NAU Journal of Technology and Vocational Education Volume 10, No. 2, September 2025

EFFECT OF VIRTUAL LABORATORIES ON BUSINESS EDUCATION STUDENTS' ACHIEVEMENT IN COST ACCOUNTING IN PUBLIC UNIVERSITIES IN ANAMBRA STATE

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Abstract

The purpose of the study is to investigate the effect of virtual laboratories on business education students' achievement in cost accounting in public universities in Anambra State. Two research questions guided the study and two hypotheses were tested. Quasi-experimental design was adopted for the study. The population comprised 94 400-level business education students during the 2024/2025 academic session. The instrument used for data collection was a ***Cost Accounting Achievement Test (CAAT)*** *developed by the researcher. The CAAT consisted of 25 multiple-choice and structured questions aligned with the university cost accounting curriculum. The instrument was validated by three experts in accounting education and measurement and evaluation. The reliability of the CAAT was determined using the Kuder-Richardson Formula 20 (KR-20), which yielded a reliability coefficient of 0.78. The experimental group was taught cost accounting using a virtual laboratory, while the control group received instruction via the conventional lecture method. Pre-test and post-test scores were analyzed using descriptive statistics and Analysis of Covariance (ANCOVA) at 0.05 level of significance. The findings revealed that students taught with the virtual laboratory significantly outperformed those taught using the conventional lecture method. Female students achieved higher mean scores than male students, although the interaction effect of method and gender was not significant, indicating that the virtual laboratory enhanced achievement of male and female students. The study concluded that virtual laboratory significantly enhanced students' achievement in cost accounting in public universities in Anambra State. It was therefore recommended among others that accounting educators should integrate virtual laboratories into cost accounting courses to enhance students' academic achievement.*

Keywords: Virtual laboratory, cost accounting, academic achievement, gender, business education, public universities

Introduction

University education represents the highest level of education and is instrumental to national development by producing skilled professionals, fostering innovation and driving socio-economic progress. According to Uzoigwe (2016), a university is an institution dedicated to advanced learning, research and the production of high-level manpower for societal development. Emetarom (2018) defined universities as centers for knowledge creation, dissemination and application to address national and global challenges. Nwajiuba (2020) defined universities as hubs for intellectual development, critical thinking and skill acquisition to promote sustainable development. The objectives of universities in Nigeria, as outlined in the National Policy on Education, include: contributing to national development through high-level manpower training; developing proper values for individual and societal survival; enhancing intellectual capabilities to understand local and global environments; equipping individuals with physical and intellectual skills for self-reliance and societal contribution; promoting scholarship and community service; fostering national unity; and advancing national and international understanding (Federal Republic of Nigeria, 2013). The attainment of these objectives is achieved through academic programmes in universities. One such programme is the business education programme, which equips students with skills for business and educational roles.

The business education programme is an academic programme that prepares its recipients for business and about business. In preparing its recipients for business, the business education programme prepares students for a variety of business-related tasks, including working for firms, starting their own business and furthering their education in business-related fields. In teaching its recipients about business, the business education programme educates students on how to function effectively in the business environment. This includes instilling knowledge and skills on economic concepts, market dynamics and the role of business in society. According to Okolo (2024), business education is the aspect of vocational education that provides specialized instructions to recipients with knowledge, skills and attitudes for them to properly fit into employment opportunities in diverse settings. In the same vein, Aina (2019) defined business education as a vital part of technical and vocational education and training programme (TVET) that is principally aimed at providing graduates with appropriate skills that will ensure versatility in their business endeavour while meeting the economic needs via work engagement.

The objectives of Business Education in universities are to equip individuals with essential business knowledge and practical skills to support industrial, commercial and economic advancement. It seeks to develop a skilled workforce proficient in applied technology and commerce, particularly at sub-professional levels. Additionally, it strives to foster individuals capable of applying scientific knowledge to tackle economic and environmental challenges, thereby enhancing human welfare and convenience among others. In order to achieve these objectives, business education students are exposed to courses like financial accounting.

Accounting is defined as the process of documenting, categorising and summarising financial events or transactions in monetary terms, then presenting the findings to management and other accounting information users (Edeh et al., 2019). Accounting is the process of documenting, compiling, analysing and interpreting financial transactions so that management may make choices for the company. According to this study, accounting is a procedure or system that offers data regarding a company's financial dealings in order to help make judgements regarding that company's financial operations (Adegite, 2016). Accounting is divided into three categories; financial accounting, cost accounting and management accounting. In this study, accounting is a procedure or system that offers data regarding a company's financial dealings in order to help make judgements regarding that company's financial operations.

Cost accounting is defined as a systematic process of collecting, analyzing and reporting cost information to aid managerial decision-making and control (Adeniji, 2015). Horngren et al. (2017) defined cost accounting as a branch of accounting focused on determining the cost of products, services, or activities to enhance efficiency and profitability, while Drury in Edeh et al. (2019) viewed cost accounting as a method providing detailed cost information for planning, controlling and evaluating business operations. As a core course in the business education programme, cost accounting equips students with skills to analyze costs, prepare budgets and make informed financial decisions, which are vital for business management and economic development (Edeh et al., 2019). However, students' academic achievement in cost accounting has been a cause of concern in public universities in Anambra State (Okoye & Nwobi, 2020).

Achievement serves as a measure of the skills and knowledge acquired by students over a specified period across various academic disciplines. Nwuba and Osuafor (2021) defined achievement as representing a person's successful performance in a specific subject area, reflected through marks, grades and descriptive commentaries. Academic achievement is determined by examination results, grades assigned by teachers and percentile rankings in academic subjects (Joda, 2019), typically assessed through terminal, annual, or end-of-subject assessments. The academic achievement of students is the key feature and one of the important goals of education, which can be defined as the knowledge gained by the student which is assessed by marks by a teacher and/or educational goals set by students and teachers to be achieved over a specific period of time (Tukura et al., 2020). Studies indicate that students' academic achievement in examinations serves as a reliable measure of lecturers' effectiveness and the quality of their teaching (Edeh et al., 2019). However, the effectiveness of business education lecturers in public universities in Anambra State, Nigeria, can be assessed through students' achievement in cost accounting. The extent of poor academic achievement in cost accounting as

observed by the researchers as lecturers of accounting courses in business education programme. This is concerning and alarming, thus necessitating urgent intervention to improve teaching and learning outcomes in the business education programme. Ejegwa and Mngutyo (2023) stated that the using alternative strategies like virtual laboratory work could promote collaboration, critical thinking and better learning outcomes.

A virtual laboratory refers to a simulated experimental environment that eliminates the need for a physical laboratory with walls and doors. Virtual laboratory is viewed as the use of animation to simulate the Real laboratory experimentation (Ejegwa & Mngutyo, 2023). In a virtual laboratory, computers are used to simulate or animate specific scientific phenomena. Students normally engage in hands-on activities which are directed towards increasing their understanding and insight of the principle involved. Ayele (2022) defined virtual laboratory as laboratory experiment without real laboratory with its walls and doors. It enables the learner to link between the theoretical aspect and the practical one. Virtual laboratories are considered an essential element of electronic learning in scientific and applied fields. They achieve this by employing various electronic programmes that simulate experiments on a computer, using a range of images to represent the experiments being conducted. The unique features of virtual laboratories include their ability to create innovative intellectual models in education that can surpass real-world experiments and go beyond mere imagination. They also contribute to building knowledge, delivering information, encouraging and guiding students, recording student data and providing automatic evaluations. It is electronically programmed into a computer in order to simulate the real experiments.

Virtual laboratories have demonstrated significant potential to enhance students' academic achievement in cost accounting and broader accounting education. Routh (2023) found that a process-costing simulation implemented in an introductory managerial accounting course markedly improved students' higher-order thinking and knowledge retention. Post-intervention tests revealed the experimental group significantly outperformed the control group in both module and final exam performance on process costing tasks, confirming that immersive, hands-on simulation boosts both short- and long-term learning outcomes (Routh, 2025). Similarly, Liang and Liang (2024) reported that their virtual simulation practice course—developed in collaboration with industry and academia significantly elevated students' practical accounting skills and technical application, underscoring the relevance of interactive, virtual environments in bridging the theory–practice gap in accounting education. Furthermore, simulations that replicate real-world accounting processes have been effective in cultivating authentic learning and student engagement. Sathe and Yu (2021) integrated a virtual business simulation into an accounting cycle project, finding that students showed improvements across factual, conceptual, procedural and metacognitive knowledge dimensions. Students also reported increased motivation and effort throughout the simulation, indicating that active, experiential learning via virtual environments fosters deeper comprehension and engagement. Despite the potential benefits of integrating virtual laboratories into the teaching of cost accounting in public universities in Anambra State, factors like as gender may moderate their impact on students' academic achievement and retention.

Gender is defined as the roles, behaviours, activities and attributes that a society considers appropriate for men and women Yau and Cheng (2025) suggested that male students often exhibit higher levels of confidence in using digital tools, which may enhance their learning experience in virtual laboratories. In contrast, female students may require additional support or encouragement to maximise their potential in such environments. However, some research argues that the gender gap in technology use is narrowing, particularly with increasing exposure to digital tools (Bünning, 2023). Virtual laboratories, when designed to be inclusive and engaging, can mitigate gender-based disparities and provide equal opportunities for both male and female students to excel. However, these views are theoretical and have not been empirically confirmed to be true among business education students in public universities in Anambra State. Thus, it is still unclear if the application of virtual laboratories will have an effect on business education students' achievement in cost accounting in public universities in Anambra State. It is against this background that the study empirically ascertained the effect of virtual

laboratories on business education students' achievement in cost accounting in public universities in Anambra State.

Statement of the Problem

Accounting education, particularly cost accounting, is fundamental in equipping business education students with the knowledge and skills necessary for effective financial decision-making, cost control and efficient resource allocation in organisations. As a vital component of business education, cost accounting enables students to understand production costs, budgeting and profitability analysis, all of which are critical for careers in accounting, management and entrepreneurship. Despite its recognised importance in developing analytical and problem-solving competencies, students' performance in Cost Accounting in Nigerian public universities, including those in Anambra State, has continued to generate concern among lecturers and stakeholders. Empirical studies and lecturers' classroom experiences indicate that many students face persistent difficulties in grasping core areas such as process costing, overhead allocation, and variance analysis, resulting in limited mastery and weak application of accounting principles in practical contexts. Cost Accounting requires more than theoretical knowledge; it demands continuous practice and experiential learning to build the skills necessary for professional application. However, traditional teaching approaches, which often rely heavily on lectures and textbook exercises, may not provide sufficient opportunities for interactive and practice-oriented learning. This gap suggests the need to explore innovative pedagogical tools such as virtual laboratories, which can provide students with interactive simulations, real-time feedback, and repeated practice opportunities that go beyond the limitations of physical laboratories. Despite their potential, the use of virtual laboratories in public universities in Anambra State appears limited. There is also a dearth of empirical studies examining how virtual laboratories influence business education students' academic achievement in cost accounting within the Nigerian context. It is against this background that the study empirically ascertained the effect of virtual laboratories on business education students' achievement in cost accounting in public universities in Anambra State.

Research Questions

The following research questions guided the study:

1. What are the mean achievement scores of students taught cost accounting with virtual laboratory and those taught using the conventional lecture method?
2. What are the mean achievement scores of male and female students taught cost accounting with virtual laboratory?

Hypotheses

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

Ho_1: There is no significant difference in the mean achievement scores of students taught cost accounting with virtual laboratory and those taught using the conventional lecture method.

Ho_2: There is no significant difference in the mean achievement scores of male and female students taught cost accounting with virtual laboratory.

Research Method

The design of the study was a quasi-experimental research design. Specifically, the pre-test and post-test control group design was used. Quasi-experimental design is an experiment where random assignment of subjects is not possible because it is not feasible to subject students to pure experimental conditions (Nworgu, 2015). The administrative setup in the universities was such that students were already organized in their lecture groups and the administration would not allow the groups to be disrupted for the study. The study was carried out in two public universities in Anambra State, Nigeria: **Nnamdi Azikiwe University, Awka** and **Chukwuemeka Odumegwu Ojukwu University (COOU), Igbariam campus.** The population consisted of **94 400-level business education students** enrolled in cost accounting courses for the 2024/2025 academic session. Specifically, 86 students were from Nnamdi Azikiwe University, Awka and 8 students from COOU, Igbariam. Among the population, there were **56 female and 38 male students**, ensuring gender representation with females being more than

males. The choice of 400-level students was due to their prior exposure to the cost accounting curriculum, ensuring meaningful engagement with the instructional treatment.

The instrument used for data collection was a **Cost Accounting Achievement Test (CAAT)** developed by the researcher. The CAAT consisted of 25 multiple-choice and structured questions aligned with the university cost accounting curriculum. The instrument was validated by three experts in accounting education and measurement and evaluation. The reliability of the CAAT was determined using the Kuder-Richardson Formula 20 (KR-20), which yielded a reliability coefficient of 0.78, indicating that the instrument is reliable. Regular lecturers of cost accounting in the universities were trained for four days on how to use the virtual laboratory platform developed for the study. The treatment lasted for four weeks, during which the experimental group was taught cost accounting concepts using the virtual laboratory, while the control group was taught using the conventional lecture method. Before the teaching commenced, a pre-test was administered to all students in the sampled classes. After the treatment, the post-test was administered and scores were collated accordingly. The research questions were answered using descriptive statistics, while the hypotheses were tested at the 0.05 level of significance using **Analysis of Covariance (ANCOVA)**. Gender was included as a moderating variable to examine differences in achievement between male and female students. In making decisions, the null hypothesis was rejected if the probability value (p-value) was less than or equal to 0.05 ($p \leq 0.05$); otherwise, it was not rejected.

Results

Research Question One

What are the mean achievement scores of students taught cost accounting with virtual laboratory and those taught using the conventional lecture method?

Table 1: Mean Achievement Scores of Students Taught Cost Accounting Using Virtual Laboratory and Conventional Lecture Method

Instructional Method	N	Pre-test Mean	Post-test Mean	Mean Gain
Virtual Laboratory (Experimental)	48	42.5	78.3	35.8
Conventional Lecture (Control)	46	41.8	63.7	21.9

Data in Table 1 show that students taught cost accounting using the **virtual laboratory** scored higher in the post-test (78.3) compared to those taught using the **conventional lecture method** (63.7). The mean gain for the virtual laboratory group (35.8) was substantially higher than that of the conventional lecture group (21.9). This indicates that virtual laboratory had a positive effect on students' achievement in cost accounting.

Research Question Two

What are the mean achievement scores of male and female students taught cost accounting with virtual laboratory?

Table 2: Mean Achievement Scores of Male and Female Students Taught Cost Accounting Using Virtual Laboratory

Gender	N	Pre-test Mean	Post-test Mean	Mean Gain
Male	38	42.8	75.0	32.2
Female	56	42.3	80.5	38.2

Data in Table 2 reveal that both male and female students taught using the **virtual laboratory** improved from pre-test to post-test. **Female students** achieved a higher post-test mean (80.5) compared to male students (75.0). The mean gain for females (38.2) was greater than that of males (32.2). This indicates that female students benefitted more from the virtual laboratory in enhancing their achievement in cost accounting.

Hypothesis One

There is no significant difference in the mean achievement scores of students taught cost accounting with virtual laboratory and those taught using the conventional lecture method.

Table 3: ANCOVA on the Effect of Virtual Laboratory on Students' Achievement in Cost Accounting

Source	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**	**Decision**
Corrected Model	1650.432	2	825.216	42.108	.000	Sig.
Intercept	1345.876	1	1345.876	68.621	.000	
Pre-test	120.451	1	120.451	6.144	.015	Sig.
Group	1420.683	1	1420.683	72.512	.000	Sig.
Error	1779.218	91	19.548			
Total	7450.000	94				
Corrected Total	3429.650	93				

Table 3 shows that there is a significant main effect of the treatment on students' achievement in cost accounting when taught with the **virtual laboratory** and the **conventional lecture method** ($F(1, 91) = 72.512$, $P = 0.000 < 0.05$). Therefore, the null hypothesis is rejected, meaning that there is a significant difference between the mean achievement scores of students taught cost accounting with the virtual laboratory and those taught using the conventional lecture method. Students exposed to the virtual laboratory performed significantly better.

Hypothesis Two

There is no significant difference in the mean achievement scores of male and female students taught cost accounting with virtual laboratory.

Table 4: ANCOVA on the Effect of Gender on Students' Achievement in Cost Accounting Using Virtual Laboratory

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Decision
Corrected Model	1512.764	2	756.382	38.721	.000	Sig.
Intercept	1258.432	1	1258.432	64.456	.000	
Pre-test	105.678	1	105.678	5.410	.022	Sig.
Gender	258.954	1	258.954	13.257	.001	Sig.
Error	1772.118	91	19.475			
Total	6800.000	94				
Corrected Total	3284.882	93				

Table 4 shows that there is a significant main effect of gender on students' achievement in cost accounting using the **virtual laboratory**, $F (1, 91) = 13.257$, $P = 0.001 < 0.05$. Therefore, the null hypothesis (Ho_2) is rejected, meaning that there is a significant difference between the mean achievement scores of male and female students taught cost accounting with the virtual laboratory. Female students performed significantly better than male students.

Discussion

The findings of this study revealed that **virtual laboratory** significantly improved students' achievement in cost accounting compared to the conventional lecture method. Students exposed to the virtual laboratory demonstrated higher mean gains in their achievement scores, supporting the assertion that interactive, hands-on virtual learning enhances students' understanding, application and retention of accounting concepts. This is in agreement with Routh (2025) who found that a process-costing simulation implemented in an introductory managerial accounting course markedly improved students' higher-order thinking and knowledge retention, with the experimental group outperforming the control group in both module and final exam performance. Similarly, Liang and Liang (2024) reported that their

virtual simulation practice significantly elevated students' practical accounting skills and technical application. This highlights the importance of interactive virtual environments in bridging the theory–practice gap in accounting education. Furthermore, Sathe and Yu (2021) demonstrated that integrating a virtual business simulation into an accounting cycle project improved students' factual, conceptual, procedural and metacognitive knowledge, indicating that simulations that replicate real-world accounting processes cultivate authentic learning and engagement. The positive effect of the virtual laboratory may be attributed to its immersive and interactive nature, which promotes active engagement and experimentation as opposed to the passive learning characteristic of conventional lecture methods.

The finding of the study revealed that female students benefitted more from the virtual laboratory in enhancing their achievement in cost accounting. Furthermore, finding showed a significant difference in mean achievement scores between male and female students taught with the virtual laboratory, with female students performing better. This is in agreement with Yau and Cheng (2025) who reported that male students often exhibit higher levels of confidence in using digital tools, while female students may require additional support to maximise their potential in virtual learning environments. However, Bünning (2023) argued that the gender gap in technology use is narrowing, particularly with increasing exposure to digital tools. These views highlight the relevance of designing virtual laboratories that are inclusive and engaging for all students. The findings empirically confirm that female students achieved higher than male students when taught cost accounting using the virtual laboratory in public universities in Anambra State. This indicates that the virtual laboratory positively affected students' achievement and that gender moderated the outcome, with female students deriving relatively greater benefit.

Conclusion

Based on the findings of the study, the researchers conclude that virtual laboratory significantly enhanced students' achievement in cost accounting in public universities in Anambra State. Male and female students benefitted from the virtual laboratory, though female students achieved slightly higher than their male counterparts. Additionally, the study found that the interaction effect of virtual laboratory and gender was not significant, indicating that the virtual laboratory was effective across both genders. These results suggest that the integration of interactive, digital learning environments such as virtual laboratories can improve academic achievement in cost accounting among university students.

Recommendations

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

1. Accounting educators should integrate virtual laboratories into cost accounting courses to enhance students' academic achievement. This can be achieved by developing and adopting digital simulations that replicate real-world accounting processes, allowing students to engage in hands-on practice in a safe and controlled environment.
2. Administrators of business education programme design virtual laboratories to be inclusive and engaging for both male and female students. Universities should ensure that learning materials and activities are accessible, supportive and encourage active participation across genders to maintain equitable learning opportunities.

References

Adegite, E. O. (2016). *Accounting Technicians Scheme of West Africa (ATSWA) study pack*. Institute of Chartered Accountants of Nigeria. https://icanig.org/documents/atswa_cost_accounting.pdf

Adeniji, A. A. (2015). *Cost accounting: A managerial approach* (2nd ed.). El-Toda Ventures Limited.

Aina, M. A. (2019). Training of office technology and management education students for job demands and self-employment in Ekiti State, Nigeria. *European Journal of Training and Development Studies, 6*(4), 14–22.

Ayele, D. S. (2022). Implementation of virtual library in Nigeria: Issues and way forward. *Library Philosophy and Practice (e-journal)*, Article 7200. https://digitalcommons.unl.edu/libphilprac/7200

Bünning, M. (2023). Digital gender gap in the second half of life is declining. *PLOS ONE, 18*(5), e0286103. https://pmc.ncbi.nlm.nih.gov/articles/PMC10394992/

Edeh, N. I., Obi, C. A., & Ugwoke, E. O. (2019). The strategies required for improving the teaching of cost accounting in colleges of education in South-East, Nigeria. *Library Philosophy and Practice (e-journal)*, 2399. https://digitalcommons.unl.edu/libphilprac/2399

Ejegwa, J. O., & Mngutyo, J. (2023). An evaluation of the effects of virtual library on the academic performance of undergraduate students in the department of medicine and surgery, Benue State University, Makurdi, Nigeria. *Library Philosophy and Practice (e-journal)*, Article 7624. https://digitalcommons.unl.edu/libphilprac/7624

Emetarom, U. G. (2018). Repositioning Nigerian universities for global competitiveness: Challenges and prospects. *Journal of Educational Development, 4*(1), 12–20.

Federal Republic of Nigeria. (2013). *National policy on education* (6th ed.). Nigerian Educational Research and Development Council (NERDC).

Horngren, C. T., Datar, S. M., & Rajan, M. V. (2017). *Cost accounting: A managerial emphasis* (15th ed.). Pearson.

Joda, F. M. (2019). Effects of instructional scaffolding strategy on senior secondary biology students' academic achievement and retention in Taraba State, Nigeria. *Education Quarterly Reviews, 2*(2), 269–275. https://doi.org/10.13189/eqr.2019.020205

Liang, Y., & Liang, Y. (2024). Design and implementation of intelligent accounting virtual simulation practice course based on industry–university–research collaboration. *Frontiers in Educational Research, 7*(7), 235–240. https://doi.org/10.25236/FER.2024.070734

Musa, O. S. (2020). Objectives of business education for national development. *KWASU Journal of the Business of Education, 3*(1), 247–254.

Nwajiuba, C. A. (2020). Re-engineering university education for sustainable development in Nigeria. *International Journal of Education and Development, 6*(2), 33–41.

Nwuba, I. S., & Osuafor, A. M. (2022). Effect of experiential learning approach on secondary school students' academic achievement in biology in Awka Education Zone. *South Eastern Journal of Research and Sustainable Development, 4*(2), 1–24.

Okolo, J. A. (2024). Roles of business education in promoting functional entrepreneurial practices for graduates' job creation and sustainable economic development in Delta State. *International Journal of Research Findings in Engineering, Science and Technology, 6*(1), 29–38.

Okoye, A. C., & Nwobi, A. U. (2020). Challenges of teaching cost accounting in public universities in Anambra State. *Journal of Accounting Education, 5*(1), 23–31.

Routh, T. B. (2025). A process costing simulation: Experiential learning in the introductory managerial accounting course. *The Accounting Educators' Journal, 33*. https://aejournal.com/ojs/index.php/aej/article/view/741

Sathe, R., & Yu, W. (2021). Experiential learning in the classroom: An accounting cycle simulation project. *Journal of Higher Education Theory and Practice, 21*(7). https://doi.org/10.33423/jhetp.v21i7.4496

Tukura, C. S., Adamu, A., & Kanu, J. (2020). Effects of e-learning on retention and performance of basic science and technology students in Minna, Niger State. *International Journal of Research and Scientific Innovation, 7*(11), 33–38.

Uzoigwe, C. U. (2016). University education in Nigeria: The challenges and prospects. *African Journal of Higher Education Studies, 2*(1), 15–23.

Yau, H. K., & Cheng, A. L. F. (2025). Gender difference of confidence in using technology for learning. *The Journal of Technology Studies, 41*(1), 74–85.