Effects of Technology-Based Learning Strategy on Senior Secondary School Students' Achievement in Mathematics in Federal Capital Territory Abuja, Nigeria

U. S. Anaduaka[1], I. A. Ojelade[2], S. U. Nwafor[3*]

[1,2,3]Department of Science and Environmental Education, Faculty of Education, University of Abuja, Abuja Nigeria

Corresponding Author: S. U. Nwafor

ABSTRACT

This study investigated the effects of technology-based learning strategy on senior secondary school students' achievement in mathematics in the Federal Capital Territory, Abuja, Nigeria. Using a quasi-experimental design, the study employed a pretest-posttest approach with a non-equivalent, non-randomized sample of 83 students divided into experimental and control groups. Data were collected using Mathematics Achievement Test (MAT). The instrument was validated by experts and subjected to reliability test which yielded 0.83 using Kuder-Richardson formula 20. Data collected were analysed using mean and standard deviation to answer the research questions while ANCOVA was used to test the null hypotheses at 0.05 level of significance. The results showed that technology-based learning significantly improved students' achievement in mathematics. Additionally, the study found no significant gender differences in students' achievement when using technology-based learning strategy. These findings suggest that technology-based learning strategy is a viable and effective teaching method that can be used without gender bias. Therefore, the study recommended among others, that teachers should be encouraged to adopt technology-based learning strategy in classroom instruction and that school administrators and curriculum planners should integrate technology-based instructional tools into Mathematics curricula, since their use has been found to significantly enhance students' academic achievement in Mathematics.

Key words: Technology-Based Learning Strategy, Students' Achievement, Mathematics

INTRODUCTION

Mathematics is widely recognized as a fundamental discipline for scientific, technological, and economic development. It provides learners with logical reasoning, problem-solving skills, and analytical competencies required for success in contemporary society. Consequently, improving the quality of mathematics instruction remains a major concern for educators and policymakers worldwide. Effective teaching depends not only on teachers' subject matter knowledge and pedagogical competence but also on the availability and appropriate use of instructional resources that facilitate meaningful learning. As educational systems continue to embrace digital transformation, technology has become an indispensable tool for improving classroom instruction and students' learning experiences.

Technology in education refers to the application of digital tools, devices and electronic resources to facilitate teaching, learning, assessment, and classroom management. These technologies include computers, mobile devices, internet facilities, interactive whiteboards, simulations, educational software, learning management systems, multimedia resources, and virtual learning environments. EL-Sofany and EL-Haggar (2020) observed that mobile technologies enhance learners' communication, collaboration, critical thinking, and engagement during instruction. Similarly, Ratheeswari (2018) reported that the integration of information and communication technology (ICT) into teaching significantly improves instructional delivery by promoting interactive and learner-centred pedagogies.

Technology-based learning encompasses the use of electronic technologies to support instructional activities and facilitate students' acquisition of knowledge and skills. According to Hosseini (2016), teachers employ

technology for instructional planning, classroom delivery, administrative responsibilities, assessment, and students' independent learning. Likewise, Morosan et al. (2017) described technology-based learning as the use of computers and related digital applications, including simulations, databases, programming, multimedia presentations, and word-processing applications, either as teacher-supported instructional tools or as independent learning resources. In mathematics education, technology enables teachers to present abstract concepts visually, design authentic problem-solving activities, provide immediate feedback, and create interactive learning environments that promote conceptual understanding.

A growing body of empirical evidence indicates that technology-enhanced instructional strategies significantly improve students' learning outcomes in mathematics. Eryigit and Kılıç (2022) reported that students achieved better learning outcomes when technology was integrated into mathematics instruction. Similarly, Anaduaka et al. (2025) found that students taught using Multimedia Technology Instruction significantly outperformed those taught through the conventional teaching method. Likewise, Ejiofor-Chima and Fekumo (2025) revealed that the flipped classroom instructional strategy significantly enhanced students' mathematics achievement compared with the conventional lecture approach. These findings suggest that technology-based instructional strategies provide opportunities for more engaging, interactive, and effective mathematics learning.

Academic achievement represents the extent to which learners attain intended educational objectives following instruction. Moore (2019) defined academic achievement as learners' performance in formal assessments and examinations, while Atchia and Chinapah (2023) identified self-motivation, time management, learning engagement, behaviour and positive attitudes as important determinants of academic success. Despite continuous educational reforms and curriculum innovations, students' achievement in mathematics in Nigerian secondary schools remains a major concern. According to the West African Examinations Council (WAEC, 2024), between 2009 and 2023, approximately 12,032,404 candidates obtained credit passes (A1–C6) in Mathematics, while 11,315,282 candidates scored below the credit level (D7–F9), representing average success and failure rates of 51.2% and 48.8%, respectively. These statistics indicate that nearly half of the candidates continue to perform below the expected proficiency level, highlighting the need for more effective instructional approaches capable of improving mathematics achievement.

One plausible explanation for this persistent underachievement is the limited integration of educational technologies into classroom instruction. Although technology-based learning has gained considerable attention globally, many Nigerian secondary schools still experience inadequate technological infrastructure, including insufficient digital devices, unreliable internet connectivity, poorly equipped classrooms and limited access to mathematics laboratories. In addition, many teachers have limited opportunities for continuous professional development in technology integration, thereby restricting the effective implementation of innovative instructional practices. These constraints often result in continued reliance on conventional teacher-centred approaches that may not adequately address the learning needs of contemporary digital learners.

Gender differences in mathematics achievement have also remained an important issue in mathematics education research. Rodriguez et al. (2020) attributed gender disparities in mathematics to factors such as low self-confidence among female students, cultural stereotypes, unequal classroom interactions, and the persistent use of traditional teaching methods. Kaiser and Zhu (2022) similarly argued that classroom interactions and societal expectations sometimes favour male learning patterns, potentially contributing to higher mathematics achievement among boys in certain educational contexts. Empirical findings, however, remain inconsistent. Wahab (2025) reported significant gender differences favouring male students following multimedia technology instruction, whereas Okwuoza and Olajumoke (2023) found that Computer-Assisted Instruction improved students' understanding of mathematics irrespective of gender. Likewise, Okpanachi et al. (2025) reported no significant gender difference in students' academic performance under multimedia instructional strategies. These divergent findings suggest that the moderating role of gender in technology-supported mathematics instruction requires further empirical investigation.

Although previous studies have demonstrated the effectiveness of various technology-supported instructional approaches, relatively few have specifically examined the effectiveness of technology-based learning on senior secondary school students' mathematics achievement within public secondary schools in the Federal Capital Territory (FCT), Abuja. Furthermore, evidence regarding whether technology-based learning benefits male and

female students equally remains inconclusive. Addressing these gaps is important for informing instructional practice and educational policy aimed at improving mathematics learning outcomes.

Therefore, this study investigated the effect of technology-based learning on senior secondary school students' achievement in Mathematics in the Federal Capital Territory, Abuja, Nigeria. Specifically, the study examined whether students taught using technology-based learning achieve significantly better than those taught using the conventional teaching method and determined whether the instructional strategy produces differential achievement outcomes based on gender.

Research Questions

The following research questions were raised to guide this study:

1. What is the difference in the mean achievement scores of students taught Mathematics using technology-based learning and those taught using conventional approach?
2. What is the difference in the mean achievement scores of male and female students taught Mathematics using technology-based learning in Senior Secondary Schools, FCT, Abuja?

Hypotheses

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

H_{o1}: There is no significant difference in the mean achievement scores of students taught Mathematics using technology-based learning and those taught with conventional method.

H_{o2}: There is no significant difference in the mean achievement scores of male and female students taught Mathematics using technology-based learning in Senior Secondary Schools, FCT, Abuja.

METHODOLOGY

This study adopted a quasi-experimental, non-randomized pretest-posttest control group design. The target population comprised 9,885 Senior Secondary School II (SS II) Mathematics students in public secondary schools in Bwari Area Council, Federal Capital Territory (FCT), Abuja. A sample of 83 SS II students drawn from two co-educational public secondary schools participated in the study. The schools were selected through purposive sampling based on the following criteria: availability of SS II Mathematics students, employment of qualified Mathematics teachers with at least a B.Sc. (Ed.) in Mathematics, and the availability of a functional computer laboratory equipped with relevant technological facilities, including laptops, internet connectivity, projectors, digital whiteboards, and related instructional devices. Two schools that satisfied these criteria were randomly selected from the thirteen eligible schools in the Area Council and assigned to either the experimental or control group through balloting. The experimental group comprised 39 students, while the control group consisted of 44 students.

Data were collected using the Mathematics Achievement Test (MAT). The instrument was developed based on a table of specifications to ensure adequate coverage of the instructional content and cognitive objectives. Face and content validity were established by the researchers' supervisors and two experts in Mathematics Education from the Department of Science and Environmental Education, University of Abuja. The reliability of the instrument was determined through a pilot study involving 25 SS II students from a school outside the study sample, using the Kuder–Richardson Formula 20 (KR-20), which yielded a reliability coefficient of 0.83, indicating that the instrument was sufficiently reliable for the study.

The experimental group was taught Mathematics using the Technology-Based Instructional Strategy, whereas the control group received instruction through the conventional teaching method. Data collected were analyzed using descriptive and inferential statistics. Mean and standard deviation were used to answer the research questions, while Analysis of Covariance (ANCOVA) was employed to test the hypotheses at the 0.05 level of significance.

RESULTS

Research Question 1: What is the difference in the mean achievement scores of students taught Mathematics using technology-based learning and those taught using conventional approach?

Table 1: Achievement Scores of Students taught Mathematics in Control and Experimental Group

Group	N	Pretest		Mean Diff.	Posttest		Mean Diff.
		Mean	SD		Mean	SD	
Experimental	39	17.41	3.7	—	29.36	5.01	—
Control	44	16.25	5.75	1.16	18.89	5.72	10.47

Table 1 shows the mean and standard deviation of Achievement Scores of Students taught Mathematics using Technology-Based Learning and those taught with conventional approach in Pre-test before the treatment and post-test after the treatment. From the results obtained, the technology-based learning group consisted of 39 students and conventional method group consisted of 44 students had 17.41 and 16.25 achievement mean score in their pre-test respectively. After the treatment, experimental group came up to a mean achievement score of 29.36 and a standard deviation of 5.01 while the control group came up to a mean achievement score of 18.89 and a standard deviation of 5.72. The mean difference in achievement scores between the two groups was 10.47 in favour of the experimental group.

Research Question 2: What is the difference in the mean achievement scores of male and female students taught Mathematics using technology-based learning in Senior Secondary Schools, FCT, Abuja?

Table 2: Achievement Scores of Male and Female Students taught Mathematics using Technology-Based Learning

Group	N	Pretest		Mean Diff.	Posttest		Mean Diff.
		Mean	SD		Mean	SD	
Male	21	18.33	3.45	2	29.33	3.92	0.06
Female	18	16.33	3.79	—	29.39	6.18	—

Table 2 shows the achievement scores of male and female students taught mathematics using technology-based learning. The male and female students had a mean achievement score of 18.33 and 16.33 respectively at their pre-test. After the treatment, the result revealed that the male students increased in mean achievement score to 29.33 and a standard deviation of 3.92 while the female students increased in mean achievement score to 29.39 and a standard deviation of 6.18. The mean difference in achievement scores between male and female students was 0.06 at their post-test slightly in favour of female students.

Test of Hypotheses

Ho_1: There is no significant difference in the mean achievement scores of students taught mathematics using technology-based leaning and those taught mathematics with conventional approach.

Table 3: ANCOVA Results of Mean Achievement Scores of Students Taught Mathematics Using Technology-Based Learning and those Taught Mathematics with Conventional Approach

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.@0.05
Corrected Model	3559.929[a]	4	889.982	64.939	0
Intercept	626.951	1	626.951	45.746	0
MATpre	1289.23	1	1289.23	94.07	0
TM	1800.93	1	1800.93	131.407	0

Gender1	0.384	1	0.384	0.028	0.867
TM * Gender	49.087	1	49.087	3.582	0.062
Error	1068.99	78	13.705		
Total	51672	83			
Corrected Total	4628.92	82			

a. R Squared = .769 (Adjusted R Squared = .757)

Table 3 shows the ANCOVA result of mean achievement scores of students taught mathematics using technology-based learning and those taught mathematics with conventional approach. From the result, there is a significant difference in the mean achievement scores of students taught mathematics using technology-based learning and those taught mathematics with conventional approach at 0.05 level of significance $F_{(1, 82)} = 1800.929$, and $p = 0.00$ which is less than 0.05 level of significance; therefore, hypothesis two is not accepted, as it can be concluded that the method of teaching had a significant impact on the mean achievement scores of students.

Ho_2: There is no significant difference in the mean achievement scores of male and female students taught mathematics using technology-based learning.

Table 4: ANCOVA Results of Mean Achievement Scores of Male and Female Students taught Mathematics using Technology-Based Learning

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.@0.05
Corrected Model	244.252[a]	2	122.126	6.186	0.005
Intercept	447.459	1	447.459	22.665	0
TBLpre	244.222	1	244.222	12.37	0.001
Gender2	19.604	1	19.604	0.993	0.326
Error	710.723	36	19.742		
Total	34571	39			
Corrected Total	954.974	38			
Corrected Model	244.252[a]	2	122.126	6.186	0.005
Intercept	447.459	1	447.459	22.665	0

a. R Squared = .769 (Adjusted R Squared = .757)

Table 4 reveals the effect of gender on mean achievement scores of students in experimental group. However, the result shows that there is no significant difference in the mean achievement scores of male and female students $F_{(1, 36)} = 0.993$, and $p = 0.326$ which is greater than 0.05 level of significance; therefore, hypothesis four which stated that gender has no significant difference in the mean achievement scores is accepted, indicating that gender does not have a significant effect on the mean achievement scores of the students taught mathematics using technology-based learning.

DISCUSSION OF FINDINGS

The finding that students exposed to technology-based learning strategies achieved higher mean achievement scores than those taught using the conventional approach further confirms the instructional effectiveness of technology integration in Mathematics teaching. The statistically significant difference in achievement in favour of the experimental group implies that technology-based strategies enhance conceptual understanding, problem-solving skills, and retention of mathematical knowledge. Digital

learning environments often provide immediate feedback, opportunities for self-paced learning, and multiple representations of concepts, which support deeper cognitive processing. This result supports the view that technology serves not only as a motivational tool but also as a powerful instructional medium capable of improving students' academic performance in Mathematics. This finding is consistent with **Anaduaka et al. (2025)**, who reported that students exposed to Multimedia Technology Instruction achieved significantly higher mathematics achievement scores than their counterparts taught using the conventional teaching method. The study concluded that integrating multimedia technology into Mathematics instruction enhances students' understanding of mathematical concepts and improves their academic achievement. The finding also concurs with Okpanachi et al. (2025), who found that students exposed to multimedia instructional strategy performed significantly better in Mathematics than their counterparts taught using the conventional lecture method. The study concluded that integrating multimedia technologies into Mathematics instruction enhances students' understanding of mathematical concepts and improves their academic achievement.

The finding that there was no significant difference in the mean achievement scores of male and female students taught Mathematics using technology-based learning strategies implies that the approach was equally effective for both genders. This indicates that technology-based learning supports equitable academic outcomes by accommodating diverse learning styles and abilities without favouring one gender over the other. The result suggests that when appropriate technological tools are effectively integrated into Mathematics instruction, students' achievement is more strongly influenced by the quality of instruction and learning experiences than by gender differences. This finding reinforces the potential of technology-based learning as an inclusive strategy for improving Mathematics achievement among all students. The result is in line with Okwuoza and Olajumoke (2023) who found that Computer-Assisted Instruction improved students' understanding of mathematics irrespective of gender. **The finding disagree with that of Wahab (2025) who** reported significant gender differences favouring male students following multimedia technology instruction**.**

CONCLUSION

Students learn better when technological aids are used in teaching Mathematics, hence achieve more academically, this improves their attitude in the learning of mathematics, especially at the senior secondary school level. However there is no significant difference in the achievement and attitude of male and female students exposed to technology-based learning, this suggests that technology-based learning is beneficial to both genders, this is because in the cause of the lesson more than two senses of the students were appealed to, which makes it possible for both male and female students to learn.

RECOMMENDATIONS

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

1. School administrators and curriculum planners should integrate technology-based instructional tools into Mathematics curricula, since their use has been shown to significantly enhance students' academic achievement and overall learning outcomes in Mathematics.
2. Educational stakeholders should ensure equal access to technological resources for all students, regardless of gender, because technology-based learning strategies have been found to improve Mathematics achievement uniformly among male and female learners.

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