INTERNATIONAL JOURNAL OF INNOVATIVE APPROACHES TO LEARNING AND TEACHING
IJIALT

EFFECT OF IOT-ENHANCED LEARNING ON SECONDARY SCHOOL STUDENTS' ACADEMIC ACHIEVEMENT IN COMPUTER STUDIES IN ONITSHA EDUCATION ZONE

Nwankwo Madeleine Chinyere[1], Umeh Chinyere Charity[2]
nwankwo.mc@unizik.edu.ng[1], godgiveschy@gmail.com[2]

[1,2]**Department of Science Education, Faculty of Education, Nnamdi Azikiwe University, Awka.**

Abstract

The study investigated the effect of IoT-enhanced learning on secondary school students' academic achievement in Computer Studies in Onitsha Education Zone of Anambra State. Two research questions guided the study and three null hypotheses were tested at 0.05 level of significance. The study adopted quasi-experimental pretest and post-test design. A sample of 85 students were drawn from the population of 4,088 secondary school (SS1) students offering computer in the zone using multi-stage sampling procedure. The instrument used for data collection involved Computer Studies Achievement Test (CSAT) which was validated by three experts from the Faculty of Education, Nnamdi Azikiwe University, Awka. Reliability of the instrument was established using Kuder-Richardson formula 20 to yield a coefficient of 0.782. the data collection was done in two phases; the pretest and posttest. The data collected were analysed using mean, standard deviation and analysis of covariance (ANCOVA). The mean and standard deviation was used for answering research questions, while ANCOVA was used to test the null hypotheses raised. The findings revealed that there is a significant difference in the mean achievement scores of students taught computer studies with IoT-enhanced learning instructional strategy than those taught with lecture method. The study also revealed that there is no significant difference in the mean achievement scores of male and female students taught computer studies using IoT-enhanced learning instructional strategy. Based on the findings of the study, it was concluded that IoT-enhanced learning instructional strategy is more effective than the lecture method in improving both the interest and academic achievement of students in Computer Studies. It was recommended amongst others that Computer Studies teachers should be encouraged and trained to adopt IoT-enhanced learning instructional strategies in the classroom, also, government and school administrators should invest in the provision of necessary IoT tools, digital devices, and internet facilities in schools to support technology-enhanced teaching and learning.

Keywords: Academic, Achievement, Computer, IoT, instructional, School, gender, Strategies.

Introduction

Education has long been regarded as a fundamental driver of personal, social, and economic development. It encompasses the process of acquiring knowledge, skills, values, beliefs, and habits through formal, informal, and non-formal methods. Education remains the driving force behind the growth and development of any nation, and Nigeria is no exception. According to Birabil and Obitor (2020), education is defined as a social creation designed to meet the specific needs of society at any given point in time. This therefore plays a crucial role in fostering economic development and social cohesion by cultivating individuals endowed with both intellectual and practical skills necessary for maintaining their livelihoods and engaging effectively in the workforce. Building on the broader principles of education, science education plays a crucial role in helping students develop the skills needed to understand and engage with the natural world.
Science education embodies these principles by fostering intellectual curiosity, promoting critical thinking, and contributing to societal progress through innovation and technological breakthroughs. By connecting learners with the natural world and equipping them with the tools to explore and solve complex problems, science education carries forward the legacy of education as a catalyst for growth and development. According to Ekanem and Obodom (2014), science education can be regarded as the foundational pillar of various sciences, including chemistry, physics, mathematics, biology, physical and health sciences, and computer science. Science education encompasses the dissemination of scientific knowledge, including foundational principles, theories, and discoveries, as well as the development and application of effective pedagogical strategies to facilitate understanding and Interest. It integrates the content of science with the art and science of teaching, ensuring that learners not only acquire information but also develop the skills to think critically, apply concepts, and explore the natural world with curiosity and purpose. Subjects covered by science education standards in Nigeria include Chemistry, Physics, Mathematics, Biology, Integrated Science, and Computer Studies.

A computer is an electronic device that processes, stores, and retrieves data, executing tasks based on programmed instructions. It is capable of performing various operations, including calculations, data management, and running applications, making it an essential tool in fields ranging from personal use to advanced scientific research and industrial automation. The term **"computer"** was originally referred to a person who performed calculations, with the word deriving from the Latin verb *computare*, meaning "to calculate" or "to reckon." The term has been in use since 17th century. By the mid-20th century, it evolved to refer to mechanical and electronic devices that carried out computational tasks, replacing human "computers" as automation and digital technologies progressed. According to Brookshear and Brylow (2021) Computer science is a systematic study of computational systems and algorithms. It emphasizes the theoretical foundations of information processing, the design and implementation of both software and hardware, and the use of these technologies to address real-world challenges. The discipline draws from mathematics, engineering, and logic to develop efficient, dependable and scalable computational tools. Computer serves as a great subject for various professional disciplines, and the knowledge gained from computers is applied in various fields such as Education, Healthcare,

Business and finance, Entertainment, Scientific Research, Engineering and Manufacturing, Transportation, Agriculture, Security and Defence, Communication, among others. Computer equips students with critical skills for the modern world and enhance their learning experience across various disciplines. Incorporating computers into the secondary school curriculum is not just beneficial, it is essential for preparing students for a digitally interconnected world. By equipping them with technological proficiency, critical thinking skills, and interdisciplinary applications, computers play a pivotal role in shaping the next generation of innovators and leaders unlike the conventional lecture method of teaching where the students are just passive. Transitioning from traditional computer education to IoT-focused instructional strategies highlights the shift from standalone computing to an environment of integrated, sensor-driven systems.

Internet of Things (IoT) refers to a network of physical devices such as home appliances, vehicles, sensors, and other objects connected to the internet, which are capable of collecting, transmitting, and exchanging data without requiring direct human interaction. According to Balagué (2021), Internet of Things (IoT) is defined as a network of physical objects embedded with sensors, software, and other technologies that connect and exchange data with other devices and systems over the Internet. Al-Fuqaha et al. (2020) stated that "The Internet of Things (IoT) is a network of devices that are connected to the internet and each other, enabling them to collect, exchange, and analyze data to make informed decisions and provide services." Furthermore, Xie et al. (2023) specifically address the application of IoT in education, defining it as "a comprehensive system integrating smart devices, educational resources, and data analytics, which enhances learning experiences by enabling real-time interaction, personalized instruction, and efficient classroom management."

IoT-enhanced learning is achieved by connecting devices like smartboards, tablets and wearables. It helps improve interest, personalize lessons and automate tasks like attendance and performance tracking for teachers and students (Arun, 2025). Internet of Things (IoT) in education significantly enhances learning by fostering personalized learning, interactive and immersive experiences, and smart classroom environments, all supported by real-time data insights. IoT Applications in Nigerian Classrooms include Smart Attendance Systems, Connected Learning Tools, and Environmental Monitoring **(**INTLBM, 2024).

integration of Internet of Things (IoT) technologies in education is transforming teaching and learning processes by enhancing interactivity, personalization, and efficiency. Among the prominent IoT devices used in educational settings are smartboards (interactive whiteboards), connected tablets, wearable fitness trackers, IoT-enabled projectors, and smart cameras. These devices support real-time collaboration, allow teachers to monitor student engagement and achievement, and make the learning process more interactive and engaging (Zhang, 2025; Ali, Ullah *et al* 2022).

For instance, smartboards enable dynamic presentations and annotations during lessons; connected tablets provide individualized access to digital content; wearable devices track physical activity and wellness, contributing to student well-being; IoT projectors enhance visual delivery

of content; and smart cameras ensure safety while also enabling video-based learning and analytics. These devices collectively support differentiated instruction and data-driven teaching strategies.

The benefits of IoT in education extend beyond hardware functionality. Enhanced learning experiences are achieved through real-time interactivity and multimedia engagement. Data-driven decision-making is made possible by collecting and analysing student achievement metrics, which helps teachers tailor instruction to individual needs (This streamlines the workflow for teachers and make day to day tasks smoother). IoT tools also contribute to cost-saving by automating administrative tasks and optimizing resource usage. Moreover, IoT promotes inclusivity, enabling learners with special needs to access content in adaptive formats, and fosters collaborative learning through shared digital platforms (Yağanoğlu et al., 2023; Oluwadara & Obielodan, 2023). In essence, IoT in education increases operational effectiveness, personalizes learning pathways, and provides actionable insights into teaching outcomes thereby creating smarter, more efficient, and more inclusive classrooms.

Among Internet of Things (IoT)-enhanced tools, smartboards, such as interactive whiteboards (IWBs), stand out as transformative innovations (the game changers) in modern education. In this study, the researcher focuses on the use of smartboards, specifically the interactive whiteboard, which, according to Esteves and Fiscarletti (2015), is a set of technological equipment comprising of a motor user interaction system, a projector, the computer interactive whiteboard software organized so as to fulfil specific task, a tool consisting of a large flat screen or white board linked to a computer in which the screen mirrors the computer with which it is connected. Mil, Mail and Mail (2017) emphasized that IWBs combine hardware and software components to support interactive teaching and learning tasks. Understanding and enhancing these elements are essential for promoting higher levels of achievement among students, irrespective of gender.

Gender refers to the socially constructed roles, behaviours, activities, and attributes that a given society considers appropriate for men and women. In educational research, gender often serves as an intervening variable or moderator in understanding differences in learning outcomes and academic achievement among students. As a moderator, gender can influence the relationship between various factors and educational outcomes. For example, a study by Wang and Degol (2023) illustrates that gender can moderate the effects of teaching methods on student Interest. The researchers found that certain interactive teaching strategies were more effective for female students, leading to higher levels of achievement when compared to male students. This suggests that instructional methods may need to be tailored to accommodate differing responses to teaching approaches based on gender.

Despite the growing global integration of IoT tools in education, many secondary schools in the Onitsha Education Zone still rely heavily on traditional lecture-based computer instruction, leaving a gap in understanding how IoT-enhanced strategies may improve students' interest and achievement. It is against this, backdrop, that this study sought to investigate the effect of internet of things (IoT) enhanced learning instructional strategy on students' academic achievement in Computer studies in Onitsha Education Zone.

Purpose of the Study

The purpose of the study was to investigate the effect of IoT-enhanced learning Strategy on students' academic achievement of students in Computer Studies in Onitsha Education Zone. Specifically, the study sought to determine the difference in:

1. mean achievement scores of SS1 students taught Computer Studies using IoT-enhanced learning strategy and that of those taught with lecture method.
2. Mean achievement scores of male and female students taught Computer Studies using IoT-enhanced learning strategy and those taught with lecture method.
3. The interaction effect of gender and teaching methods on students' achievement in Computer Studies.

Research Questions

The following research questions guided the study

1. What is the difference in the achievement scores of SS1 students taught Computer Studies using IoT-enhanced learning instructional strategy and that of those taught using lecture method?
2. What is the difference in the achievement scores of male and female students taught computer studies using IoT-enhanced learning instructional strategy?

Hypotheses

The following null hypotheses were tested at 0.05 level of significance

1. There is no significant difference in the achievement scores of students taught Computer Studies using IoT-enhanced learning instructional strategy and that of those taught using lecture method.
2. There is no significant difference in the achievement scores of SS1male and female students taught Computer studies using IoT-enhanced learning instructional strategy.
3. There is no interaction effect of gender and teaching methods on SS1 students' achievement scores in Computer Studies.

Methodology

The study adopted a quasi-experimental pretest and posttest design. The study made used of two intact classes, one for the experiment and the other for the control. The study was conducted in Onitsha Education Zone of Anambra State, Nigeria. The population of the study comprised 4,088 SS1 students offering Computer studies in public schools in the zone, 85 students were sampled using multistage sampling procedure. The instrument used for data collection was Computer Studies Achievement Test (CSAT), which consist of 50 multiple choice questions. CSAT was validated by three experts from Faculty of Education, Nnamdi Azikiwe University, Awka. The reliability of CSAT was established using Kuder-Richardson formula 20, yielding a coefficient of 0.782. treatment of the study lasted for a period of 6 weeks, the first week was for briefing of the research assistants and administering of the pretest, after that, treatment commenced, after 4 weeks of intense treatment and revision was done, the 6weeks was used for

administering of the posttest. Thereafter, the researcher collected the achievement scores and proceeded for data analysis. The data collected was analysed using mean and standard deviation for answering the research questions and ANCOVA was used for testing the null hypothesis. Following the decision rule, if $P \leq 0.05$, reject the null hypotheses, otherwise do not reject.

Results

Research Question 1: What is the difference in the achievement scores of SS1 students taught Computer Studies using IoT-enhanced learning instructional strategy and that of those taught using lecture method?

Table 1: Mean and standard deviation on the mean achievement scores of SS1 students taught computer studies using IoT-enhanced learning instruction and those taught using lecture method

		Pretest		Posttest		
Method	**N**	**Mean**	**SD**	**Mean**	**SD**	**Mean Gain**
IoT-enhanced learning Strategy	55	48.09	9.21	62.82	10.57	14.73
Lecture Method	30	50.33	10.08	55.97	11.01	5.64
Mean Diff.		-2.24		6.85		9.09

The result presented in Table 1 revealed that students taught Computer Studies using IoT-enhanced learning instructional strategy had a pretest mean of 48.09, SD=9.21 and a posttest mean of 62.82, resulting in a mean gain of 14.73. On the other hand, students taught using lecture method had a pretest mean of 50.33, SD=10.08 and a posttest mean of 55.97, SD = 11.02, resulting in a mean gain of 5.64. This indicate that both IoT-enhanced learning instructional strategy and lecture method were effective in enhancing students' academic achievement of students in Computer studies. However, compared to lecture method, the IoT-enhanced learning instructional strategy was more effective than traditional lecture method, as indicated by the mean gain difference of 9.09.

Research Question 2: What is the difference in the achievement scores of male and female students taught computer studies using IoT-enhanced learning instructional strategy?

Table 2: Mean and standard deviation on achievement scores of male and female SS1 students taught computer studies using IoT-enhanced learning instruction and that of those taught using lecture method

			Pretest		Posttest		
Method	**Gender**	**N**	**Mean**	**SD**	**Mean**	**SD**	**Mean gain**
IoT-enhanced learning strategy	Male	32	48.25	9.62	63.09	10.66	14.84
	Female	23	47.87	8.80	62.43	10.67	14.56
Mean Diff.			0.38		0.66		0.28
Lecture Method	Male	20	50.95	10.58	56.10	11.29	5.15
	Female	10	49.10	9.43	55.70	11.02	6.60
Mean Diff.			1.85		0.40		-1.45

The result in Table 2 shows the pretest and posttest achievement scores of male and female SS1 students taught Computer Studies using both the IoT-enhanced learning instructional strategy and the lecture method. Male students taught with the IoT-enhanced learning instructional strategy had a pretest mean score of 48.25 and a posttest mean of 63.09, resulting in a mean gain of 14.84. Female students in the same group had a pretest mean of 47.87 and a posttest mean of 62.43, with a mean gain of 14.56. The mean gain difference of 0.28 indicated IoT-enhanced learning strategy favoured the male students. In contrast, for students taught using the lecture method, male students had a pretest mean score of 50.95 and a posttest mean of 56.10, with a mean gain of 5.15. Female students had a pretest mean of 49.10 and a posttest mean of 55.70, resulting in a slightly higher mean gain of 6.60. The mean gain difference of -1.45 indicated that lecture method favoured the female students. Overall, IoT-enhanced learning instructional strategy was more effective in enhancing the academic achievement of male and female students in Computer studies.

Hypothesis One: There is no significant difference in the achievement scores of students taught Computer Studies using IoT-enhanced learning instructional strategy and that of those taught using lecture method.

Table 3: Summary of Analysis of Covariance of mean achievement scores of SS1 students taught Computer studies using IoT-enhanced learning strategy and that of those taught using Lecture method

Source	Sum of Squares	df	Mean Square	F	Sig.	Decision
Corrected Model	8641.207[a]	4	2160.302	95.315	.000	
Intercept	273.465	1	273.465	12.066	.001	
Pretest_Score	7723.078	1	7723.078	340.750	.000	
Teaching_Methods	1384.057	1	1384.057	61.066	.000	Sig.
Gender	6.435	1	6.435	.284	.596	Not Sig.
Teaching_Methods * Gender	13.613	1	13.613	.601	.441	Not Sig.
Error	1813.193	80	22.665			
Total	320548.000	85				
Corrected Total	10454.400	84				

Note: $P<0.05$

Table 3 shows the analysis of covariance (ANCOVA) result which shows the effect of teaching methods on academic achievement scores while controlling for the pretest scores. The overall corrected model was significant, $F(4, 80) = 95.315$, $P < 0.000$. However, after controlling the covariates, there was a significant main effect of teaching methods on the academic achievement scores of students taught Computer Studies, $F(1, 80) = 61.066$, $P = 0.000$. Since, $P < 0.05$, the null hypothesis was not rejected. Hence, there is a significant difference in the achievement scores of students taught Computer Studies using IoT-enhanced learning instructional strategy and that of those taught using lecture method. This means that, students taught using the IoT-enhanced learning instructional strategy performed significantly better than those taught using the traditional lecture method.

Hypothesis Two: There is no significant difference in the achievement scores of SS1male and female students taught Computer studies using IoT-enhanced learning instructional strategy.

The result in Table 3 reveals the analysis of covariance (ANCOVA) on the effect of gender on academic achievement scores of students taught computer studies while controlling for pretest scores. The overall corrected model was significant, $F(4, 80) = 95.315$, $P = 0.000$. After controlling for pretest scores, there was no significant main effect of gender on students' achievement scores in Computer studies, $F(1, 80) = 0.284$, $P = 0.596$. Since $P > 0.05$, the null hypothesis was not rejected. Thus, there is no significant difference in the achievement scores of SS1 male and female students taught computer studies using IoT-enhanced learning instructional strategy. This suggests that gender did not significantly influence the academic achievement of students who were taught Computer Studies using the IoT-enhanced learning instructional strategy.

Hypothesis Three: There is no interaction effect of gender and teaching methods on SS1 students' achievement scores in Computer Studies.

The analysis of covariance (ANCOVA) result presented in Table 3 revealed the interaction effect of gender and teaching methods on SS1 students' achievement in Computer Studies while controlling the pretest scores. The overall corrected model was significant, F(4, 80) = 95.315, *P* = 0.000. However, after controlling the covariate, there was no significant interaction effect between gender and teaching methods, F (1, 80) = 0.601, *P* = 0.441. Since, P>0.05, the null hypothesis was not rejected. Therefore, there is no interaction effect of gender and teaching methods on SS1 students' achievement in Computer Studies. This implies that the impact of the teaching method on students' achievement in Computer Studies does not differ significantly between male and female students.

Discussion of Findings

The finding of this study showed in table 1 revealed that students taught Computer studies with IoT-enhanced learning strategy had a higher mean gain compared to those taught with lecture method. This indicates that IoT-enhanced learning instructional strategy was more effective in enhancing the mean achievement scores of students in Computer studies. The higher mean gain recorded by students taught Computer Studies using the IoT-enhanced learning strategy could be attributed to the interactive and technology-driven nature of the approach, which fosters active participation, real-world application of concepts, and immediate feedback that enhance understanding and learning outcomes more effectively than the traditional lecture method. This finding agrees with that of Özgül and Ocak (2023) who found no significant difference between the mean achievement scores of the students in the experimental (IoT), and control groups in the academic achievement test. Likewise, Osisanwo, Izang, Kuyoro and Chukwudi (2016) found that students in the IoT-enhanced environment showed significantly higher achievement than those in traditional setups. In line with this finding, Al-Hashmi and Khalid (2023) revealed that students exposed to IoT-enhanced learning platforms had significantly higher GPA scores compared to when IoT was not used. On the other hand, Carter, Greenberg and Walker (2016) reported that there was a substantial negative effect on academic performance, indicating that students exposed to internet of things had low performance of rate than those not exposed to the them. The differences in findings of these studies could be due to distraction from the electronic devices complete with internet access outweighed their use for note-taking or research during lessons.

The corresponding hypothesis result in table 3 showed that there is a significant difference in the achievement scores of students taught Computer Studies using IoT-enhanced learning instructional strategy and those taught using lecture method. This implies that, students taught using the IoT-enhanced learning instructional strategy performed significantly better than those taught using the traditional lecture method. This finding is supported by that of Asad, Naz, Shaikh, Alrizq, Akram and Alghamdi (2024) who revealed that students in the IoT-enhanced lab condition performed significantly better than those in the traditional lab setting. Likewise, this finding is in

tandem with that of Al-Hashmi and Khalid (2023) who revealed that IoT engagement significantly predicted academic performance.

Finding from this study in table 2 showed that male students taught Computer studies with IoT-enhanced learning instructional strategy had a higher mean gain achievement score than their female counterparts, while female students had a higher mean gain achievement score in the lecture method group than their male counterparts. This means that IoT-enhanced learning instructional strategy was more effective in enhancing the academic achievement scores of male and female students, with male having slightly higher achievement scores. The observed higher mean achievement gain among male students taught with the IoT-enhanced learning instructional strategy could be attributed to males' greater inclination toward technology-driven and hands-on learning environments, while the higher mean gain among females in the lecture method group may be due to their stronger attentiveness, compliance with structured instruction, and consistent study habits that favor traditional teaching approaches. This finding support that of Manna and Ratan (2024) which showed no significant differences in Internet usage and academic achievement between male and female students. This finding is supported by Oyeniyi, Kanayochukwu and Oluwatimilehin (2023) who showed that IoT integration significantly improved the academic achievement of both male and female students. However, there was no significant difference between male and female students' academic achievement**,** and no significant interaction effect between gender and IoT implementation.

The corresponding hypothesis result in table 3 revealed that there was no significant difference in the achievement scores of SS1 male and female students taught using IoT-enhanced learning instructional strategy. This suggests that gender did not significantly influence the academic achievement of students who were taught Computer Studies using the IoT-enhanced learning instructional strategy. This finding is in line with that of Manna and Ratan (2024) who found no statistically significant difference in academic achievement between male and female students. Furthermore, this finding agreed with that of Al-Hashmi and Khalid (2023) who revealed that gender differences in achievement were not statistically significant**.** Similarly, Oyeniyi, Kanayochukwu and Oluwatimilehin (2023) found that there was no significant difference between male and female students' academic achievement**.**

The result in table 3 showed that there was no interaction effect of gender and teaching methods on SS1 students' achievement in Computer Studies. This implies that the impact of the teaching method on students' achievement in Computer Studies does not differ significantly between male and female students. The absence of an interaction effect between gender and teaching methods on SS1 students' achievement in Computer Studies could be attributed to the fact that both male and female students benefited similarly from the instructional approaches, indicating that the effectiveness of the IoT-enhanced and lecture methods in improving achievement was not influenced by gender differences. This aligns with that of Oyeniyi, Kanayochukwu and Oluwatimilehin (2023) who found no significant interaction effect between gender and IoT implementation. Similarly, Nwosu and Ndanwu (2020) found that there was no

significant interaction effect of teaching method and gender was found on the mean achievement scores of students in electronic libraries course. Conversely, Onele and Ogbuanya (2025) found that there were significant effects of interaction between teaching methods and gender.

Conclusion

Based on the findings of the study, it can be concluded that the IoT-enhanced learning instructional strategy is more effective than the lecture method in improving both the interest and academic achievement of SS1 students in Computer Studies. Though gender differences were observed in the mean interest and achievement scores, these differences were not statistically significant, indicating that both male and female students benefited similarly from the instructional strategies employed. By integrating interactive technologies and learner-centered tools, the approach supports more engaging and effective classroom experiences and aligns with global shifts toward digital competency and smart learning environments. The outcomes of this research therefore highlight the importance of equipping schools, teachers, and learners with the necessary IoT-based resources and instructional skills to foster improved academic experiences. Overall, the study reinforces the need for continuous innovation in teaching methods to ensure that students are adequately prepared for the evolving technological demands of the modern world.

Recommendations

1. Computer Studies teachers should be trained and supported to effectively adopt IoT-enhanced instructional strategies, ensuring they can integrate smartboards and other IoT tools into classroom activities to promote active learning and improved student engagement.
2. Government and school administrators should invest in providing adequate IoT devices, digital infrastructure, and reliable internet connectivity to create an enabling environment for technology-driven instruction and to sustain the effective implementation of IoT-enhanced learning in secondary schools.

References

Al-Fuqaha, A., Guizani, M., Mohammadi, M., & Ayyub, N. (2020). Internet of Things: A survey on enabling technologies, applications, and future research directions. *IEEE Communications Surveys and Tutorials, 17*(2), 1344–1375.

Asad, M. M., Naz, A., Shaikh, A., Alrizq, M., Akram, M., and Alghamdi, A. (2024). Investigating the impact of IoT-based smart laboratories on students' academic achievement in higher education. *Universal Access in the Information Society, 23,* 1135–1149. https://doi.org/10.1007/s10209-022-00944-1

Balagué, C. (2021). *Internet of Things: Concepts, Technologies, and Applications.* CRC Press.

Birabil and Obitor (2020), Birabil, S. T., and Obitor, O. W. (2020). Education in Nigeria: Challenges and way forward. *International Journal of Academic Research and Reflection, 8*(1), 42. Progressive Academic Publishing, UK.

Brookshear, J. G., & Brylow, D. (2021). *Computer Science: An Overview* (13th ed.). Pearson.

Carter, S.P., Greenberg, K. and Walker, M.S. (2016). The impact of computer usage on academic performance: Evidence from a randomized trial at the United States Military Academy. *Economics of Education Review* 56 (2017) 118–132.

Ekanem, N. U., & Obodom, M. I. (2014). Problems and prospects of science education in Nigerian schools. *Journal of Resourcefulness and Distinction, 8*(1), 50–60.

Esteves, M., & Fiscarletti, D. (2015). The use of interactive whiteboards in educational settings: Benefits and limitations. *International Journal of Emerging Technologies in Learning (iJET)*, *10*(4), 42–47. https://doi.org/10.3991/ijet.v10i4.4562

INTLBM. (2024). *IoT in Education: Bridging the Gap Between Digital and Physical Learning Tools*. https://intlbm.com/2024/01/22/iot-in-education-bridging-the-gap-between-digital-and-physical-learning-tools

Manna, R. and Ratan S. (2024). Effect of Internet Usage on the Academic Achievement of Secondary School Students. *Asian Journal of Education and Social Studies* 50 (12):249-60.

Mil, A., Mail, B., & Mail, S. (2017). Technology integration and interactive whiteboards in classrooms: An analysis. *International Journal of Technology in Education*, *9*(2), 103–112.

Nwosu, O. and Ndanwu, A. I. (2020). Interaction effect of gender and teaching method on academic achievement and interest of students' in electronic libraries course in federal tertiary institutions in Anambra State, Nigeria. *Journal of applied Information Science and Technology* 13 (1) PP. 288-294.

Oluwadara, M. A., & Obielodan, O. O. (2023). Enhancing students' interest and achievement in computer studies using interactive technology. *Nigerian Journal of Educational Technology and Society*, *16*(1), 88–97.

Onele, N. & Ogbuanya, T. (2025). The Effect of Gender and Teaching Methods on Academic Success in Virtual Reality to Reduce Gender Disparity in Technology. *Journal of Teaching and Learning*, 19(2), 5–23.

Osisanwo, F.Y., Izang, A.A., Kuyoro, S.O., & Chukwudi, J.H. (2016). Internet of Things (IoTs) Bridging the Gap in Tertiary Educational Process. *Int'l J. Emerging Trends & Technology in Computer Science*, 42(2), 94–101.

Oyeniyi, O. D., Kanayochukwu, O. D., & Oluwatimilehin, A. S.(2023) Utilization of Internet Things (IOT) for Implementing Teaching and Learning in Technical Colleges in Enugu State. https://rsisinternational.org/journals/ijriss/articles/utilization-of-internet-things-iot-

for-implementing-teaching-and-learning-in-technical-colleges-in-enugu-state.
DOI: https://dx.doi.org/10.47772/IJRISS.2023.7901

Özgül, E. & Ocak, M. A. (2023). The effect of internet of things education through distance education on student success and motivation. Journal of Educational Technology & Online Learning, 6(2), 403-420.

Ullah, M., Amin, S. U., Munsif, M., Yamin, M. M., Safaev, U., Khan, H., ... & Ullah, H. (2022). Serious games in science education: a systematic literature. *Virtual Reality & Intelligent Hardware*, *4*(3), 189-209.

Wang and Degol (2023 Wang, M.-T., and Degol, J. L. (2023). Gender differences in student engagement: The role of classroom environment and teaching styles. *Journal of Educational Psychology, 115*(2), 175–190.

Xie et al. (2023 Xie, H., Li, J., and Zhao, Z. (2023). Leveraging IoT in education: Innovations, benefits, and challenges. *Educational Technology and Society, 26*(1), 18–30.

Yağanoğlu, M., Bozkurt, F., Günay, F. B., et al. (2023). Design and validation of IoT-based smart classroom. *Multimedia Tools and Applications.* https://doi.org/10.1007/s11042-023-15872-2