

Exploring the Role of Digital Resources in Enhancing the Teaching and Learning of Biology in Secondary Schools in Cross River States, Nigeria.

By

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The study explored the role of digital resources in enhancing the teaching and learning of Biology in secondary schools in Cross River States, Nigeria. The study was guided by three objectives, three research questions and three null hypotheses. A descriptive survey research was adopted and it was conducted in Cross River State, Nigeria. The population for the study was 105 Biology teachers selected from 60 secondary schools (both public and private) in the three education zones (Calabar, Ikom, and Ogoja) in Cross River State and studied. Structured questionnaire consisting of 33 items were used for data collection. The instrument was face validated by three experts. Cronbach alpha reliability method was used to determine the internal consistency of the instrument and it yielded a reliability coefficient of 0.84. Data collection was done by the researcher and three research assistants. Data analysis was carried using mean, standard deviation and ANOVA. The results revealed 10 digital resources that can be used for teaching and learning Biology in secondary schools; twelve (12) impacts of digital resources in enhancing student learning outcomes in Biology in secondary schools; and 10 challenges militating against the use of digital resources for teaching and learning Biology in secondary schools in Cross River State among others. Based on the findings, the study concluded that there is a need for targeted interventions to improve the access and use of digital resources in teaching Biology, ultimately leading to better educational outcomes for students. It was recommended among others that government should invest in the necessary digital infrastructure, such as reliable electricity and internet services, to support effective use of digital resources in secondary schools.

Keywords: Digital Resources, Biology, Enhancing, Teaching, Learning, Secondary Schools, Cross River State.**Introduction**

Globally, the integration of digital resources in education has become increasingly important, especially in the wake of the COVID-19 pandemic, which highlighted the need for adaptable and technology-enhanced learning environments. The COVID-19 pandemic has accelerated the adoption of digital learning platforms, highlighting the necessity for educators to adapt their teaching strategies to include digital resources

(Adedoyin & Soykan, 2020). This shift underscores the importance of investigating how these resources can be effectively integrated into education in order to foster a more engaging and productive learning environment.

Digital resources refer to digital and technological tools that facilitate the handling and processing of information, utilizing electronic gadgets to enhance communication and learning. In teaching biology, ICT tools like computers, internet, and multimedia projectors can enhance student engagement and understanding of complex concepts. Digital resources include e-books, online articles, educational websites, and multimedia content can be utilized in teaching and learning (Liu & Wang, 2022). In a biology classroom, these resources can enrich the curriculum by providing interactive simulations of biological processes, such as cellular respiration or photosynthesis. By using platforms like Khan Academy or online biology labs, teachers can create engaging learning experiences in Biology that cater to diverse learning styles which helps to enhance students understanding.

The advent of digital technologies presents both opportunities and challenges, especially in the field of science education. The rapid advancement of digital technologies has transformed educational landscapes globally. According to UNESCO (2020), digital resources facilitate interactive and engaging learning experiences, which can significantly enhance students' comprehension and retention of complex biological concepts. Moreover, the use of digital tools, such as simulations and virtual labs, has been shown to promote active learning, allowing students to experiment and explore biological phenomena in ways that traditional methods cannot provide (Hodges et al., 2020). The use of digital resources particularly in education has garnered significant attention in recent years, particularly in the context of enhancing teaching and learning outcomes. In the Nigerian context, studies indicate that the integration of digital technology in education can bridge gaps in resource availability and improve the quality of instruction (Mokhtar et al., 2021).

In spite of the above opportunities, there are still challenges associated with the adoption of digital resources in Nigerian secondary schools. The challenges include limited access to technology, inadequate teacher training, and poor internet connectivity (Adeshina, 2024; Udam & Ali, 2024). Factors such as teacher training, access to technology, and infrastructural challenges may influence the effectiveness of these digital tools in the classroom.

Despite these challenges, research suggests that the effective integration of digital resources can lead to improved learning outcomes and better preparation of Biology students for the digital age (Eseroghene & Barisi, 2020). Biology, as a fundamental subject in the secondary school curriculum, plays a critical role in shaping students' understanding of life sciences and fostering scientific literacy in this digital era. However, the extent to which secondary school biology teachers in Cross River State utilize these digital resources remains largely underexplored. Hence, this study aimed to explore the role of digital resources in enhancing the teaching and learning of Biology in secondary schools in Cross River States, Nigeria.

Statement of the Problem

The integration of digital resources in education has transformed how subjects are taught and learned globally. In Nigeria, particularly in Cross River State, the adoption of such resources in secondary school Biology education remains suboptimal. Previous studies have highlighted various challenges and benefits associated with the use of digital tools in teaching sciences. For instance, Okwor et al. (2021) found that while teachers acknowledged the potential of digital resources to enhance learning, a significant number lacked the necessary training to effectively incorporate these tools into their teaching practices. Similarly, Ugbong et al. (2022) identified that limited access to digital infrastructure in rural areas hampers effective utilization of technology in the classroom.

Furthermore, Effiom and Bassey (2023) emphasized the impact of socio-economic factors on the availability and use of digital resources in secondary schools, suggesting that schools in urban areas

significantly outperformed those in rural settings in terms of digital integration in teaching practices. This disparity underscores a critical gap in understanding how digital resources can be harnessed to improve educational outcomes for all students, regardless of their geographical location.

Despite these insights, there is a notable lack of comprehensive studies focusing specifically on the role of digital resources in enhancing the teaching and learning of Biology in secondary schools within Cross River State. Existing literature primarily addresses broader educational technology issues without delving into subject-specific applications and outcomes. Thus, the current research aims to explore the specific ways in which digital resources can enhance Biology teaching and learning, addressing the unique challenges faced in Cross River State.

Objectives of the Study

The main objective of the study is to explore the role of digital resources in enhancing the teaching and learning of Biology in secondary schools in Cross River States, Nigeria. The specific purposes are to:

1. assess the digital resources for teaching and learning Biology in secondary schools in Cross River States, Nigeria.
2. examine the impact of digital resources on student learning outcomes in Biology in secondary schools in Cross River States, Nigeria.
3. ascertain the challenges militating against the utilization of digital resources for teaching and learning Biology in secondary schools in Cross River States, Nigeria.

Research Questions

The study is guided by the following research questions:

1. What are the digital resources for teaching and learning Biology in secondary schools in Cross River States, Nigeria?
2. How do digital resources impact on students' learning outcomes in Biology in secondary schools in Cross River States, Nigeria?
3. What are the challenges militating the utilization of digital resources for teaching and learning Biology in secondary schools in Cross River States, Nigeria?

Hypotheses

The following hypotheses were formulated and tested at 0.05 level of significance.

1. There is no significant difference in the digital resources for teaching and learning Biology in secondary schools in Cross River States, Nigeria.
2. There is no significant impact of digital resources on student learning outcomes in Biology in secondary schools in Cross River States, Nigeria.
3. There is no significant challenges militating against the utilization of digital resources in in teaching Biology in secondary schools in Cross River States, Nigeria.

Methodology

A descriptive survey research was adopted and it was conducted in Cross River State, Nigeria. A total of 105 Biology teachers. A total of 60 secondary schools (both public and private) were randomly selected from the three education zones (Calabar, Ikom, and Ogoja) in Cross River State and studied. That is, 20 secondary schools from each of the education zone. The 105 Biology teachers consisted 41 from Calabar education zone, 35 from Ikom education zone and 31 from Ogoja education zone. All the Biology teachers in the 60 selected secondary schools were studied. Simple random sampling technique was adopted in the selection of the 20 secondary schools in each of the education zone.

The instrument for data collection was a structured questionnaire. The questionnaire consisted of 33 items. The questionnaire was divided into two parts 1 & 2. Part 1 obtained the personal information of the

respondents while Part 2 was further divided into three sections A, B and C with each section soliciting responses on a particular research question. The instrument was structured into four-point response options of Strongly Agree (SA), Agree (A), Disagree (D) and Strongly Disagree (SD) with assigned weights of 4, 3, 2, and 1 respectively. The structured questionnaire was face validated by three experts, two from the Department of Biology Education, while one expert from the Department of Computer Science, all from University of Calabar, Cross River State. Further, the reliability of the questionnaire was determined using Cronbach Alpha method. Twenty (25) copies of the validated questionnaire were trial tested by administering to Biology teachers (10 males and 15 females) in secondary schools in Akwa-Ibom State. The completed instruments were collected and analyzed, and it yielded a reliability coefficient of 0.84, which indicated that the questionnaire was reliable and can be used to collect the desired data from the respondents.

Data collection was carried out by the researcher and three research assistants. Each research assistant was made to administer data in the selected 20 secondary schools in one education zone. A total of 105 copies of the questionnaire were administered to the secondary school Biology teachers in the study area. At the end, 95 copies of the instruments were retrieved and used for data analysis, implying that 10 copies of the instrument were not used for data analysis. The used instrument for data analysis comprises 38 from Calabar education zone, 30 from Ikom education zone and 27 from Ogoja education zone.

Data analysis was carried using mean, standard deviation and t-test statistics. Mean was used to answer the three research questions; standard deviation was used to determine how close or far the respondents were to the mean and to one another. The cut-off point of 2.50 was used for decision-making regarding the mean; while ANOVA was used to test the null hypotheses at 0.05 level of significance. All the data analyses were carried out with the use of statistical package for Social Sciences (SPSS) 25.0 version.

Results Presentation and Discussion

Table 1: Mean Responses, Standard Deviation and ANOVA Analysis on the Digital Resources for Teaching and Learning Biology in Secondary Schools in Cross River States, Nigeria

S/N	Digital resources for teaching and learning Biology in secondary schools include:	\bar{X}	SD	Rmks	P-value	Rmks
1	Google Classroom	3.20	0.88	Agreed	0.50	N.S
2	Artificial intelligent tools (Chat GPT, Grammarly, Quillbot, etc)	3.03	0.70	Agreed	0.07	N.S
3	Social media platforms such as WhatsApp, Facebook, Youtube etc.	3.16	0.60	Agreed	0.87	N.S
4	Educational websites such as Khan Academy, Biology Digest etc.	3.00	0.76	Agreed	0.13	N.S
5	Interactive Simulations such as virtual labs and simulations for biology experiments	3.11	0.48	Agreed	0.22	N.S
6	Multimedia projectors for presenting Biology concepts	3.04	0.58	Agreed	0.12	N.S
7	Microsoft Teams	2.80	0.87	Agreed	0.12	N.S
8	Interactive/electronic whiteboards for lesson presentation	3.07	0.90	Agreed	0.08	N.S
9	Biology Apps for learning biology concepts.	2.90	0.76	Agreed	0.77	N.S
10	Online assessment tools such as Kahoot, Google form, Quizizz)	3.14	0.89	Agreed	0.09	N.S

Key: X = Mean; SD = Standard Deviation, Total Population = 95 Biology teachers (38 from Calabar education zone, 30 from Ikom education zone and 27 from Ogoja education zone); SD = Standard Deviation; Rmks = Remarks; N.S (Non-significant)

The data in Table 1 showed the result mean responses, standard deviation and ANOVA analysis of digital resources for teaching and learning Biology in secondary schools in Cross River States. The result revealed that all the 10 items obtained mean values above 2.50 cut of mark, which implied that the respondents agreed that the items are the digital resources that can be adopted in teaching and learning Biology in secondary schools. The tools found include Google classroom; artificial intelligent tools such as Chat GPT, Grammarly, Quillbot; social media platforms such as WhatsApp, Facebook, Youtube; educational websites such as Khan Academy, Biology Digest; multimedia projectors for presenting Biology concepts; Microsoft teams; interactive/electronic whiteboards for lesson presentation; online assessment tools such as Kahoot, Google form, Quizizz among others. Also, the corresponding standard deviation to each of the items ranged from 0.48 to 0.90, implying that the opinions of the respondents were not far from each other. In addition, the ANOVA result revealed that all the items got p-values above 0.05 ($P > 0.05$)’ this means there is no significant difference among the views of the Biology teachers in the in three education zones (Calabar, Ikom, and Ogoja) on the digital resources for teaching and learning Biology in secondary schools in Cross River States. Therefore, the null hypothesis is upheld.

The findings are in line with Liu and Wang (2022), who identified the e-books, educational websites, and multimedia content as digital resources that can be used in teaching and learning. In a Biology classroom, these resources can enrich the curriculum by providing interactive simulations of biological processes, such as cellular respiration or photosynthesis. The finding also aligns with Johnson and Adams (2022), who opined that Google Classroom and Microsoft Teams are vital digital resources that can allow students to work together on Biology projects and share resources. Google Classroom is a free web service that integrates Google Docs, Drive, and Gmail which allows teachers to create, distribute, and grade assignments in a paperless way (Alabi & Oduola, 2021). For biology, teachers can create assignments that involve research, presentations, and collaborative projects. The findings further strengthen Eze and Nwagu (2021), who maintained that Kahoot is an important digital tool that can be employed by teachers in online assessment of students. The authors added that Kahoot is an interactive game-based learning platform that allows teachers to create quizzes and games. Biology teachers can create engaging quizzes to assess student understanding of biological concepts and foster competition and collaboration.

Table 2: Mean Responses, Standard Deviation and ANOVA Analysis on the Impact of Digital Resources on Student Learning Outcomes in Biology in Secondary Schools in Cross River States, Nigeria

S/ N	The impact of digital resources on student learning outcomes in Biology in secondary schools are:	\bar{x}	SD	Rmks	P-value	Rmks
1	The use of digital resources capture students' interest and encourage active participation	3.30	0.78	Agree	0.09	N.S
2	Interactive simulations help students grasp complex biological concepts	3.12	0.89	Agree	0.24	N.S
3	Students can learn at their own pace, leading to better comprehension	3.33	0.60	Agree	0.80	N.S
4	Online platforms facilitate group work and peer learning	3.10	0.64	Agree	0.36	N.S
5	Online assessment tools provides immediate feedback to students	3.16	1.00	Agree	0.09	N.S
6	Digital tools can be accessed anytime, allowing for flexible learning environments	3.19	0.68	Agree	0.15	N.S
7	Students build digital literacy and research skills alongside Biology knowledge when using digital tools	3.10	0.70	Agree	0.08	N.S
8	Teachers can tailor resources to meet varying student needs	3.21	0.90	Agree	0.31	N.S

9	Digital tools provide resources for lesson planning and assessment	3.01	0.89	Agree	0.71	N.S
10	Digital resources promote exploration and inquiry in Biology	3.13	0.62	Agree	0.06	N.S
11	They enhances peer teaching opportunities as students can teach each other using digital platforms	3.18	0.80	Agree	0.52	N.S
12	Combining digital and traditional methods enhances overall understanding of students in Biology.	3.29	0.94	Agree	0.79	N.S

Key: X = Mean; SD = Standard Deviation, Total Population = 95 Biology teachers (38 from Calabar education zone, 30 from Ikom education zone and 27 from Ogoja education zone); SD = Standard Deviation; Rmks = Remarks; N.S (Non=(Non-significant)

Table 2 revealed that all the twelve (12) items on the impact of digital resources on student learning outcomes in Biology in secondary schools in Cross River State got mean values ranging from 3.01 to 3.33 which is above 2.50 cut of point. This implied that the respondents agreed that all the items are the impacts of digital resources on student learning outcomes in Biology in secondary schools. The impacts identified include that digital resources capture students' interest and encourage active participation; students can learn at their own pace, leading to better comprehension; online platforms facilitate group work and peer learning; online assessment tools provide immediate feedback to students; digital tools can be accessed anytime, allowing for flexible learning environments; teachers can tailor resources to meet varying student needs; combining digital and traditional methods enhances overall understanding of students in Biology among others. Furthermore, the supporting standard deviation for all the items ranged from 0.60 to 1.00, indicating that the respondents were very close to the mean and not far from one another in their responses. In addition, the ANOVA result indicated that there is no significant difference among the views of the Biology teachers in the three education zones (Calabar, Ikom, and Ogoja) on the impact of digital resources on student learning outcomes in Biology in secondary schools in Cross River State, since all the items got p-values above 0.05 ($P > 0.05$). Hence the null hypothesis is accepted.

The finding aligns with Okwori (2021), who pointed out that digital resources, such as interactive simulations and educational videos, can enhance student active participation and engagement in Biology classes. Students are more likely to participate in lessons when they can visualize complex processes like photosynthesis or cellular respiration through animations. The finding is also in support with Nwokedi (2022), who noted that digital platforms allow for personalized learning experiences, enabling students to learn at their own pace. This is particularly valuable in Biology, where students can revisit complex concepts through various resources until they achieve understanding. In addition, the findings are in accordance with Asuquo (2021), who contended that digital tools facilitate collaboration among students, allowing them to work on group projects or discussions online. This collaboration can lead to deeper understanding as students explain concepts to one another and engage in peer learning.

Table 3: Mean Responses, Standard Deviation and ANOVA Analysis on the Challenges Militating Against the Utilization of Digital Resources for Teaching and Learning Biology in Secondary Schools in Cross River States.

S/N	Challenges against the use of digital resources for teaching and learning Biology include:	\bar{x}	SD	Rmks	P-values	Rmks
1	Limited internet access hampers the use of online resources	3.39	0.60	Agreed	0.05	N.S
2	Inadequate Infrastructure such as computer labs, internet facilities etc.	3.30	0.67	Agreed	0.08	N.S

3	High costs of digital devices and software can be prohibitive for schools and students	3.10	0.78	Agreed	0.11	N.S
4	Many educators lack the skills to effectively use digital resources	3.11	0.69	Agreed	0.23	N.S
5	Resistance to change (some educators prefer traditional teaching methods over digital approaches	3.03	0.80	Agreed	0.07	N.S
6	Many students may not be proficient in using technology for learning	2.91	0.90	Agreed	0.24	N.S
7	Frequent power outages disrupt the use of digital tools for teaching	3.34	0.98	Agreed	0.08	N.S
8	Absence of government policies promoting digital education	2.90	0.82	Agreed	0.06	N.S
9	Security concerns as fear of cyberbullying and data privacy can deter the use of online platforms	2.45	0.60	Disagreed	0.09	N.S
10	Poor funding of schools limit the use of digital resources.	3.40	0.56	Agreed	0.12	N.S
11	Heavy teaching loads can limit time for exploring digital tools	2.70	0.78	Agreed	0.34	N.S

Key: X = Mean; SD = Standard Deviation, Total Population = 95 Biology teachers (38 from Calabar education zone, 30 from Ikom education zone and 27 from Ogoja education zone); SD = Standard Deviation; Rmks = Remarks; N.S (Non-significant)

Table 3 showed that 10 items out of the 11 items on the challenges militating against the use of digital resources for teaching and learning Biology got mean responses above 2.50 cut of point. This revealed that the respondents accepted that all the items are the challenges against the use of digital resources for teaching and learning Biology in Cross River State. The challenges found include limited internet access hampers the use of online resources; inadequate infrastructure such as computer labs, internet facilities; high costs of digital devices and software can be prohibitive for schools and students; resistance to change; frequent power outages disrupt the use of digital tools for teaching; poor funding of schools limit the use of digital resources among others. The corresponding standard deviation for all the items ranged from 0.56 to 0.98, showing that the respondents were very close to the mean. Also, the ANOVA result indicated that all the items got p-values above 0.05 ($P > 0.05$), indicating that there is no significant difference among the opinions of Biology teachers in the in three education zones (Calabar, Ikom, and Ogoja) on the challenges militating against the use of digital resources for teaching and learning Biology in Cross River States. Therefore, the null hypothesis is not rejected.

The findings are in support with Okwakpam (2022), who opined that many secondary schools in Cross River State lack the necessary infrastructure to support the use of digital resources. This includes insufficient internet connectivity, lack of computers or tablets, and inadequate electricity supply. Without these essential components, teachers and students cannot effectively access digital resources for biology education (Okwakpam, 2022). The finding also show solidarity with Nwogbo (2023), who buttressed that many Biology teachers in Cross River State do not receive adequate training on how to integrate digital resources into their teaching practices. This lack of professional development leads to a reliance on traditional teaching methods, limiting the potential benefits of digital tools. The finding further aligns with Eze (2023), who noted that some educators and stakeholders in the educational system exhibit resistance to adopting digital resources, often due to a preference for traditional methods or skepticism about the effectiveness of technology in education. This cultural resistance can stifle innovation and discourage the integration of digital tools in biology teaching. In addition, the result is in line with Udo (2022), who maintained that the high costs associated with procuring digital tools, software, and subscriptions can be

prohibitive for many schools in Cross River State. Limited funding and budget constraints may prevent schools from investing in necessary digital resources for effective biology teaching.

Conclusion

The study explored the role of digital resources in enhancing the teaching and learning of Biology in secondary schools in Cross River States, Nigeria. The findings revealed that digital resources have a significant impact on student learning outcomes and that teacher training is crucial for effective utilization. However, challenges such as inadequate infrastructure and limited access to technology hinder the adoption of digital resources. The study therefore concludes that there is a need for targeted interventions to improve the access and use of digital resources in teaching Biology, ultimately leading to better educational outcomes for students.

Recommendations

The following recommendations are made based on the findings of the study:

1. There is need for government and secondary school administrators to develop comprehensive training programs for teachers focused on the effective integration of digital resources into Biology instruction, ensuring they are well-equipped to utilize technology in their teaching.
2. Curriculum planners and developers at secondary schools should revise the Biology curriculum to incorporate digital resources systematically, ensuring that teachers have clear guidelines and support for their implementation in lessons.
3. Government should invest in the necessary digital infrastructure, such as reliable electricity and internet services, to support effective use of digital resources in schools.
4. Government should develop and implement policies to support the integration of digital resources in teaching and learning at secondary schools.

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