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EFFICACY OF VIRTUAL LEARNING ENVIRONMENT (VLE) AS AN INNOVATIVE APPROACH FOR IMPROVED LEARNING OF BIOLOGY AMONG SECONDARY SCHOOL STUDENTS IN SOKOTO STATE, NIGERIA

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Abstract

The incorporation of virtual learning environment (VLE) into the biology education is capable of bringing innovative and transformative opportunities for STEM (Science, Technology, Engineering, and Mathematics) education. This study therefore examined the efficacy of virtual learning environment (VLE) as an innovative approach for improved learning of Biology among secondary school students in Sokoto State, Nigeria. The study employed quasi experimental design with a population of 3716 senior secondary schools (SS II) in Sokoto metropolis. A sample of 132 students obtained from two intact classes were used for the study. Two objectives, two research questions, and two corresponding null hypotheses guided the study. Biology Performance Test (BPT) was used as an instrument for data collection which was validated by experts and exhibited reliability of 0.79 using test re-test method and Pearson Product Moment Correlation Coefficient PPMCC). Mean, standard deviation and independent t-test statistics were used for data analyses and results obtained showed that there was significant difference between the performance of experimental group and control group in favor of the experimental group and no significant difference was found in the performance of male and female students taught with virtual learning environment. It was recommended among others that the use of virtual learning environment should be incorporated at secondary school level for better teaching and learning of biology with special attention given to both male students in virtual learning environments as virtual learning environment is gender friendly. State government and other stakeholders should endeavor to equip all secondary schools within the state with resources needed for virtual learning environments.

Key Words: Virtual Learning Environment (VLE), STEM education, Biology education

Introduction

There has been a growing concern by stakeholders on incorporating technology into the education system, particularly in the field of biology in 21st century. Alwis, (2018) argued that 21st century skills are expressed as being creative, innovative and thinking

critically, solving problems, having communication skills, working in a team, information and communication technologies literacy, local and universal citizenship awareness, life and career awareness. Conversely, Bybee (2010) addressed 21st century skills as critical thinking, creativity, cooperation, motivation, and metacognitive skills. Hence, it is possible to comment that the emerging science and technology of our present century have shaped both education system and expectations for a future individual. One is this emerging technologies being clamored for advancement of teaching and learning is virtual learning environments.

Virtual learning environment (VLE) is an online platform that facilitates education by providing resources, tools, and communication channels for students and instructors. It typically includes features like course materials, discussion forums, assessments, and sometimes live sessions, allowing for remote learning and collaboration. It's a digital space where learners and educators conduct online courses. This means, through VLE, educators may deliver course materials through video presentations, audio recordings, virtual classes or any other digital means

Science, Technology, Engineering, and Mathematics education (STEM) which is refers to an interdisciplinary approach to learning that integrates concepts and principles from Science, Technology, Engineering, and Mathematics required application of 21st century technologies (Corlu, Capraro, & Capraro, 2014). STEM education equips students with the knowledge, skills, and competencies needed to succeed in the 21st-century workforce and address complex global demands of the societies. Core Components of STEM Education is Science education which focuses on developing students' understanding of natural phenomena, scientific principles, and the scientific method. Students learn to ask questions, query issues, make observations, and conduct experiments to explore and explain the world around. Technology education introduces students to various tools, technologies, and digital platforms used in today's society. According to Şahin (2015), technology facilitated the discovery of new products and enhanced the implementation of STEM activities in different ways. This includes computer programming, digital literacy, and the application of technology to solve real-world problems. Therefore, it is pertinent that core subjects under STEM Education like biology be given an upmost attention through the application of available technologies.

The relevance of always keeping in touch with the recent trends and developments in science education especially in biology education is crucial for educators to provide their students with relevant and effective learning experiences. As the world continues to evolve and new technologies emerge, it is therefore essential that educators keep up to date and prepare to incorporate them in their teaching methods. Along with the critical need for educators to keep up to date, the importance of incorporating emerging technologies such as virtual learning environment is purely for enhancement of teaching and learning process. According to Samuel and Ukpoh (2021), no nation can afford to neglect science education at any level of its education provided they want to thrive in any field of human endeavor. They further stressed that science education is an instrument for producing resources necessary for socio-economic, scientific and technological development needed for advancement of any nation.

Biology which is a branch of science that deals with the study of life, is one of the science subjects offered by secondary school students. The subject is indispensable for the study of medical, para medical and other science related courses at the tertiary institutions (Mahmud, Muhammad & Ibrahim, 2022). According to Ejeh, Adejoh, Ochu and Egbe-

Okpenge (2021), biology is very important science subject and a requirement for higher learning in a number of science related professional courses like Medicine, Agriculture, and Pharmacy among others. Looking at the relevance of this subject, therefore, the learning of these living organisms and their interactions with environment must be made friendly and real to students in the class rooms with the help of Virtual learning environment.

Theoretical Basis

The theoretical basis of using Virtual learning environment (VLE) is hinged upon, Kwon (2017) who introduced technology in education and further added technological knowledge as a critical component to it. By integrating component of technological knowledge to the three previous components, which are mastery of course, content knowledge, and pedagogic knowledge, which they focused on teacher professional development. Koehler and Mishra (2005) in Kwon (2017) introduced three essential components of teacher professionalism: CK, PK, and TK. From the thoughts, the term (Technology, Pedagogy, Content, and Knowledge) TPCK emerged. This emphasized the idea that science teachers should address TPCK, and take into account the educators' and students' needs, by using various kinds of up-to-date technology that is available to teachers and students which include but not limited to using free smartphone apps or software, technological gadgets that teachers and students have free access to. The TPCK model is relevant to this study, because the model sees technology as a major part of the teaching and learning process. While the increasing use of technology as educational tools has technically changed the previous ways of imparting knowledge; the TPCK model seeks to be the modern-day solutions and the way forward.

Literature Review

Investigations in to virtual learning environments and its related variables as well as gender abound. Oladejo, Nwaboku, Okebukola, and Ademola (2023), investigated the gender difference in students' performance in chemistry. Owing to the current growth of the effects of the use of computer simulations on students' performance in science in the literature, this study investigated if the use of computer simulation as an intervention would enhance the performance of female students relative to males in senior school chemistry in Ado-Odo-Ota, Nigeria. The study found no statistically significant difference between the performance of the male and female students. While there was a statistically significant main effect of treatment on the students' performance, the interaction effect of gender and treatment did not attain statistically significant difference. The study concluded that the use of computer simulation can help bridge the gap between male and female students' performance in chemistry and overall, boost the performance of the students. They therefore recommended government, school owners and chemistry teachers to find to implement of the findings of this study for enhanced performance.

Dharriyat (2023) investigated adapting virtual learning on students' performance among colleges of education in north-central Nigeria. The result of the findings showed that virtual learning has a positive impact on the performance of students as compared to conventional learning and that the academic performance of male students was higher than their female counterparts through the use of virtual learning. On the basis of this findings, the study recommended that virtual learning needs to be given topmost priority as it proved superior over conventional method of learning. Similarly, Alves, Miranda, and Morais, (2017) investigated the influence of virtual learning environments in

students' performance and the results showed that there are relatively positive indicators regarding students' access to a virtual learning environment and the relation between such access and their performance.

Neji and Ntibi (2019), studied on the effect of E-Learning devices on chemistry and students' academic performance in Calabar municipality, Cross River State and the result of the analysis revealed that the experimental group taught with e-learning devices significantly outperformed their counterparts taught with conventional method. More so, gender and school location showed a significant difference when taught with e-learning devices. Based on the findings, recommendation were made that secondary schools and tertiary institution teachers should make a consorted effort toward the use of e-learning devices that would enhance students' performance in Chemistry and facilitate creativity in the learner.

Virtual Learning Environment (VLE) and Biology Education

The incorporation of virtual learning environment (VLE) as an emerging technologies into the biology education offers transformative opportunities for STEM (Science, Technology, Engineering, and Mathematics) education (Neji & Ntibi 2019). This fusion of virtual learning environment into biology education provides students with immersive, interactive, and engaging learning experiences capable of enhancing comprehension and retention of information that may be lacking in the traditional teaching method (Kwon, 2017). Real-world application of emerging technologies, such as augmented reality (AR), artificial intelligence (AI), and biotechnology tools like CRISPR, offer students the chance to engage with cutting-edge research and applications in biology. This exposure can inspire students to pursue careers in STEM fields and understand the relevance and impact of biology in everyday life. Students can personalize learning via adaptive learning platforms powered by AI can tailor educational content to each student's learning style, pace, and interests. Virtual learning environment (VLE) where students can work together in virtual labs, conduct experiments, and solve problems as a team can address individual learning needs, fostering a deeper understanding and appreciation for biology. This collaborative environment encourages communication, critical thinking, and problem-solving skills essential for STEM disciplines. Virtual learning environments (VLE) makes biology education more accessible to students worldwide, regardless of their geographical location or physical limitations. This inclusivity ensures that all students have equal opportunities to explore and engage with biology.

Virtual learning environment (VLE) encourages active learning through hands-on exploration, experimentation, and problem-solving, promoting critical thinking, collaboration, and inquiry-based learning among students (Selzer, Gazcon, & Larrea, 2019)

In a related development, Samuel and Ukpoh (2021) stated that digital technologies such as virtual learning environment can serve four main purposes in STEM education classrooms and biology inclusive:

1. **Access to materials:** Information and communication technologies can provide direct access to multimedia (visual, audio, and text) materials that are in fact engaging, authentic, and comprehensible but yet challenging for learners.

2. **Communication opportunities:** Communicative opportunities through technologies include interaction with the computer (e.g., computers and video

games) and interaction through the computer with remote audiences (e.g., blogs, wikis, and 3D virtual worlds).

3. **Feedback:** Certain computer programs have the capacity to provide instant feedback on various practical skills.

4. **Learner motivation:** Students become more engaged and active.

This implies that, virtual learning environment does not only aid in the delivery of information but also help in creating a more engaging and immersive learning environment. For instance, virtual simulations and interactive games can be used to reinforce complex concepts and make learning more enjoyable for students. Moreover, online platforms such as forums and discussion boards can facilitate collaboration and discussion between students and teachers, promoting a more active and participatory learning process and by extension enable efficient and effective assessment methods.

Workability of Virtual Learning Environment (VLE)

Virtual learning environment operates through a blend of technology, content delivery, and interaction mechanisms that simulate a classroom-like environment, in an online setting. Here's a quick breakdown of the pieces based on the submission of (Samuel & Ukpoh 2021) and (Dharriyat 2023)

- ✓ **Digital Platforms:** At the heart of virtual learning are platforms or Learning Management Systems (LMS) like Moodle, Blackboard, or Canvas. These platforms host courses, track student progress, and facilitate interactions.

- ✓ **Content Delivery:** Instructors can upload various materials such as videos, slides, readings, and quizzes. These can be accessed by students anytime (asynchronous) or at scheduled times (synchronous).

- ✓ **Interactive Tools:** Virtual learning is not just about content consumption. There should be interactive components. Platforms often have tools for real-time discussions, forums, and chats, allowing students to ask questions, collaborate on projects, or engage in discussions.

- ✓ **Assessments:** Just like traditional learning, there are typically quizzes, tests, as well as standard classroom assignments. Feedback can be provided directly through the platform.

- ✓ **Flexibility & Personalization:** By nature, virtual learning is its adaptable, often more so than traditional classrooms allow for. Courses can often be tailored to individual student needs, allowing them to progress at their own pace or delve deeper into areas of interest.

- ✓ **Engagement Mechanisms:** To keep students engaged, virtual learning often incorporates multimedia elements and interactive simulations. These not only make learning more enjoyable but also enhance retention.

Requirement for Virtual Learning Environment (VLE)

As an instructor for virtual learning classes, you will need some equipment and a learning content management system to deliver the educational materials.

- **Computer:** Teachers want to have a computer that has sufficient RAM, a decent hard drive storage for files, and is easy to connect to the Internet with an Ethernet cable and Wi-Fi.

- **Internet Connection:** A high-speed internet connection is important if you plan to conduct real-time virtual presentations using video streaming or group chats.

- **Microphone:** You want to have a decent microphone that makes your voice sound good. In my experience, here are some of the best microphone options for eLearning.

- **Webcam:** You need a webcam if you plan to use video streaming.

- **Software:** You need software to help you create virtual learning content and a content management system to present the content in an organized way and track students' progress with quizzes as they finish each section of the course.

System Design for Virtual Learning Environment (VLE)

The design of a virtual classroom system consists of several modules which help it to meet up with its designed objectives. The assignments module enables teachers to grade and provide comments for uploaded files and assignments created on and off line, the chats module allows participants to have a real-time synchronous discussion via the web while the glossaries module enables participants to create and maintain a list of definitions in a way similar to the dictionary (Huertas, 2007 & Gibbs, 2000). The modules for lessons, quizzes and wiki are made up of contents that make them to function optimally in interesting and flexible ways. A whiteboard is also presented as a main presentation window for writing and displaying of images (Huertas, 2007 & Gibbs, 2000). The audio features allow participation in conversations during a classroom session using microphones and speakers (or headset) via Voice over Internet Protocol (VoIP) while the video features allow the transmission and receipt of video broadcasts in real life and interactive manners. Coordinated approach will be used in the system development.

Problem Statement

The litmus test for stability and improved students' academic performance is the senior secondary certificate examination (SSCE) conducted by West African Examination Council (WAEC) on yearly basis. The WAEC chief examiner's report 2018-2022 consistently reported decline in the performance of secondary school students at the examination particularly in biology, chemistry and physics. Some of the reasons raised are connected to lack of mastery of key areas perhaps as a result of poor delivery of such areas to students by their respective teachers. These recurring trend of low scores in these subjects underscores a deeper concern regarding the quality of education and the effectiveness of teaching methodologies. With tertiary institutions placing considerable emphasis on these foundational science subjects, students' proficiency in these subjects do not only determines their academic prospects but also shapes their career trajectories. However, the transition from secondary to higher education proves to be a difficult one for many students, particularly those who struggle to grasp the complexities of foundational sciences i.e. biology, chemistry and physics. The outbreak of the COVID-19 pandemic and other related global crises further exacerbated the challenges facing education in northern Nigeria and particularly in Sokoto state, underscoring the urgent

need for innovative solutions that are technologically based to resolve the crisis of school closure. To this end, efficacy of virtual learning environment (VLE) as an innovative approach for improved learning of biology among secondary school students in Sokoto State, Nigeria

Objectives of the Study

The objectives of this study are to find;

i. the difference in the academic performance of Sokoto state secondary schools students taught biology using virtual learning environment and those taught using conventional method

ii. the difference in the academic performance of male and female Sokoto state secondary schools students taught biology using virtual learning environment

Research Questions

The following research questions guided the study:

i. What is the difference in the academic performance of Sokoto state secondary schools students taught biology using virtual learning environment and those taught using conventional method?

ii. What is the difference in the academic performance of male and female Sokoto state secondary schools students taught biology using virtual learning environment?

Null Hypotheses

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

i. Ho1: There is no significant difference in the academic performance of Sokoto state secondary schools students taught biology using virtual learning environment and those taught using conventional method

ii. Ho2: There is no significant difference in the academic performance of male and female Sokoto state secondary schools students taught biology using virtual learning environment

Methodology

The study employed quasi-experimental pre-test post-test design. The population of the study was (3716) senior secondary school II (SS II) students in Sokoto metropolis. Two schools were purposively selected for the research and two intact classes were selected to participate in the study. A pre-test was administered to the students to establish the equivalence and homogenous nature of the subjects. Two intact classes of secondary school II (SSII) were selected from each school. One class each was assign into the experimental and control groups. Two intact classes which are made up of one hundred and thirty two (132) students (Male 79, Female 53) were used for the study from two coeducational public senior secondary schools which were in existence for more than ten years. The instrument for data collection was Biology Performance Test (BPT) developed by the researcher and it consists of 30 multiple choice items with A to D options. Every

correct response in each item carries one mark while wrong response carries no mark. The test items were developed using SS II biology curriculum. The BPT was used to evaluate academic performance of SS II students both before and at the end of the instructional processes (pretest and posttest). The items in the Biology Performance Test (BPT) were subjected to content and face validations. The content validation of BPT was ensures by following strictly the test-blue print by experts while face validations was done by three biology teachers from the department of biology in three different senior secondary schools in Sokoto metropolis which are part of the population of the study but not involved in the study. The biology teachers were requested to validate the content of the instrument and vet the virtual learning environment package that was used for the treatment. These experts validated the items in terms of clarity of language, appropriateness and adequacy of the items in measuring what they are supposed to measure. The instrument items were also subjected to trail testing to ascertain the reliability of the instrument. One intact stream consisting of 30 SS II students was used for the BPT pilot-testing. The school used for the pilot testing was in the population but not part of the sample of the study. Test re-test method was used in pilot testing the test items for the reliability coefficient. The data obtained from the pilot testing was subjected to statistical analysis using Pearson Product Moment Correlation Coefficient. The reliability coefficient of 0.79 was obtained which showed that the instrument is valid and reliable.

Biology Performance Test (BPT) was administered to experimental and control groups before the commencement of the experiment. The items of BPT were reshuffled for the posttest after the treatment which lasted for a period of six weeks. The reshuffled BPT was administered to experimental and control. Both the pre-BPT and post-BPT were marked by the researcher according to the marking scheme. The research questions were answered using descriptive statistics of mean and standard deviation. The null hypotheses formulated were tested at $p \leq 0.05$ level of significance using inferential statistics of independent t-test statistics.

Results

Research Question 1: What is the difference in the academic performance of Sokoto state secondary schools students taught biology using virtual learning environment and those taught using conventional method?

Table 1: Mean and Standard Deviation of Academic Performance scores of students in Experimental and Control Groups

Groups	N	Mean	Standard Deviation	Mean Difference
Experimental Group	64	12.26	4.07	2.08
Control Group	68	10.34	4.64	

Source: Field work 2023

Table 1 showed that the students in experimental group taught biology using virtual learning environment had a mean performance scores of 12.26 with a standard deviation of 4.07, while those taught biology using conventional teaching method had a mean performance score of 10.34 with a standard deviation of 4.64. Therefore, the difference

between the mean performance scores of students taught biology with virtual learning environment and those taught using conventional teaching method is 2.08. This implies that there is difference in the posttest mean scores of students of the experimental and control groups, in favor of the students taught using virtual learning environment.

Research Question 2: What is the difference in the academic performance of male and female Sokoto state secondary schools students taught biology using virtual learning environment?

Table 2: Mean and Standard Deviation of Academic Performance of male and female Students in Experimental Group

Experimental Group	N	Mean	Standard Deviation	Mean Difference
Male	34	12.10	4.84	0.87
Female	30	10.11	3.97	

Source: Field work 2023

Table 2 showed that the male students taught biology using virtual learning environment had a mean performance scores of 12.10 with a standard deviation of 4.84 while the female students taught biology using virtual learning environment had a mean performance scores of 10.11 with a standard deviation of 3.97. Therefore, the difference between the mean academic performance scores of male and female students taught biology using virtual learning environment is 0.87. Hence, there was a difference in the posttest mean scores of male and female students. This indicates that the male students performed slightly higher than the female students.

Ho1: There is no significant difference in the academic performance of Sokoto state secondary schools students taught biology using virtual learning environment and those taught using conventional method.

Table 3: Analysis of independent t-test on Academic Performance scores of students in Experimental and Control Groups

Groups	N	Mean	SD	df	t-cal	p-value	Remark
Experimental Group	64	12.26	4.07	130	4.17	0.00	Sig.
Control Group	68	10.34	4.64				

Source: Field work 2023 Significant at $p \leq 0.05$

Table 3 reveals that calculated t-value is 4.17 and the p-value 0.00. Therefore, p-value of 0.00 is less than significant level of $p \leq 0.05$. Based on this evidence, the null hypothesis was rejected. This shows that there is significant difference between the mean performance scores of students taught biology using virtual learning environment and those taught using conventional teaching method in favor of the students taught using virtual learning environment. This implies that virtual learning environment was more effective than conventional method in teaching and learning of biology.

Ho2: There is no significant difference in the academic performance of male and female Sokoto state secondary schools students taught biology using virtual learning environment.

Table 4: Analysis of independent t-test of Academic Performance of Male and Female Students of Experimental Group

Experimental Group	N	Mean	SD	df	t-cal	p-value	Remark
Male	34	12.10	4.84	62	1.09	0.21	Not Sig.
Female	30	10.11	3.97				

Source: Field work 2023 Significant at $p \leq 0.05$

Table 4 reveals that calculated t-value is 1.09 and the p-value 0.21. Therefore, p-value of 0.21 is greater than significant value of $p \leq 0.05$. Hence, the null hypothesis was retained. This shows that there was no significant difference between the mean academic performance scores of male and female students taught biology using virtual learning environment. This implies that virtual learning environment bridged the gap on academic performance between male and female students, therefore is gender friendly.

Discussion

The finding of this study shows that there was a significant difference in the mean performance scores of students taught biology using virtual learning environment and those taught using conventional teaching method in favor of the students taught using virtual learning environment. The finding is in agreement with the work of Dharriyat (2023) who investigated adapting virtual learning on students' performance among colleges of education in north-central Nigeria. The result of the findings showed that virtual learning has a positive impact on the performance of students as compared to conventional learning. Also, the finding of this study agrees with the finding of Alves, Miranda, and Morais, (2017) who investigated the influence of virtual learning environments in students' performance and the results showed that there are relatively positive indicators regarding students' access to a virtual learning environment and the relation between such access and their performance. The result could be due to the fact that virtual learning environment employed for the experimental group was ICT based and user friendly.

Equally important, no significant difference between the mean academic performance scores of male and female students taught biology using virtual learning environment. This finding is in agreement with the finding of Oladejo, Nwaboku, Okebukola, and Ademola (2023) who investigated the gender difference in students' performance in chemistry. Owing to the current growth of the effects of the use of computer simulations on students' performance in science, this study investigated if the use of computer simulation as an intervention would enhance the performance of female students relative to males in senior school chemistry in Ado-Odo-Ota, Nigeria. The study found no statistically significant difference between the performance of the male and female students.

Conclusion

The following conclusion were drawn from the findings of the study: it was revealed that virtual learning environment was found to be an effective method in improving academic performance of secondary school students in biology than conventional teaching method. Virtual learning environment proved to be an effective strategy in enhancing the performance of biology students irrespective of gender.

Recommendations

Based on the findings of the study, the recommendations are made;

1. Biology teachers should utilize virtual learning environment in teaching and learning of biology at secondary schools in Sokoto State, Nigeria. Virtual learning environment should be used to teach both male and female secondary school students in Sokoto State irrespective of gender, as it is proven to be gender friendly.

2. Government and other stakeholders should make available enabling environment that will allow the application of virtual learning environment in secondary schools

3. The government should as well organize workshops and conferences to enable teachers get acquitted with proper management and application virtual reality and emerging technologies to enhance biological science Education.

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