor ICT infrastructure, inadequate funding, limited internet access, and unreliable electricity supply as barriers to effective digital technology integration in Nigerian schools.

Conclusion

Based on the findings of this study, it can be concluded that digital technology integration plays a significant role in improving Biology teaching and learning in secondary schools in Edu Local Government Area, Kwara State. The study established that digital technologies positively influence students' academic performance, interest, and engagement in Biology learning. The use of videos, animations, simulations, educational websites, and other digital resources enhances students' understanding of complex biological concepts, stimulates motivation, increases classroom participation, and promotes independent learning. The findings further revealed statistically significant relationships between digital technology integration and students' academic performance, interest, and engagement in Biology. Despite these benefits, inadequate digital infrastructure and limited access to technological resources remain significant challenges that may hinder effective implementation. Therefore, increased efforts toward providing adequate technological facilities and promoting technology-supported instructional practices are essential for improving Biology education outcomes.

Educational Implications of the Study

The findings of this study have important implications for educational policy, curriculum implementation, school administration, and classroom practice. First, the positive influence of digital technology integration on students' academic performance suggests that educational stakeholders should prioritize the incorporation of digital learning resources into Biology instruction to enhance learning outcomes. Second, the significant effect of digital technology on students' interest and engagement implies that teachers should adopt technology-supported pedagogical approaches capable of making Biology lessons more interactive, motivating, and learner-centred. Third, curriculum planners may need to strengthen the integration of ICT competencies and digital learning activities within the Biology curriculum to support effective science learning. Furthermore, school administrators and policymakers should recognize that adequate investment in digital infrastructure, internet connectivity, and teacher professional development is necessary for successful technology integration. Finally, the findings provide empirical evidence that can guide future educational reforms aimed at improving science education and achieving sustainable educational development in Nigeria.

Recommendations

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

1. Government at all levels should provide adequate digital infrastructure, including computers, projectors, internet facilities, multimedia devices, and virtual laboratory resources in secondary schools to support effective Biology instruction.
2. School administrators should ensure that existing digital facilities are properly maintained and made accessible to both teachers and students for instructional purposes.
3. Biology teachers should be encouraged to integrate digital technologies such as videos, simulations, animations, educational websites, and virtual laboratories into their classroom instruction to improve students' understanding and engagement.
4. Regular training, workshops, and professional development programmes should be organized for teachers to enhance their digital literacy skills and competence in technology-supported teaching.
5. Curriculum developers should strengthen the integration of digital learning activities and ICT-related competencies into the Biology curriculum to align with contemporary educational practices.
6. Schools should provide students with opportunities to access digital learning resources beyond the classroom to encourage independent learning and continuous academic engagement.



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7. Government and educational stakeholders should address challenges related to inadequate funding, poor electricity supply, and limited internet connectivity, particularly in rural and semi-urban schools.
8. Further studies should be conducted using larger samples and different geographical locations to provide broader evidence on the impact of digital technology integration on science education in Nigeria.

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