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Virtual Learning with Zoom and Google Meet: Advancing Biology Outcomes in Secondary Schools in Rivers State

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ABSTRACT

This study investigated the effect of virtual learning platforms on Biology student performance in public senior secondary schools. Guided by three research questions and corresponding hypotheses, the study adopted a quasi-experimental pretest-posttest design involving a sample of 274 students from a population of 11,177 students. The instrument for data collection was a researcher-designed achievement test titled: Biology Performance Test (BPT). The BPT consisted of 25 multiple choice test items on Adaptation and Habitat. Face and content validation were carried out on the instruments by three experts. The instrument was trial tested and Kuder-Richardson Formula 21 (K - R21) was used to calculate the reliability of the instrument. A reliability coefficient of 0.78 was obtained. Mean and standard deviation were used to answer research questions while the hypotheses were tested using ANCOVA at a significance level of 0.05. Findings showed that Zoom and Google Meet groups showed substantial posttest gains (10.32 and 9.73 mean scores) over the control (3.52), rejecting null hypotheses ($F=395.531$, $p<0.05$; $F=453.237$, $p<0.05$) and no significant gender differences emerged ($p=0.053$), with platforms equally effective for male and female students. The study concluded that virtual platforms enhanced Biology outcomes beyond traditional methods, supporting integration into curricula despite infrastructure challenges. It was recommended amongst others that school administrators should integrate virtual learning platforms into routine science curricula, particularly in contexts with limited face-to-face classroom interaction.

Keywords: Online platform, science education, video conferencing tools, academic performance, biology.

INTRODUCTION

Science is a fundamental pillar of the secondary school curriculum. Its designation as a compulsory subject aims to cultivate scientific attitudes, foster a spirit of inquiry, nurture critical thinking, and promote independent learning, while enhancing learners' comprehension of the physical world from multiple perspectives (Mishra & Yadav, 2013). As a systematic enterprise grounded in verifiable knowledge, science is an inexhaustible repository that continually expands intellectual horizons and facilitates the exploration, understanding, and generation of novel ideas (Obafemi & Aderonmu, 2022). Rooted in the study of nature, it relies on observation and experimentation. In the 21st century, science has emerged as a driving force of national prosperity, underpinning advancements in diverse fields such as pharmaceuticals, digital technologies, medical procedures, biotechnology, and agriculture. These

developments are exemplified by the production of human insulin, genetically modified foods, the proliferation of smartphones and computers, and the integration of health applications and diagnostic technologies into everyday life (Nnodim & Ndioho, 2023).

Recent technological advancements have profoundly transformed science education. The integration of digital tools into classrooms has enhanced educational quality across disciplines. Platforms such as Zoom and Google Meet have become indispensable, particularly following the COVID-19 disruptions to synchronous learning (Ohei, 2023). In Nigeria, these technologies offer educators a means to address enduring challenges in science education and other domains requiring deep conceptual mastery.

As a cornerstone of curricula worldwide, science education underpins national development by cultivating innovation. Scientific inquiry serves as the nexus linking technological advancement, social progress, and innovation. Comprehensive science programs encompass mathematics, physics, chemistry, biology, technical drawing, environmental science, and advanced mathematics, with an emphasis on experiential learning (Abubakar & Olamoyegun, 2023).

Within this framework, Biology assumes a central role by elucidating the principles of life. It equips students with foundational knowledge in cellular and molecular biology, genetics, ecology, and evolution, fostering comprehension of life's interconnectedness and humanity's place within it. A robust grounding in Biology enables students to navigate the implications of contemporary scientific discoveries, technological innovations, and environmental challenges, informing career choices and societal contributions. Consequently, biological sciences are instrumental to a nation's infrastructural, economic, and social advancement (Abubakar, Ogunseye, & Ogunode, 2021).

Despite its established role as a compulsory cornerstone of secondary education intended to cultivate critical inquiry and scientific literacy, the effective delivery and outcomes of science education in contexts such as Nigeria face significant challenges. While modern digital technologies offer demonstrated potential to enhance pedagogical quality and address conceptual difficulties, a persistent gap exists between the intended objectives of science curricula and the actual realities of classroom instruction and student engagement. This problem is multifaceted, stemming from potential deficits in infrastructure, teacher capacity to integrate technology, and curriculum execution, particularly in hands-on and experimental learning essential for subjects like Biology. Consequently, there is a risk that the fundamental goals of science education—to foster a spirit of inquiry, independent learning, and a deep comprehension of the natural world—remain unmet. This gap ultimately hinders the development of the scientifically-literate citizenry and skilled innovators necessary for national development in an era driven by scientific and technological advancement. Therefore, the core problem is the ineffectiveness in translating the mandated vision of science education into tangible, high-quality learning experiences that leverage contemporary technological tools to achieve its critical objectives, particularly within resource-constrained educational systems. Hence, this study strives to investigate the effect of virtual learning platforms on students' performance in Biology in senior secondary school in Rivers State

Aim and Objectives of the Study

This study aimed to investigate the effect of virtual learning platforms (Zoom and Google Meet) on students' performance in Biology in senior secondary school in Rivers State. The specific objectives of the study were:

1. examine the effect of Zoom instructional strategy (ZIS) on Biology students' academic performance in public secondary schools in Rivers State.
2. determine effect of Google Meet instructional strategy (GMIS) on Biology students' academic performance in public secondary schools in Rivers State.
3. ascertain the difference in the effect of Zoom instructional strategy (ZIS) and Google Meet instructional strategy (GMIS) on Biology students' academic performance in public secondary schools in Rivers State based on gender

Research Questions

The following research questions guided this study:

1. What is the effect of Zoom instructional strategy (ZIS) on Biology students' academic performance in public secondary schools in Rivers State?
2. What is the effect of Google Meet instructional strategy (GMIS) on Biology students' academic performance in public secondary schools in Rivers State?
3. What is the difference in the effect of Zoom instructional strategy (ZIS) and Google Meet instructional strategy (GMIS) on students' academic performance in public secondary schools in Rivers State based on gender?

Hypotheses

The following null hypotheses were formulated and tested at 0.05 significance level;

1. There exists no significant effect of Zoom instructional strategy (ZIS) on Biology students' academic performance in public secondary schools in Rivers State.
2. There exists no significant effect of Google Meet instructional strategy (GMIS) on Biology students' academic performance in public secondary schools in Rivers State.
3. There is no significant difference in the effect of Zoom instructional strategy (ZIS) and Google Meet instructional strategy (GMIS) on Biology students' academic performance in public secondary schools in Rivers State based on gender.

MATERIALS AND METHODS

This study adopted a quasi-experimental pre- and post-test design. The population of this study consisted of public senior secondary school students majoring in biology in selected schools in Rivers State. This was made up of 11,177 students. The sample of this study comprised two hundred and seventy-four (274) students from public senior secondary schools. A multi-stage sampling procedure was adopted to determine the sample of the study. The instrument for data collection was a researcher-designed achievement test titled: Biology Performance Test (BPT). The BPT consisted of 25 multiple choice test items on items on Adaptation and Habitat. Face and content validation were carried out on the instruments by one Test and Measurement expert and two Science Education experts all from the Ignatius Ajuru University of Education, Port Harcourt, Rivers State. The instrument was trial tested and Kuder-Richardson Formula 21 (K - R21) was used to calculate the reliability of the instrument. A reliability coefficient of 0.78 was obtained for BPT. The method of data collection was done in phases. After selecting sampled schools, the researcher trained Biology teachers (professional B.Ed/B.Sc(Ed) holders) as research assistants. Four handled the two experimental groups using Zoom instructional strategy (ZIS) and Google Meet instructional strategy (GMIS), the other two used conventional methods for the control group. Identical test items were used for both experimental and control groups. Pretest scores were compared to confirm group equivalence pre-treatment. Post-test items were the same but reshuffled; post-test scores were compared to pretest scores to assess treatment effects. The gathered data was examined using mean and standard deviation to answer research questions while the hypotheses were tested using ANCOVA at a significance level of 0.05.

RESULTS AND FINDINGS

Research Question One: *What is the effect of Zoom instructional strategy (ZIS) on Biology students' academic performance in public secondary schools in Rivers State?*

Table 1: Mean and standard deviation on effect of Zoom application on Biology students' academic performance in public secondary schools in Rivers State

Group	n	Pre-test		Post test		Mean Gain score
		Mean	SD	Mean	SD	
Control	54	7.50	1.42	11.02	1.55	3.52
Experimental (Zoom)	50	7.18	2.00	17.50	1.74	10.32

Table 1 analyzes the mean and standard deviation of Zoom's impact on Biology students' performance in Rivers State public secondary schools, revealing differences between the Control group (n=54) and Experimental (Zoom) group (n=50). The Control group improved modestly from a pretest mean of 7.50 (SD 1.42) to a posttest mean of 11.02 (SD 1.55), yielding a gain of 3.52 under conventional teaching. In contrast, the Experimental group showed greater gains, rising from a pretest mean of 7.18 to a posttest mean of 17.50 (SD 1.74), for a gain of 10.32.

Research Question Two: *What is the effect of Google Meet instructional strategy (GMIS) on Biology students' academic performance in public secondary schools in Rivers State?*

Table 2 Mean and standard deviation on effect of Google Meet on Biology students' academic performance in public secondary schools in Rivers State

Group	n	Pre-test		Post test		Gain score
		Mean	SD	Mean	SD	
Control	54	7.50	1.42	11.02	1.55	3.52
Experimental (Google Meet)	58	8.20	2.99	17.93	1.82	9.73

Table 2 presents the mean and standard deviation regarding the impact of Google Meet on the academic performance of Biology students in public secondary institutions within Rivers State.

The Control Group, comprising 54 students, exhibited a pre-test mean score of 7.50 with a standard deviation of 1.42, which increased to a post-test mean score of 11.02 with a standard deviation of 1.55. This yielded a gain score of 3.52, indicating a modest enhancement in performance following instruction. Nonetheless, the modest gain score suggests that the conventional instructional approach employed for this group had limited efficacy in enhancing students' academic advancement.

In contrast, the Experimental Group (Google Meet Class), consisting of 58 students, exhibited a pre-test mean score of 8.20, which substantially increased to a post-test mean of 17.93 following the intervention. This resulted in an average gain score of 9.73, which exceeds that of the control group. The higher gain score indicates that the Google Meet application substantially contributed to improving students' academic performance in Biology.

Research Question Three: *What is the difference in the effect of Zoom instructional strategy (ZIS) and Google Meet instructional strategy (GMIS) on students' academic performance in public secondary schools in Rivers State based on gender?*

Table 3: Mean and standard deviation on the difference in the effect of Zoom application and Google Meet on students' academic performance in public secondary schools in Rivers State based on gender

Group	Gender	n	Pre-test		Post test		Mean Gain score	Mean Diff
			Mean	SD	Mean	SD		
Control	Male	20	7.90	1.25	10.80	1.44	2.90	0.99
	Female	34	7.26	1.48	11.15	1.62		
Experimental (Zoom)	Male	17	6.94	2.56	17.29	2.367	10.35	0.04
	Female	33	7.30	1.69	17.61	1.35		
Experimental (Google Meet)	Male	21	7.62	3.12	17.19	1.66	9.57	0.54
	Female	37	8.24	2.94	18.35	1.80		

Table 3 presents the mean and standard deviation analysis of the differences in the impact of Zoom and Google Meet on students' academic performance in public secondary institutions in Rivers State, categorised by gender. In the Control Group, male students exhibited a pre-test mean score of 7.90, which increased to 10.80 in the post-test, resulting in a mean gain score of 2.90. The female students in the control group initially achieved a pre-test mean score of 7.26, which increased to 11.15, resulting in a mean gain score of 3.89. This yielded an average difference of 0.99, indicating a disparity in students' academic performance based on gender.

In the experimental groups, where instruction was delivered via Zoom and Google Meet, both genders exhibited a notable improvement in academic achievement. Among students who utilised the Zoom application, male students exhibited a pre-test mean score of 6.94, which increased to 17.29, resulting in a mean gain score of 10.35. Conversely, female students had a pre-test mean of 7.30, which improved to 17.61, yielding a mean gain score of 10.31. This resulted in an average difference of 0.04 between male and female students. Similarly, within the Google Meet group, male students commenced with a pre-test mean score of 7.62 and increased to 17.19, resulting in a gain score of 9.57. Female students, on the other hand, had a pre-test mean of 8.24 and improved to 18.35, achieving a gain score of 10.11. This resulted in an average difference of 0.54 between male and female students. These findings indicate that the impact of the Zoom application and Google Meet on students' academic performance in public secondary institutions in Rivers State varies in congruent with gender.

Hypothesis One: There exists no significant effect of Zoom instructional strategy (ZIS) on Biology students' academic performance in public secondary schools in Rivers State.

Table 4 Summary of ANCOVA analysis on effect of Zoom application on Biology students' academic performance in public secondary schools in Rivers State.

Tests of Between-Subjects Effects						
Dependent Variable: Post-test (Control and Zoom)						
Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	1091.277a	2	545.638	200.516	.000	.799
Intercept	1143.349	1	1143.349	420.168	.000	.806
Pretest	.643	1	.643	.236	.628	.002
Group (Control and Zoom)	1076.309	1	1076.309	395.531	.000	.797
Error	274.839	101	2.721			
Total	22144.000	104				
Corrected Total	1366.115	103				

a. R Squared = .799 (Adjusted R Squared = .795)

Table 4 provides a summary of the ANCOVA analysis regarding the impact of the Zoom application on the academic performance of Biology students in public secondary institutions within Rivers State. The findings indicated that the Zoom application exerted a substantial influence on the academic performance of Biology students ($F(1, 101) = 395.531, p < 0.05$). This indicates that students instructed via the Zoom application demonstrated superior performance compared to the control group, with pretest scores exerting no substantial effect ($p = 0.628$). The null hypothesis was denied, demonstrating that the Zoom application has a substantial impact on the academic performance of Biology students in public secondary institutions within Rivers State.

Additionally, the Partial Eta squared (η^2) value of 0.797 indicated that 79.7% of the pupils instructed via Zoom Application demonstrated enhanced academic performance compared to others. This confirms that the Zoom application is an effective tool that can enhance the academic performance of Biology students in comparison to traditional teaching methods alone.

Hypothesis Two: There exists no significant effect of Google Meet instructional strategy (GMIS) on Biology students' academic performance in public secondary schools in Rivers State.

Table 5 Summary of ANCOVA analysis on effect of Google Meet on Biology students' academic performance in public secondary schools in Rivers State.

Tests of Between-Subjects Effects						
Dependent Variable: Post-test (Control and Google Meet)						
Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	1336.606a	2	668.303	230.294	.000	.809
Intercept	1918.750	1	1918.750	661.191	.000	.858
Pretest	.392	1	.392	.135	.714	.001
Group (Control and Google Meet)	1315.275	1	1315.275	453.237	.000	.806
Error	316.314	109	2.902			
Total	25521.000	112				
Corrected Total	1652.920	111				

a. R Squared = .809 (Adjusted R Squared = .805)

Table 5 provides a summary of the ANCOVA analysis examining the impact of Google Meet on the academic performance of Biology students in public secondary institutions within Rivers State. The findings indicated that Google Meet exerted a substantial influence on the academic performance of Biology students ($F(1, 101) = 453.237, p < 0.05$). This indicates that pupils instructed via Google Meet outperformed the control group, with pretest scores exerting no substantial effect ($p = 0.714$). The null hypothesis was rejected, demonstrating that Google Meet has a substantial impact on the academic performance of Biology students in public secondary institutions within Rivers State.

Additionally, the Partial Eta Squared (η^2) value of 0.806 indicated that 80.6% of pupils instructed via Google Meet demonstrated enhanced academic performance compared to others. This confirms that Google Meet is an effective platform capable of enhancing the academic performance of Biology students when compared to traditional teaching methods alone.

Hypothesis Three: There is no significant difference in the effect of Zoom instructional strategy (ZIS) and Google Meet instructional strategy (GMIS) on Biology students' academic performance in public secondary schools in Rivers State based on gender.

Table 6: Summary of ANCOVA on the difference in the effect of Zoom application and Google Meet on Biology students' academic performance in public secondary schools in Rivers State based on gender

Tests of Between-Subjects Effects						
Dependent Variable: Zoom Application and Google Meet Posttest Score						
Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	1660.202 ^a	6	276.700	100.020	.000	.796
Intercept	3042.195	1	3042.195	1099.672	.000	.877
Zoom and Google Meet Pretest	.071	1	.071	.026	.873	.000
Group (Control and Experimental Group)	1493.778	2	746.889	269.980	.000	.778
Gender	10.508	1	10.508	3.798	.053	.024
Group * Gender	3.153	2	1.576	.570	.567	.007
Error	426.034	154	2.766			
Total	40813.000	161				
Corrected Total	2086.236	160				

a. R Squared = .796 (Adjusted R Squared = .788)

The findings of the ANCOVA analysis examining the difference in the impact of Zoom application and Google Meet on the academic performance of Biology students in public secondary institutions in Rivers State, based on gender, are presented in Table 4.11. The revised model is statistically substantial ($F(6, 154) = 100.020, p < .05$), indicating a substantial aggregate impact of the instructional methodologies and demographic factors examined.

In contrast, the gender variable does not reach statistical significance ($F(1, 154) = 3.798, p = .053$), with an effect size indicated by a Partial Eta Squared of .024. This indicates that there exists no substantial difference in academic performance between male and female pupils following instruction via Zoom Application and Google Meet.

The interaction between group and gender is not statistically substantial ($F(2, 154) = 0.570, p = .567$), exhibiting a negligible effect size (Partial Eta Squared = .007). This indicates that the disparity in the efficacy of the Zoom application and Google Meet was not influenced by gender. Both male and female pupils received equal benefits.

DISCUSSION OF FINDINGS

Tables 1 and 4 show that Biology students in Rivers State public secondary schools achieved significantly better results through Zoom-based instruction compared to traditional in-person classes. While both groups improved after the intervention, Zoom learners outperformed the control group, highlighting the platform's positive impact. Prior studies support these findings: Zoom fosters collaboration, engagement, and active learning through features like breakout rooms, polls, and screen sharing (Hua, & Shaw, 2020). Students reported higher satisfaction and engagement (Chavoshi & Hamidi, 2019), and performance gains were consistent across gender and subject areas (Chukundah, 2024; Kusuma & Hamidah, 2020; Onumba & Nnamani, 2023). However, some research suggests Zoom is not always the most effective tool. For instance, Google Meet yielded stronger outcomes in Computer Studies (Amadi & Abraham, 2023; Amadi & Anekwe, 2023). Effectiveness may vary depending on subject matter, student skills, and platform design. Other studies (Jimoh et al., 2022; Nurwati et al., 2021) confirm Zoom's benefits for academic performance and retention, though challenges such as connectivity and device access remain (Okolo et al., 2022). Overall, Zoom's interactive design makes it a valuable tool for science education, particularly in visually demanding subjects like biology. Incorporating such digital platforms into regular instruction could enhance learning beyond emergency contexts.

Tables 2 and 5 reveal that Biology students in Rivers State public secondary schools taught via Google Meet significantly outperformed those taught through traditional methods. The platform's interactive features fostered engagement, collaboration, and improved academic outcomes, aligning with prior studies that highlight its effectiveness across subjects (Amadi & Abraham, 2023; Amadi & Anekwe, 2023; Abubakar et al., 2022; Ukonu & Egbe, 2021). Google Meet's tools—screen sharing, breakout rooms, and integration with Google Workspace—helped address challenges of conventional teaching, while its role during COVID-19 further demonstrated its capacity to sustain learning (Dube, 2020). Despite these benefits, limitations such as poor internet access, lack of devices, and low digital literacy in underserved areas reduced its impact (Okolo et al., 2022). Overall, Google Meet proves to be a dynamic and adaptable instructional tool, though its success depends on technological readiness and context.

Tables 3 and 6 show that Zoom and Google Meet significantly improved Biology grades for both male and female students in Rivers State, with the gender gap narrowing substantially. While female students in the control group initially performed slightly better, online instruction benefited both sexes equally, with only minor, statistically insignificant differences between platforms ($p = .053$; Partial Eta Squared = .024). These results align with prior studies (Mohammed & Bello, 2024; Akinyemi, et al. 2023), all of which found no gender-based disparities in academic gains from Zoom or Google Meet. Research further shows that when students are engaged and digitally literate, virtual platforms are equally effective across genders (Olarenwaju & Chidiebere, 2021). Supported by gender-neutral learning theories like UDL (Meyer, Rose, & Gordon, 2014), these platforms' multimodal features—video, audio, chat, and interactive tools—create inclusive environments that minimize traditional classroom gender dynamics.

Overall, Zoom and Google Meet enhance Biology performance regardless of gender, with negligible differences between male and female students.

CONCLUSION

This study concluded that relative to traditional instructional approaches, the integration of video conferencing applications such as Zoom and Google Meet significantly enhanced the academic performance of Biology students in public secondary schools in Rivers State. Furthermore, the use of these digital platforms proved equally effective across genders, demonstrating that both male and female students derived comparable educational benefits from online instruction.

RECOMMENDATIONS

Based on the findings and conclusion of this study, the following recommendations were made:

1. Given Zoom's substantial positive effect on Biology students' academic performance, school administrators should integrate it into routine science curricula, particularly in contexts with limited face-to-face classroom interaction.
2. Considering Google Meet's significant influence on Biology achievement, its utilization as a supplementary educational tool is advised. Targeted technical and pedagogical training for educators is further recommended to optimize platform features—such as screen sharing, breakout rooms, and live Q&A—thereby enhancing student learning outcomes.
3. Educators and lawmakers should prioritise ensuring that all students, irrespective of gender, have equal access to digital learning resources like Zoom and Google Meet since these platforms are equally beneficial to male and female students and have no discernible effect on the academic performance of biology students. It is important to continue advocating for gender-sensitive educational resources in an effort to preserve inclusion.

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