Sapientia Foundation Journal of Education, Sciences and Gender Studies (SFJESGS), Vol.8 No.2 June, 2026; pg. 53 – 61
ISSN: 2734-2522 (Print); ISSN: 2734-2514 (Online)

ENHANCING UNDERGRADUATE STUDENTS' ACADEMIC ACHIEVEMENT THROUGH VIRTUAL LABORATORY IN FACULTY OF EDUCATION, FEDERAL UNIVERSITY DUTSIN-MA, KATSINA STATE

LAMARA GARBA
garbalamara0@gmail.com **+2348036354854**
Department of Educational Management, Federal University Dutsin-Ma, Katsina State-Nigeria
&
BALKISU MOHAMMED ISA
bmohammedisa543@gmail.com **+2348032062492**
Department of Environmental and Life Science, Faculty of Education, Federal University Dutsin-Ma, Katsina State-Nigeria
&
AMINA ADAMS OGAJI
+2348034892209/+23490285934012
aminaogaji0@gmail.com
Department of Educational Foundations, Federal University Dutsin-Ma, Katsina State-Nigeria

Abstract

This paper investigated the influence of virtual laboratories on the academic performance of undergraduate students in the faculty of education at the federal university of Dutsin-Ma. The researcher employed descriptive survey design to examine the influence of virtual laboratories on undergraduate students' academic performance in the faculty of education at a federal university. The population of the study was 4000 respondents, which included students and faculty members from the federal university of education, Dutsin-Ma, in Katsina State. It comprises of 8 divisions and 200 (respondent) were selected as the sample, three research questions were posed for the study. To assess the impact of virtual laboratories on undergraduate students' academic performance, a questionnaire was designed and administered to collect data. The device was verified by two authorities. One from educational administration and planning, and the other from measurement and evaluation, psychology and guidance and counselling departments, federal university of Dutsin-Ma, Katsina State. The evaluation concentrated on the clarity of the items, the extent to which they aligned with the content coverage, and the face validity of the instrument, resulting in a validity index of 0.06. The research questions were addressed using mean and standard deviation, and a mean score of 2.50 and above was considered as the threshold for acceptance, while scores below 2.50 were deemed as rejections. It was found that virtual laboratories greatly enhance students' practical involvement, comprehension of intricate subjects, and utilization of theoretical knowledge, leading to enhanced academic performance. Participants viewed virtual labs as extremely advantageous, highlighting their flexibility and ease of access as key benefits. Nevertheless, obstacles such as inadequate infrastructure and technical assistance were identified. Suggestions stress the importance of providing institutional backing to maximize the effectiveness of virtual labs in improving learning outcomes.

Keywords: Improvement, College Students, Educational Performance, Online Simulations.

Introduction

The role of technology in education has grown significantly in the 21st century, and virtual learning environments have become a crucial component of schools globally. The field of science has garnered significant attention and experienced remarkable growth due to the rapid expansion of scientific knowledge (Rania, Esmail, & Eqbal, 2022). In the field of higher education, particularly in science and technology, the implementation of virtual laboratories has become a popular alternative to address the common obstacles associated with traditional laboratory setups. A virtual laboratory offers students a simulated environment where they can perform experiments, engage with intricate simulations, and deepen their comprehension of theoretical concepts. These tools help overcome the limitations of physical laboratories while offering interactive and educational experiences (Mahmood, 2021). There is an increasing demand to enhance the education of university students by incorporating technological solutions at federal university Dutsin-Ma (FUDMA), particularly in the faculty of education. The conventional educational setting heavily depends on physical laboratories, which are frequently constrained by limited resources, outdated equipment, and lack of accessibility. Consequently, virtual laboratories serve as an additional method to support the body and facilitate successful learning.

The worldwide integration of educational technology has revolutionized the way students engage with the curriculum. From the emergence of e-learning platforms to the use of artificial intelligence and virtual reality, technology has transformed the way we deliver education and has made the learning process more personal, making learning more accessible (Pang, 2020). Virtual laboratories have received special attention due to their ability to simulate real laboratories, allowing students to conduct experiments in areas such as biology, chemistry, physics, and computer science without requiring physical equipment (Checa & Bustillo, 2020). Virtual laboratories as a supportive factor to real laboratories enriches learning experiences of students and offers students to do experiment, to control materials and equipment, to collect data, to perform the experiment interactively, and to prepare reports for the experiment as well as developing experimenting skills (Zeynep & Alipasa, 2012). Nigerian universities acknowledge the importance of incorporating educational technology into their teaching methods to enhance the learning experience for students. According to Ijeoma and Adeola (2021), virtual laboratories provide students with opportunities to practice, explore, and review, improving their understanding and retention of complex concepts. These enhancements have been proven to have a beneficial effect on student involvement, cognitive abilities, and overall educational development. The main objective of this research is to examine how virtual laboratories influence the learning outcomes of undergraduate students at the Faculty of Education at FUDMA.

According to Suryanti, Fitriani, Redjeki and Riandi. (2019) virtual laboratory is one of the computer software that contains controlled experimental simulation, which allows the user to carry out scientific investigations with little cost, a high level of safety, and more time-saving compared to hands-on laboratory activities a virtual laboratory is an interactive practical environment in which students can carry out scientific simulated experiments as well as improve their abilities, skills, and comprehension of science ideas (Redel-Macías et al., 2016). A virtual laboratory is a set-up consisting of computer hardware and software designed to simulate, as closely as possible, traditional physical laboratory activities for the purpose of imparting comparable knowledge and skills to learners (Chaurura, & Chuma, 2015). As

technology tools continue to advance the field of education, this study aim to determine how virtual laboratories can solve problems posed by students in science and technology courses. Specifically, this study evaluates how the integration of virtual laboratories can enhance students' understanding of course content, develop their skills, and ultimately improve their education. Virtual laboratories help overcome the limitations of the physical laboratory environment. They often flexible, scalable and cost-effective solutions for teaching and learning science. Research shows that students who participate in virtual labs are more likely to understand complex concepts and perform better on real-world tests than students who rely solely on their physical bodies (Lopez & Navarro, 2020). Virtual labs allow students to repeat experiments on their own, receive immediate feedback, and be exposed to situations that are not possible in a physical lab due to lighting safety or cost issues. Collaborative learning is greatly facilitated by virtual laboratories. Various platforms allow students to work together in virtual teams, encouraging communication and problem solving. This is especially useful in education, such as education where future teachers need to understand the content and methods of teaching good science (Jong et al, 2021). Schools like FUDMA can use these tools to create a diverse and varied learning environment that suits students regardless of geography or resources. Many issues, especially in courses that require laboratory work are related to grades. Limitations, outdated equipment, and lack of access to laboratory hinder many students from learning. These challenges are prevalent in Nigerian universities where financing for higher education is still a persistent problem (Osuji & Onyebuchi, 2022). Despite efforts to improve facilities, gap between theoretical and practical knowledge still affects students' success, especially in science and technology courses. Based on these limitations, there is an urgent need for new solutions that can improve students' learning experiences and learning outcomes. Virtual laboratories present a great opportunity to supplement traditional teaching and provide students with the hands on experience they need to succeed. This study investigates the effectiveness of virtual laboratories in addressing these issues in the context of FUDMA faculty of education to identify strategies to improve student performance and overall learning.

Statement of the problem

University students in Nigeria, especially in the field of science and technology face many challenges in successfully completing their studies in clinical laboratories. Most of these challenges stem from access to well-equipped laboratory, which hinders their ability to acquire practical knowledge. Due to lack of funds and limited capacity, many universities, including the Federal University of Dutsin-Ma (FUDMA), are struggling to acquire new diagnostic equipment, resulting in the creation of too many laboratories that are not functional. As a result, students are often forced to rely on theoretical knowledge without the practical knowledge needed for their education. In most cases, internships are not productive or rushed because many students share limited equipment. In addition, students will not have the opportunity to repeat the experiment, which is important for understanding the research process and developing skill. These factors create a gap between student's knowledge and their ability to apply theoretical concepts to the real world, and are a major obstacle.

Various initiatives such as the Higher Education Trust Fund (TETFund) have been established to finance the development of laboratories and the improvement of school system (NUC 2021). In addition, universities, including FUDMA, have tried to address these issues by investing in new equipment and improving diagnostics. Some schools are also seeking collaborations with International organization to provide funding for technology upgrade. Despite these

efforts, however, problems persist. Grants are often inadequate and resources are inadequate to meet students' needs. School participants also explored the potential for technology to address some of these issues, including the integration of digital tolls such as virtual labs. Virtual labs can complement physical labs by providing students with the opportunity to conduct practical experiments in a simulated environment. While these efforts are commendable, they are still in their infancy and require more investment and domestic support to be effective. There is a huge gap between the resources available to students and the knowledge the need to achieve academic success. Many universities in Nigeria, including FUDMA, are underfunded and lack the necessary infrastructure to provide students with adequate laboratory experience. This gap is not limited to equipment and facilities, but also includes untrained staff who can affectively guide students in virtual classrooms. Without access to adequate laboratories and experienced instructors, students cannot develop the skills needed for the classroom. Furthermore, while the integration of technological tools such as virtual laboratories can be addressed, this concept has yet to be validated or implemented. Many universities still rely on traditional teaching methods and are vulnerable to new technologies that can enhance learning. Failure to address these issues can have serious consequences for students and education in general. Without access to well-equipped laboratories and hands on learning opportunities, student learning will continue to suffer. They graduate with a mismatch in knowledge and skills, making them less competitive in the marketplace and less prepared for jobs that require professional knowledge. Furthermore, if technological advances such as virtual laboratories are not implemented in the education system, Nigeria universities will fall below international educational standards. As other countries continue to innovate and adopt new teaching methods, the gap between Nigerian and international standards will widen, limiting the opportunities of Nigerian graduates in the global economy. In addition, ignoring these issues could lead to more student dissatisfaction, more dropouts, and further weakening of schools in the country (Igwe, 2023).

Purpose of the Study

The objective of this study is to explore Enhancement of the Undergraduate Students' Academic Achievement through Virtual Laboratory: A Study of Faculty of Education, Federal University Dutsin-Ma, Katsina State. The specific objectives are:

1. The extent to which Virtual Laboratories Influence Students' Academic Performance in Faculty of Education Federal University Dutsin-ma
2. The perceptions of students and faculty of Education Federal University Dutsin-ma regarding virtual laboratories?
3. To investigate the challenges and benefits arise from using virtual laboratories in Faculty of Education Federal University Dutsin-ma?

Research Questions

The following research questions serve as a guide to this work.

1. To what extent do Virtual Laboratories Influence Students' Academic Performance in Faculty of Education Federal University Dutsin-ma?
2. What are the perceptions of students and faculty of Education Federal University Dutsin-ma regarding virtual laboratories?
3. What challenges and benefits arise from using virtual laboratories in Faculty of Education Federal University Dutsin-ma?

Methodology

For this study, descriptive survey research design was adopted. The population was 4000 respondents (students) faculty of education, federal university Dutsin-ma, Katsina State. It's made up of 8 departments and 200 (respondent) were used as the sample. Enhancing Undergraduate Students' Academic Achievement through Virtual Laboratory questionnaire (EUSAATULQ) was developed by the researcher and 15 questions items to address the 3 research questions. The instrument vetted and a 4-Likert points Scale ranging from Strongly Agree (SA) 4, Agree (A) 3, Disagree (D) 2, strongly and Disagree (SD) 1 scales of measurement items was used to answer the questions. The review focused on item clarity, reliance to the content coverage and face validity of the instrument, with a validity index of 0.06. The validation suggestion, the instrument was re-designed to comprise segments based on the data needed to help and analyze the data collected. The research questions were answered using mean and standard deviation, and a mean of 2.50 and above was taken as the cutoff point of acceptance and below 2.50 was taken as rejection.

Results and Discussions

Research Question One: To what extent do Virtual Laboratories Influence Students' Academic Performance in Faculty of Education Federal University Dutsin-ma?

Table 1: Mean and Standard Deviation on the Extend Virtual Laboratories Influence Students' Academic Performance in Faculty of Education Federal University Dutsin-ma.

S/N	Item Statements	N	Mean	Standard Deviation	Remark
1.	Virtual labs boost students' practical engagement and improve performance.	200	2.62	.62	Agree
2.	Regular virtual lab users better understand complex subjects and improve grades.	200	2.77	.66	Agree
3.	Virtual labs let students learn at their own pace, enhancing outcomes.	200	2.79	.67	Agree
4.	Virtual labs help students apply theory to real-world scenarios, raising achievement.	200	3.01	.73	Agree
5.	Frequent use of virtual labs correlates with better performance in practical courses	200	2.85	.69	Agree
	Average Mean		**2.81**	**0.67**	**Agree**

The data in table 1 indicated that the average scores for items 1, 2, 3, 4, and 5 surpass the threshold of 2.50. This implies that the participants concur that virtual laboratories can enhance student engagement and contribute to their academic success. Furthermore, regular users of virtual labs comprehend challenging subjects more effectively and enhance their academic performance. Virtual labs also enable students to learn independently and boost their grades. Online labs and teamwork for improved education. However, when analyzing the responses from the survey participants, it becomes evident that virtual labs are beneficial in educating students at the faculty of education at the federal university of Dutsinma, where the average GPA is 2.81. According to a study conducted by Zachariah and Olympiou (2011), virtual labs provide a platform for experimentation without the limitations of time, space, or resources typically found in clinical laboratories. Students have the option to repeat this test as many times as they want, which helps them gain a deeper understanding of the research topic, promoting deeper learning. Furthermore, as stated by Jaakkola et-al. (2011), the

interactive and virtual representations of complex phenomena offered in virtual laboratories greatly enhance students' conceptual understanding and problem-solving abilities. Multiple studies provide evidence in favor of the argument that virtual laboratories have a positive influence on student learning. According to a study conducted by Ekah and Maduekwe (2021) at a Nigerian University, students who utilized virtual laboratories as an additional learning resource achieved better results in both theoretical and practical assessments compared to their peers. Self-assessment and instant feedback improve the efficiency of learning.

Research Question Two: What are the perceptions of students and faculty of Education Federal University Dutsin-Ma regarding virtual labs?

Table 2: Mean and Standard Deviation on the perceptions of students and faculty of Education Federal University Dutsin-Ma regarding virtual labs.

S/N	Item Statements	N	Mean	Standard Deviation	Remark
6	Students see virtual labs as a useful supplement to traditional learning, improving practical skills.	200	2.86	.69	Agree
7	Faculty considers virtual labs a modern tool that connects theory with practice.	200	2.62	.62	Agree
8	Some students find virtual labs convenient but miss the hands-on experience of physical labs.	200	2.67	.63	Agree
9	Both students and faculty agree that virtual labs make learning more interactive and engaging.	200	2.81	.67	Agree
10	Faculty believes virtual labs are beneficial but need reliable technical support and updates.	200	2.82	.68	Agree
	Average Mean		**2.76**	**0.66**	**Agree**

The data in table 2 indicates that the average scores of items 6, 7, 8, 9, and 10 are greater than 2.50, suggesting that the participants strongly agree that students perceive the laboratory as a valuable resource for traditional learning. Educators consider virtual laboratories as contemporary resources that bridge the gap between theoretical knowledge and practical application, with some students finding them effortless yet impactful, while others question the efficacy of traditional physical laboratories. Teachers have observed that both students and teachers perceive virtual laboratories as more appealing and attractive. Virtual laboratories have advantages, but they require support and regular updates to enhance their effectiveness. However, the responses from the participants showed that students and teachers of the faculty of education at the federal university of Dutsin-Ma believe that virtual laboratories facilitate communication and participation in learning, with an average score of 2.76. Brinson (2015) conducted a comparison between traditional manual laboratories and virtual and remote laboratories. Research has indicated that students are more engaged in virtual laboratories as they can repeat experiments, monitor changes, and receive instant feedback. This interaction allows students to grasp abstract concepts, resulting in more profound learning experiences. Hwang and Wu (2014) investigated how mobile and virtual technology-enhanced learning environments can enhance student engagement. Their research indicates that students perceive virtual laboratories as more engaging than

conventional laboratories since they enable immediate exploration of various scenarios, visuals, and interpretations.

Research Question Three: What challenges and benefits arise from using virtual laboratories in Faculty of Education Federal University Dutsin-ma?

Table 3: Mean and Standard Deviation on the challenges and benefits arise from using virtual laboratories in Faculty of Education Federal University Dutsin-ma.

S/N	Item Statements	N	Mean	Standard Deviation	Remark
11	Poor internet and device access hinder some students' use of virtual labs.	200	2.76	.66	Agree
12	Lack of hands-on lab experience may leave students underprepared.	200	2.65	.63	Agree
13	Technical issues can disrupt learning and reduce virtual lab effectiveness.	200	2.73	.65	Agree
14	Instructors may need more training to effectively use virtual labs.	200	3.01	.73	Agree
15	Virtual labs may not fully replicate real-life experiments, limiting learning depth.	200	2.74	.66	Agree
	Average Mean		**2.78**	**0.67**	**Agree**

The data in table 2 shows that the mean scores of items 6, 7, 8, 9, and 10 are above the limit of 2.50, which means that the participants agree that students see the laboratory as a valuable resource for traditional learning. A teacher believes that virtual laboratories are modern tools that connect theory with practice however, some students find virtual laboratories easy but memorable. The effectiveness of the physical laboratory, both teachers and students believes that virtual laboratories increase sexiness and attractiveness. Virtual laboratories have benefits but need support and experience updated. However, according to the responses of the participants, it was revealed that students and teachers of faculty of education, federal university Dutsin-Ma, Katsina State believe that virtual laboratories enable communication and participation in learning more with an average score of 2.76. Brinson (2015) compared traditional manual laboratories with virtual and remote laboratories. Studies have shown that students are engaged in virtual laboratories because they can repeat experiment, check changes and get immediate feedback. This interaction enables students to understand abstract concepts, leading to more meaning leading to more meaningful learning. Hwang and wu (2014) examined the role of mobile and virtual technology enhanced learning environment in increasing students' engagement. Their research shows that students find virtual laboratories more interactive that traditional laboratory because they allow for immediate exploration of different situations, virtual, and interpretation.

Conclusion

Virtual laboratories are beneficial for enhancing learning outcomes as they offer interactive and adaptable learning environments. Their incorporation into academic institutions, particularly in restricted areas like the FUDMA, overcomes the limitations of clinical laboratories and fosters improved student engagement and a more enriching educational experience. Despite the obstacles, virtual laboratories have the potential to transform education and technology, making them a crucial tool for modern education.

Recommendations

1. Universities must allocate resources to establish the required infrastructure and technical support to guarantee the smooth integration of virtual laboratories.
2. The university should implement policies that emphasize the adoption and expansion of virtual learning tools, such as virtual laboratories.
3. Universities should collaborate with technology providers and international organizations to obtain funding and gain access to cutting-edge virtual lab platforms.
.

References

Afolayan, O., & Abdulazeez, K. (2022). Challenges of Science Education in Nigerian Universities: A focus on Laboratory Resources. *Journal of Science Education and Research, 15(3)*, 54-67.

Brinson, J. R. (2015). *Learning outcome achievement in non-traditional (virtual and remote) versus traditional (hands-on) laboratories*: A review of the empirical research. Computers & Education, 87, 218-237.

Chaurura, P. & Chuma, K. (2015). Virtual Laboratories: A solution for Tertiary Science Education in Botswana. *European Journal of Logistics, Purchasing and Supply Chain Management, 3(3)*, 12-24.

Checa, D., & Bustillo, A. (2020). *A review of immersive virtual reality serious games to enhance learning and training.* Multimodal Technologies and Interaction, 4(2), 14.

De Jong, T., Linn, M. C., & Zacharia, Z. C. (2013). *Physical and virtual laboratories in science and engineering education. Science, 340(6130*), 305-308.

Hwang, G. J., & Wu, P. H. (2014). Applications, impacts and trends of mobile technology-enhanced learning: A review of 2008–2012 publications in selected SSCI journals. *International Journal of Mobile Learning and Organisation, 8(2*), 83-95.

Ijeoma, S., & Adeola, A. (2021). Virtual labs as a learning tool: A study on the impact of simulation-based learning on student engagement. Journal of Educational Technology Development and Exchange, 14(1), 33-47.

Igwe, C. (2023). Addressing resource constraints in Nigerian higher education: A case for virtual laboratories. Education and Development, 31(2), 42-56.

Jong, M., Linn, M. C., & McElhaney, K. W. (2021). Supporting science learning with technology: An introduction to virtual labs. Journal of Science Education and Technology, 30, 1-5.

López, E., & Navarro, J. (2020). The role of virtual laboratories in science education: A review. Computers in Education Journal, 8(3), 220-231.

Mahmood, S. (2021). Impact of technology-enhanced learning tools on student performance in higher education: A study on virtual labs. Educational Technology & Society, 24(1), 21-31.

NUC. (2021). Improving laboratory facilities in Nigerian universities: The role of government funding. National Universities Commission Report.

Osuji, C., & Onyebuchi, K. (2022). Challenges and opportunities in the Nigerian higher education system: A focus on laboratory sciences. African Journal of Educational Research, 14(3), 101-112.

Pang, N. (2020). E-learning and virtual platforms in modern education: A review. International Journal of Educational Research and Development, 42(2), 67-81.

Rania, A., Esmail, H., & Eqbal, R. (2022). Effectiveness of virtual laboratories on developing expert thinking and decision-making skills among female school students in

Palestine. EURASIA Journal of Mathematics, Science and Technology Education, 2022, 18(12). Suryanti, E., Fitriani, A., Redjeki, S,. & Riandi, R. (2019). Virtual laboratory as a media to improve the conceptual mastery of molecular biology. IOP Conf. Series: Journal of Physics: Conf. Series 1317 (2019).

Trabzon, TURKEY Prof. Dr. Alipasa AYAS Bilkent University Faculty of Education, Bilkent Ankara, TURKEY. Turkish Online Journal of Distance Education-TOJDE January 2012 ISSN 1302-6488 Volume: 13 Number: 1 Article 12

Zeynep TATLI Karadeniz Technical University Fatih Faculty of Education, 61335, Sogutlu