



Effects of Computer-Assisted Instruction on the Academic Performance in Trigonometry among Male and Female Senior Secondary School Students in Kogi State, Nigeria

Dharriyat Salami^{1*}, Yusuf Feyisara Zakariya², Mamman Musa², and Yahaya Korau Kajuru²

¹Science Education Department, Confluence University of Science and Technology, Osara, Kogi State, Nigeria

²Department of Science Education, Ahmadu Bello University, Zaria, Kaduna State, Nigeria

*Corresponding author: rockschamber@gmail.com

Abstract

This study explored the effects of computer-assisted instruction on the academic performance in trigonometry among male and female senior secondary school students in Kogi State, Nigeria. The study was guided by two research objectives, two research questions, and two null hypotheses tested at $\alpha=.05$ level of significance. The researcher employed a pretest and posttest quasi-experimental design. The population of this study comprised 410 male students and 346 female students with a total of 744 SSSII students of coeducational government-owned schools in Kogi State, Nigeria. The sample size for this study was selected through a non-probability purposive sampling technique involving two groups, which were an experimental group (32 students) and a control group (35 students), with a total of 67 students sampled. This study used the Trigonometry Performance Test (TPT) instrument, which was validated, and the reliability of the instrument was determined using a test retest and the reliability coefficient was calculated using Pearson Product Moment Correlation to be 0.74. Descriptive mean and standard deviations were used to answer the research questions, and inferential statistics in the form of an independent t-test were used to test the null hypotheses. The result showed significant difference does not exist in the performance scores of male students (Mean = 22.33, SD = 3.79) and female students (Mean = 24.76, SD = 3.58) with $t(30) = -1.865, p = .072$ in the exp group. The results showed a significant difference in students' performance in the exp group (Mean = 23.56, SD = 3.78) and those in the control group (Mean = 19.45, SD = 4.31) with $t(65) = 4.13, p < .001$. It is recommended based on this finding that there should be equal access to CAI by both male and female students.

Keywords: computer-assisted instruction, male, female, trigonometry, and performance.

1 Introduction

Technology-mediated learning can come in the form of computer-assisted instruction, the integration of computer-based instructions in the teaching-learning process has been adopted through the use of computers and other technological gadgets for curriculum content delivery (Ayuba & Timayi, 2018; Salami & Umar, 2024). Computer-assisted instruction (CAI) is another type of e-learning that uses computers (Salami & Umar). This could mean interactive software for the students or the kind of training software used by Patrick Suppes of Stanford University in 1966. Computer-assisted instruction uses a combination of multimedia such as text, graphics, sound, and video to enhance learning (Sharma, 2017). The primary value of CAI is interactivity – it allows students to become active learners instead of passive learners by utilizing various methods such as quizzes and other computer-assisted teaching and testing mechanisms (Salami & Umar, 2024). The potential benefits of Computer-Assisted Instruction (CAI) cannot be underestimated in the contemporary world since there are established findings on the instructional value of computers, particularly in advanced countries (Salami & Umar, 2024).

There is an urgent need for a paradigm shift in the methods by which the contents of mathematics are passed on to the students, especially in twenty-first-century classrooms. The use of technology, especially Multimedia projection in teaching, can be a solution to the performance of students (Yang & Kwon, 2024). The use of technology instructions has been effective in teaching all domains of subjects and improved students' performance towards learning more than the traditional method of teaching (Kairouz et al, 2021). Computer games (AutoThinking) improve students' learning performance in computational thinking better than the conventional approach. Digital didactic games are promising tools to aid the teaching and learning process, as they bring the previously abstract content closer to the student's reality (Vieira & Santos, 2023). The use of multimedia projection, a subset of Information and Communication Technology (ICT), can

enhance teaching and learning. Thus, every teacher must be ICT literate in all ramifications (Azare, 2019). Trigonometry involves abstract concepts such as trigonometry ratios, angles among others which could be difficult for students to understand when presented through verbal explanations and static diagrams only, and computer instruction can also increase students' performance as it has shown high positive effects on the performance of students (Salami & Umar, 2024), hence the need for effects of computer-assisted instruction on academic performance in trigonometry among male and female students in Kogi State, Nigeria.

In addition to the computer-assisted instruction, the academic performance of students in mathematics is an important variable that needs to be addressed. Science educators have given various definitions of academic performance; performance simply means the use of scientific knowledge acquired by an individual to solve a problem confronting him in society (Musa, 2020). Putz et al (2020), the steady increase in students' learning performance resulting from the constant refinement of workshops demonstrates the usefulness of incorporating gamification principles into educational activities. The use of computer systems, especially Multimedia projection in teaching, can be a solution to the academic performance of students in mathematics.

This study therefore highlights the following two research objectives:

1. To compare the performance of male and female senior secondary school students taught trigonometry using computer-assisted instruction.
2. To compare the performance of senior secondary school students taught trigonometry using computer-assisted instruction and those taught using the conventional teaching method.

The following two research questions were also raised:

1. What is the difference between the mean performance scores of male and female students taught trigonometry using computer-assisted instruction?
2. What is the difference between the mean performance scores of students taught trigonometry using computer-assisted instruction and those taught using the conventional teaching method?

2 Literature Review/Theoretical Framework

This study is anchored in the Cognitive Theory of Multimedia Learning (CTML), which evolved over the past 40 years by Richard Mayer. The name and graphical representation shifted from "dual-coding model" to "generative theory" and finally to CTML, focusing on dual channels, limited capacity, and active processing (Mayer, 2024). According to Mayer (2024), the core ideas and multimedia design principles are: Core Ideas: Dual channels (Separate channels process visual/pictorial and auditory/verbal information), Limited capacity (Working memory can only process small amounts of information), and Active processing (Learning requires selecting, organizing, and integrating information). Design Principles: CTML supports 15 multimedia design principles to minimize extraneous processing, manage essential processing, and foster generative processing, such as the coherence principle (excluding irrelevant information), modality principle (use audio narration with visuals instead of on-screen text), and segmenting principle: break content into smaller, manageable parts (Mayer, 2024). Mayer's CTML has been applied broadly in computer instruction, simulations, and virtual learning environments. In mathematics education, multimedia learning supports the modality principle and the segmenting principle, which improve comprehension by reducing cognitive load and breaking complex processes into manageable steps. Principles like multimedia (words + visuals) and temporal contiguity (simultaneous presentation) directly enhance performance in mathematics by fostering deeper understanding. This theory has been successfully utilized by Salami and Umar (2024), Ejimonye et al. (2020), Hamzat et al. (2017), and Edo (2017) to carry out similar studies.

Smith and Doe (2018) investigated computer-based learning in secondary mathematics: A meta-analysis. The study involved quasi experimental, investigating performance and retention for six weeks in secondary school trigonometry. 60 SSII students from two comparable classes were assigned to either CBI ($n = 30$) or CTI ($n = 30$). ANCOVA was used to examine post-instruction performance. Retention was measured by a follow-up test. Results indicated no statistically significant difference between CBI and CTI on posttest performance after adjusting for pretest scores, $F(1,57) = 0.65$, $P = .423$, $n^2 = .011$. Retention scores also did not differ significantly, $t(58) = -0.74$, $p = .463$, Cohen's $d = 0.19$. This study is similar to the present study in the area of independent variables such as computer instruction and conventional method, and in the aspect of performance.

This study by Usman and Jilang (2018) investigated the Effects of Computer-assisted Instruction, (CAI) on Students' performance and interest in Secondary School Physics in Jos North Local Government Area, Plateau State. This study was motivated by the prevalence of poor students' performance in physics, which was due to defective methods of teaching used by teachers. The design used in this study was quasi-experimental. Specifically, the pretest-posttest control group design. The sample of the study comprised eighty-five (85) SS2 physics students in Jos North local government area of Plateau State, Nigeria. Three research questions and four hypotheses were formulated to guide the study. Two instruments, namely the Physics Performance Test (PPT) and the Physics Interest Questionnaire (PIQ), were used to collect data for the study. The PPT consisted of 40 items, which were developed based on the concept of units and measurements, motion, vectors, projectiles, and simple harmonic motion, while the PIQ consisted of 16 items. The two instruments were validated, and the reliability coefficients of the two instruments, PPT and PIQ, were computed, and the indices stood at 0.85 and 0.88, respectively. Data collected for the study were analyzed with the use of simple percentages, t-tests, and analysis of variance (ANOVA) using SPSS version 22. The findings of the study revealed that the use of CAI helped in enhancing students' performance in physics and helped in improving students' interest in physics. This study was carried out in Jos, Plateau State, while the present study was in Okene, Kogi State. This study was carried out in Physics while the present was in the mathematics concept (Trigonometry). This study used t-test and ANOVA only, while the present study used an independent t-test. This study did not compare gender, but the present study was able to show performance among males and females when exposed to computer-assisted instructions.

Salami and Umar (2024) investigated the effect of computer instructions on the attitude and academic performance of students in trigonometry among senior secondary schools in Okene. The study was guided by two research questions and null hypotheses at a 0.05 level of significance. The population of the study comprised 962 Senior Secondary School II students, of which 67 subjects were sampled for the study. The researcher employed a pretest and posttest quasi-experimental design. A mean and standard deviation were used to answer the responses to the research questions, and the Mann-Whitney U test and t-test were used to test the null hypotheses at a 0.05 level of significance. The results showed a significant difference exists in the performance of students taught trigonometry using computer instruction and those taught using the conventional method in favour of the former students but failed to show the performance scores of male and female students when exposed to computer-assisted instruction. Salami and Umar (2025) investigated the effect of learning strategy through the use of instruction technology interactive animation media in mathematics among senior secondary school students in Lokoja, Nigeria. The study was guided by two research questions and null hypotheses tested at $\alpha=0.05$ level of significance. The researcher employed a pretest and posttest control quasi-experimental design. The population of the study comprised 710 male students and 446 female students with a total of 1156 senior secondary school students in Lokoja, Nigeria. The sample size for this study was selected through a non-probability purposive sampling technique involving 87 students sampled. The study used Mathematics Performance Test (MPT). Descriptive mean and standard deviations were used to answer the research questions, and inferential statistics in the form of independent t-test was used to test the null hypotheses. The results showed a significant difference exists on students' performance when exposed to IAM and control method. The results showed that the use of IAM is gender friendly.

3 Materials and Methods

The quasi-experimental research design was adopted for this study. This involved pretest and post-test been administered to both experimental and control groups. Two groups were involved, which were one experimental (Computer-Assisted Instruction) and one control group (Conventional Method). Each group was pre-tested to ascertain their level of knowledge. After the pretest, the experimental group (Computer-Assisted Instruction) received experimental treatments for six weeks while the control group (Conventional Method) received no treatment for six weeks. After that, both groups were subjected to a post-test to measure their performance in week seven.

The population of the study was 400 male students and 344 female students with a total of seven hundred and forty-four (744) Senior Secondary School II (SSS 2) students drawn from ten (10) coeducational government-owned public schools in Okene. The coeducational government-owned schools were chosen because of the gender variable captured in the research. A purposive non-probability sampling technique was used to select the two schools for this study. Computer-assisted instruction was purposively assigned the experimental group, which consisted of 32 students of an intact class, and the control group (conventional method) was assigned purposively, which consisted of 35 students of an intact class also. The sample size for this study was a total of 67 subjects. Trigonometry Performance Test (TPT) was used as an instrument for this study which consisted of 40 items drawn from past senior secondary school examinations and was validated by three senior lecturers from the department of Science Education and two senior lecturers from department of Psychology

Education, their suggestions and recommendations were duly carried out. Test-retest method was used to determine the reliability and Pearson Product Moment Correlation was used to calculate the reliability coefficient of 0.74 which is considered to have acceptable level of internal consistency and is therefore considered reliable for the study. The instrument, TPT was used to collect the pre-test and post test data and independent t-test was used to analyze the data after testing for normality and the data were normally distributed.

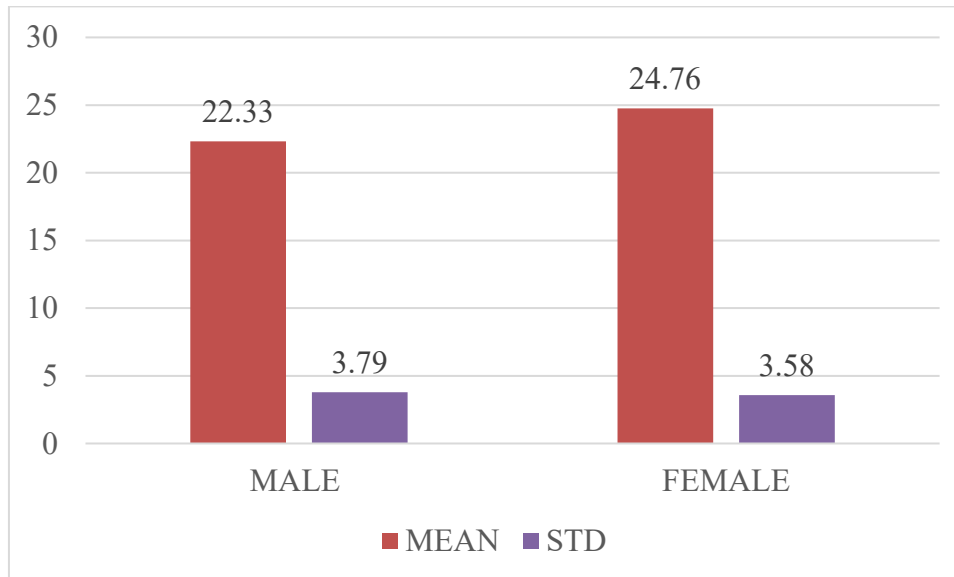
4 Results

Question One: What is the difference between the mean performance scores of male and female students taught trigonometry using computer-assisted instruction?

I analyzed the pre-test and post-test data on male and female senior secondary school students' performance in trigonometry for the experimental group. The descriptive statistics in the form of means and standard deviations for both male and female groups are presented in Figure1.

Figure 1

Summary Statistics: Performance of Males and Females in Exp Group



Hypothesis One: There is no significant difference in the mean performance scores of male and female senior secondary school students taught trigonometry using computer-assisted instruction.

To answer this research hypothesis, the pre-test and post-test data on male and female senior secondary school students' mean performance in trigonometry for the experimental group (computer-assisted instruction) were analyzed. The inferential statistics in the form of independent t-tests for both male and female groups are presented in Table1. Independent t-test was used for the null hypothesis because the data were tested for normality and were normally distributed with Kolmogorov-Smirnov $Z = 1.07$ and $p = .20$, the data were continuous, and the groups were not related.

Table 1

Summary Statistics of Post-test Performance of Male and Female Students in Exp Group

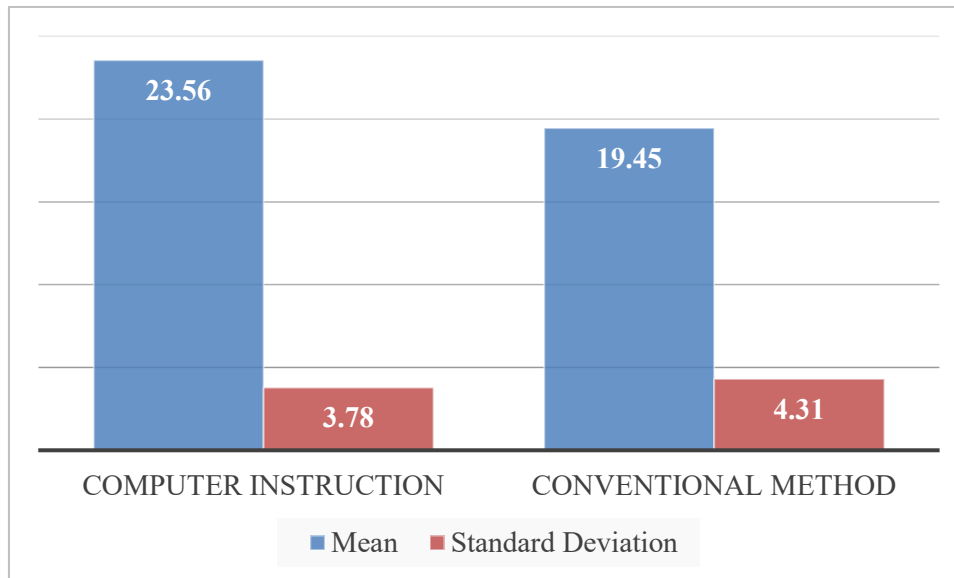
Variable	N	Mean	Std	Df	t-value	p-value	Remark
Male	15	22.333	3.792	30	-1.865	.072	Not rejected
Female	17	24.765	3.580				

Question Two: What is the effect of computer-assisted instruction and conventional methods on the academic performance of students in trigonometry?

The post-test data on students' performance in trigonometry for the experimental group (computer-assisted instruction) and the control group (the conventional method) was analyzed. The descriptive statistics in the form of means and standard deviations for both groups are presented in Figure 2

Figure 2

Summary statistics of post-test Performance in the Exp and Control Groups



Hypothesis Two: There is no significant difference in the mean performance scores of students taught trigonometry with the use of computer-assisted instruction and the conventional method.

The post-test data on students' performance in trigonometry for the experimental group (computer-assisted instruction) and the control group (the conventional method) was analyzed. The inferential statistics in the form of t-tests for both groups are presented in Table 2. In this hypothesis, t-test statistics was used because the researcher found that the data were normally distributed with the use of Kolmogorov-Smirnov Z of 1.072 and 0.574 for the experimental group (computer-assisted instruction) and the control group (the conventional method), respectively, and $p = .20$ and $.897$, respectively. The data were continuous, and the groups were not related.

Table 2

Summary Statistics of Post-test Performance in the Exp and Control Groups

Variables	Study groups	N	Mean	STD	Mean difference	df	t-value	p-value	Remark
Mean Performance	Exp	32	23.56	3.783	4.105	65	4.128	<.001	Rejected
	Control	35	19.45	4.306					

5 Discussion

The results of the findings revealed that the performance differences in gender within the group are almost the same. That is, both male and female students taught trigonometry using computer-assisted instructions performance were almost at the same level. The result is supported by the previous work of Salami and Umar (2025) on learning strategy through the use of instruction technology interactive animation media (IAM) in mathematics among senior secondary school students in Lokoja, Nigeria, which shows that there was no significant difference in the post-test performance scores of male and female students taught using the IAM package.

The results of the findings show that the performance of students exposed to computer-assisted instruction is higher than that of their counterparts in the conventional method. This result is supported by the work of Salami and Umar (2024) who investigated the effect of computer instructions on the attitude, and academic performance of students in trigonometry among senior secondary schools in Okene, but contrary to this findings is the work of Smith and Doe (2018), who investigated computer-based learning in secondary mathematics: A meta-analysis and found that computer-based instruction did not produce superior performance in trigonometry as compared with a well-delivered conventional method. It is inline with the findings of this study that computer-assisted instructions should be used in teaching trigonometry in secondary schools and future research involving the use of computer-assisted instruction could be carried out in other levels of education such as primary and tertiary schools in Nigeria.

6 Conclusion

From the discussion of this study, it is therefore concluded that gender status has no significant effect on the performance ability of male and female students taught with computer-assisted instruction. Computer-assisted instructions have a highly positive effect on the academic performance of students in trigonometry. The following recommendations were made based on the findings of this study:

1. Teachers and school administrators should ensure equal access to computer facilities and learning opportunities for both male and female.
2. The use of CAI should be encouraged in secondary schools as it has shown to have high positive result in terms of academic performance.

7 Declarations

Ethical statements: Introductory letter from the department of science education was obtained and presented to the zonal educational office, and secondary schools involved in this study, and a verbal consent to proceed with the research was given by the zonal director and the school principals.

Conflict of Interest: *There was no financial or non-financial conflict of interest.*

Author Contributions: At the time of this research, the first author, Dr. Dharriyat conceptualized the study, conducted the literature review, collected and analyzed the data, interpreted the findings and prepared the manuscript as part of a postgraduate thesis. Prof. Yayaha, Prof. Musa, and Dr. Yusuf supervised the research, and provided guidance on the study.

Acknowledgments: This is to acknowledge the supervisory support of Dr. Yusuf F. Z., Prof. Kajuru Y. K., and Prof. Mamman Musa.

Data Availability Statement: The data used for this study is available and can be accessed on request from the first author, Dr. Dharriyat Salami.

8 Reference

- Azare, G. D. (2019). *Information and Communication Technology*. Foreword for SDGs Workshop, Kaduna: NTI.
- Edo, E. E. (2017). Impact of computer animation learning on students' academic performance in Akwa Ibom College of Education, AFAHA, NSIT. *Multidisciplinary Journal of Research Development*, 2(26), 1596-1743.
- Ejimonye, J.C., Onuoha, J.C., Ugwuanyi, C.S., Eneogu, N.D., Ugwuanyi, B.E & Ogbuehu, S.N (2020). Effectiveness of two-dimensional animation technique in enhancing students' motivation in quantitative economics concepts. *International Journal of Future Generation Communication and Networking (IJFGCN)*, 13(1),27-38.
- Hamzat, A., Bello, G., & Abimbola, I.O. (2017). Effects of computer animation instructional package on students' performance in practical biology. *Cypriot Journal of Educational Sciences*, 4(12), 218 -227.
- Kairouz, P. McMahan, B. H., Aurelien, B. V., Mehdi, B. & Ariun, B. (2021). Advances and open problems in federated learning. *Foundations and Trends in Machine Learning*, 14(1), 1-210

- Mayer, R. E. (2024). The past, present, and future of the cognitive theory of multimedia learning. *Educational Psychology Review*, 36(8), 1-25
- Musa, M. (2020). Academic self-efficacy and academic performance among university undergraduate students: An antecedent to academic success. *European Journal of Education Studies*, 34(2), 782-834
- Putz, L. M., Hofbauer, F. & Treiblmaier, H. (2020). Can gamification help to improve education? Findings from a longitudinal study. *Computer in Human Behavior*, 110, 106392
- Salami, D., & Umar, S. (2024). Effect of computer instructions on academic performance and attitude among senior secondary schools in Okene, Kogi State. *Custech International Journal of Education*, 1(1), 368-383
- Salami, D., & Umar, S. (2025). Learning Strategy through the use of instruction technology interactive animation media (IAM) in mathematics among senior secondary school students in Lokoja, Nigeria. *Edited Conference Proceedings of the 1st International Conference of the Faculty of Science and Technology Education, Custech Osara*, 4(1), 145-154
- Smith, J., & Doe, A. (2018). Investigated computer-based learning in secondary mathematics: A meta-analysis. *Journal of Mathematics Education*, 11(2), 45-67.
- Usman, I.S., & Jilang, W.W. (2018). Effects of computer-assisted instruction on students' performance and interest in secondary school physics in Jos North Local Government Area of Plateau, Nigeria. *KIU Journal of Social Sciences*, 4(1), 105-114
- Vieira, B. R. & Santos, C. Q. (2023). Learning through play: design and creation of a narrative game-based learning experience. *Proceedings of the XXII Brazilian Symposium on Human Factors in Counting Systems*, 1-11
- Yang, S. & Kwon, K. (2024). How are pre-service teachers' technology integration beliefs revealed across different majors through their eportfolio? *Society for Information Technology and Teacher Education International Conference*, 283-287

Publisher's Note

The views, interpretations, and conclusions expressed in this article are solely those of the author(s) and do not necessarily reflect the views or policies of the Journal of Studies in Science and Mathematics Education (JOSSME), its publisher, editorial board, editors, reviewers, or the authors' affiliated institutions. The publisher remains neutral with respect to jurisdictional claims in published maps, institutional affiliations, and other representations. Any products, materials, methods, or manufacturers mentioned or evaluated in this article are presented solely for scholarly purposes and do not constitute endorsement, recommendation, or guarantee by the publisher.