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Computer assisted instructions and students' academic achievement in senior secondary school chemistry in Calabar Municipality, Nigeria

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Abstract
This study investigated computer-assisted instruction and students' academic achievement in senior secondary school chemistry in Calabar Municipality, Nigeria. The study adopted a non-randomized quasi experimental research design. The population comprised all senior secondary school II (SSS2) chemistry students, totalling 900. A sample of 80 chemistry students were randomly drawn from two schools. One research instrument was used. It was the Chemistry Achievement Test (CAT). The instrument was validated and found to be reliable, with a reliability coefficient of 0.8 using Kuder Richardson formula 20. Two hypotheses were formulated and tested at 0.05 level of significance using analysis of covariance (ANCOVA) as statistical tool. The findings revealed that computer assisted instruction was significant, while gender influence was not significant. This implies that computer-assisted instruction (CAI) had an effect on the academic achievement of SS2 Chemistry students, whereas gender does not influence the academic achievement when taught using computer assisted instruction. Based on the findings, it was recommended that students should be encouraged to own computers, preferably laptops, to enhance their academic performance through individual study.
Keywords: computer, assisted instructions, academic achievement, chemistry, students

Introduction
Education in the senior secondary school in Nigeria has grouped students into the arts and science classes. The science class is made up of students who are interested in the study of subjects like chemistry, biology and physics. Chemistry is the scientific study of matter,

its properties, composition, structure, and the changes it undergoes during chemical reactions (Idiege et al., 2021).

It is often called the central science because it bridges other natural sciences like physics, biology, and environmental science. Chemistry plays a crucial role in numerous aspects of human lives, making it highly relevant in various fields. Chemistry is fundamental in medicine and healthcare, particularly in drug discovery, development, and production (Nja et al., 2023).

Nigeria's reliance on industrialized nations for economic stability has prompted a focus on science education. However, challenges such as inadequate funding, poor orientation, and a lack of teaching facilities have led to sub-optimal science education outcomes. These issues result in poor academic performance in science subjects at the secondary school level, emphasizing the need for innovative teaching approaches (Afolabi, 2022).

Computer-Assisted Instruction (CAI) is a method where written and visual information is logically presented to learners through a computer. It incorporates visual elements like pictures and diagrams, along with auditory components, providing a comprehensive learning experience. This study investigates the effect of Computer-Assisted Instruction (CAI) on secondary school students' academic achievements in chemistry, recognizing the importance of innovative approaches to enhance learning outcomes. Edyburn (2024) highlights the role of CAI in providing equitable access to educational materials and removing barriers to learning. With the flexibility of accessing CAI materials anytime and anywhere, students can engage in independent and self-paced learning experiences, accommodating their individual constraints and preferences. However, the effectiveness of CAI in improving students' academic performance is contingent upon various factors, including the quality of instructional design, teacher support, and integration into the curriculum. Muftawu and Benard (2024) reported a significant impact of CAI on students' achievements. The provision of IT to schools and its use for educational purposes can increase students' achievements in at least two ways: the availability of CAI in the classroom shifts the level of educational inputs and could thus affect students' learning outcomes. It increases the vector of school inputs by providing infrastructure to schools (for example, computer laboratories and software) and training to teachers, potentially improving learning outcomes.

Research conducted by Clark and Mayer (2019) suggests that CAI positively influences students' cognitive skills, such as problem-solving, critical thinking, and knowledge

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retention. Moreover, CAI enhances students' engagement by providing a dynamic and interactive learning environment. Studies by Hwang and Wu (2014) have demonstrated that the interactive nature of CAI increases students' motivation and participation in learning activities. Means et al. (2014) found that personalized instruction through CAI resulted in significant improvements in students' academic achievement. By tailoring instructional content to individual student's needs, preferences, and learning styles, CAI promotes deeper engagement and mastery of Chemistry.

Gender-related disparities in academic performance have been a long-standing issue in education systems worldwide. Despite efforts to promote gender equality, discrepancies persist, particularly in STEM (Science, Technology, Engineering, and Mathematics) subjects such as chemistry. Computer-assisted instruction (CAI) has been hailed as a potential solution to enhance learning outcomes. However, its impact on gender-related performance gaps in chemistry among senior secondary school students warrants closer examination (Okereke & Onwukwe, 2011).

In chemistry, girls have often been under-represented and have shown lower performance compared to boys, despite similar levels of ability and interest (Gonzuk & Chargok, 2016). In chemistry education, CAI can supplement traditional instruction by offering visualizations of complex concepts, virtual experiments, and interactive modules, thereby enhancing understanding and engagement (Okereke & Onwukwe, 2011; Nja et al., 2024). While CAI has the potential to mitigate gender-related disparities in academic performance, its effectiveness depends on various factors. Research suggests that girls often benefit more from collaborative learning environments and contextualized instruction, which CAI can facilitate. However, access to technology and digital literacy skills may pose barriers, particularly for students from marginalized backgrounds (Busari et al., 2016). Studies examining the impact of CAI on gender-related disparities in chemistry education have yielded mixed results. Some research indicates that CAI can narrow the gap by providing a supportive learning environment that fosters confidence and participation among girls. Conversely, other studies have found no significant difference in performance between genders, suggesting that CAI alone may not be sufficient to address deep-rooted societal attitudes and systemic biases.

The gender disparity in academic achievement in chemistry and science subjects, as observed by Yang (2014) and Gonzuk and Chargok (2016), persists despite efforts to promote equity. However, it has been shown that ability is not the determining factor in whether or not females participate in science, as argued by Olasehinde and Olatoye

(2014). Instructional context plays a crucial role, as indicated by Erinosho (2018), where girls and boys perform equally well if the context is fair and conducive. Studies have shown conflicting results regarding the factors influencing students' academic achievement. While some studies, such as those by Kissau (2016) and Bosede (2014), suggest that sex and location of school influence achievement, others, like Udousoro (2011) argue that gender does not affect academic performance. CAI has been found to engage learners and motivate them, as indicated by Busari et al. (2016); and it helps overcome low academic self-concept in chemistry, as found by Samuel and Okonkwo (2020). Regarding gender differences in performance, some studies, like those by Igboegwu and Okonkwo (2014), found no significant difference; while others, like Ezeudu and Obi (2015), found significant differences favouring male students.

The theory of constructivism which was propounded by Jean Piaget (1955) states that people construct their own understanding and knowledge of different things through experiencing things and reflecting on those experience. Constructivism learning theory by Jean Piaget generally explains that when a person or learner encounters with something new, first they have to reconcile it with their previous ideas and experiences, maybe to change what they believed or maybe to dismiss the new information as irrelevant. The process of teaching and learning science subjects involves asking of questions, experiment, Computer (powerpoint), observation, exploration and assessment and all those activities are elaborated as main principles of constructivism learning theory.

Statement of problem

Nigerian universities clearly stated that the mandatory subjects for all courses in medical/pharmaceutical and health science are chemistry, mathematics, physics, and biology. In engineering/environmental technology, education science, computer and agricultural science, chemistry is required (Jamb, 2023). The importance of this subject for students' future career aspirations in those academic and professional disciplines cannot be overemphasized. Unfortunately, the performance and attitude of students in this important subject have not been encouraging (Nja & Ideba, 2021).

This study aims to address this poor academic achievement by integrating a computer-based method into chemistry teaching, with the specific goal of dispelling the notion that the subject is inherently abstract. The study was interested in finding out if there is any effect of computer-assisted instruction method on students' academic achievement in chemistry.

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Purpose of the study

The purpose of the study is to determine the effect of computer-assisted instructions on the academic achievement of secondary school students in chemistry, in Calabar Municipality of Cross River State, Nigeria. Specifically, this study sought to determine:

1. the mean academic achievement score of SS2 chemistry students when taught with and without computer assisted instructions.
2. the influence of gender on the academic achievement of SS2 chemistry student when taught with and without computer assisted instructions.

Research questions

The following are the research questions:

1. What is the mean academic achievement score of SS2 chemistry students when taught with computer assisted instructions and lecture method?
2. What is the influence of gender on the academic achievement of SS2 chemistry students when taught with computer assisted instructions and lecture method?

Hypotheses

In other to answer the research questions, the following hypotheses are formulated:

Ho1: There is no significant difference in the mean academic achievement of SS2 chemistry students when taught with computer assisted instructions and lecture method.

Ho2: There is no significant difference in the mean score of the academic achievement of female and male chemistry students taught with computer assisted instruction and lecture method.

Methodology

A quasi non-equivalent, non-randomized factorial design was used in this study. It is a modification of pretest posttest control group design with one treatment variable and one moderator variable. The factorial 2 × 2 design is simply:

Y O_1 x_1 0_2 E

O_1 x_2 0_2 C

E = Experimental, C = control

x_1 = treatment with computer assisted instruction

x_2 = treatment without computer assisted instruction

Y = moderator variable (attitude)

O_1, O_1 = Pretest measurement

0_2, 0_2 = Post-test measurement

Teaching in the experimental class was done using the computer assisted instruction while lecture method was used for the control group. The experimental and control group were given pre-test and post-test. The sample was made up of 100 SS2 chemistry students. A break-down of this figure showed 60 students in experimental and 40 students in the control groups.

One instrument was used for this study named Chemistry Achievement Test (CAT). It was a 20 item five response options objective test. This served as the pretest and posttest after validation. One hundred SS2 students in Calabar municipality in the 2024/2025 academic session formed the sample of this study. Sixty (n = 60) students were assigned to experimental and forty (n = 40) students were assigned to the control group. Both the experimental and control groups participated in the pretest/posttest test. Reliability was done using Kuder Richardson formula 20 and the result had a coefficient of 0.8

This research was carried out during the first semester of 2024/2025 academic year for the experimental and control groups. This covered 6 weeks (one month and two weeks) for the control and experimental groups. The choice of 6 weeks was to avert maturation, which can compromise the internal validity. The experimental group was taught using computer assisted instruction.

Presentation of results

Research question 1: What is the mean academic achievement score of SS2 chemistry students when taught with computer assisted instructions and lecture method?
Research question 2: What is the influence of gender on the academic achievement of SS2 chemistry students when taught with computer assisted instructions and lecture method?

Table 1 was used to answer the first and second research questions.

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Table 1: Mean and standard deviation of gender and students' academic achievement in chemistry when taught with computer assisted instruction and lecture method.

Treatment	Gender	Mean	Std. Deviation	N
Computer	male	41.03	4.16	28
	female	41.20	4.24	32
	Total	41.10	4.16	60
lecture	male	34.03	5.26	17
	female	31.25	5.28	23
	Total	33.48	5.32	40

Table 1 indicated that there is a difference in the mean gain scores of students in the two treatment groups. The mean score in the group taught with computer assisted instruction was higher (41.10) than the group taught with lecture method (33.46); hence the effect of computer assisted instruction is higher than that of Lecture method. Table 1 also showed the influence of gender when students were taught using computer assisted instruction as male and female had almost the same mean scores, 41.03 and 41.20 respectively.

Ho1: There is no significant difference in the mean academic achievement of SS2 chemistry students when taught with computer assisted instructions and lecture method.
Ho2: There is no significant difference in the mean score of the academic achievement of female and male chemistry students taught with computer assisted instruction and lecture method.

Table 2: Summary of 2-way ANCOVA of influence of gender on students' academic achievement in chemistry when taught with computer assisted instruction and lecture method.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	1457.360[a]	4	364.340	16.791	.000	.414
Intercept	5267.443	1	5267.443	242.752	.000	.719
pretest	12.051	1	12.051	.555	.458	.006
treatment	1265.164	1	1265.164	58.306	.000	.380
gender	28.088	1	28.088	1.294	.258	.013
treatment * gender	40.457	1	40.457	1.864	.175	.019
Error	2061.390	95	21.699			

Total	148299.000	100
Corrected Total	3518.750	99

a. R Squared = .414 (Adjusted R Squared = .390)

Table 2 indicated that the calculated F value for treatment (teaching with and without computer assisted instruction was is 58.306 with a p-value of .000 which is statistically significant at .05 significant level and (1, 100) degrees of freedom. That means there is a significant difference in the mean academic achievement score of students taught with computer assisted instruction and lecture methods. Therefore, the null hypothesis is rejected. That Table 1 indicated the influence of gender on the academic achievement of SS2 chemistry students taught with and without the computer assisted instruction. The calculated F value for the interaction of treatment and gender is 1.864 with p-value of .175 which is not statistically significant at .05 level (p>.05). This implies that there is no significant difference in male and female students' academic achievement in chemistry when taught chemistry with computer assisted instruction and lecture methods. Therefore, the null hypothesis was not rejected.

Discussion of the findings

The result of the testing of hypothesis one indicated a significant difference in the mean academic achievement score of students taught with computer assisted instruction and lecture methods. This means that CAI significantly affects the academic achievement of chemistry students in the study area. This may be because CAI offers a potential solution to enhance teaching effectiveness, individualize instruction, and improve students' academic performance in challenging concepts. Another reason is that CAI has emerged as a promising tool to address educational disparities by providing personalized learning experiences, interactive simulations, and immediate feedback. Its flexibility allows students to learn at their own pace, catering to diverse learning styles. In chemistry education, CAI can supplement traditional instruction by offering visualizations of complex concepts, virtual experiments, and interactive modules, thereby enhancing understanding and engagement.

This finding is in agreement with Edyburn (2014), who highlights the role of CAI in providing equitable access to educational materials and removing barriers to learning. With the flexibility of accessing CAI materials anytime and anywhere, students can engage in independent and self-paced learning experiences, accommodating their individual constraints and preferences. However, the effectiveness of CAI in improving

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students' academic performance is contingent upon various factors, including the quality of instructional design, teacher support, and integration into the curriculum. CAI holds great potential for enhancing students' academic performance through its impact on cognitive development, engagement, personalized learning, and accessibility. As technology continues to evolve, CAI will play an increasingly vital role in shaping the future of education, offering innovative solutions to meet the diverse needs of learners in chemistry worldwide.

The finding of this study also supports that of Muftawu and Benard (2024) whose studies showed a significant impact of CAI on students' achievements. The provision of IT to schools and its use for educational purposes can increase students' achievements in at least two ways: the availability of CAI in the classroom shifts the level of educational inputs and could thus affect students' learning outcomes. It increases the vector of school inputs by providing infrastructure to schools (for example, computer laboratories and software) and training to teachers, potentially improving learning outcomes. Exposure to CAI may increase the cognitive abilities of students, allowing them to learn faster. Improving the quality of education and training is a critical issue, particularly at a time of educational expansion. Research conducted by Clark and Mayer (2019) suggests that CAI positively influences students' cognitive skills, such as problem-solving, critical thinking, and knowledge retention. Through interactive simulations and multimedia resources, CAI engages students in active learning, stimulating their cognitive processes and deepening their understanding of complex concepts. Moreover, CAI enhances students' engagement by providing a dynamic and interactive learning environment.

The finding of this study is also supported by Hwang and Wu (2014), who asserted that the interactive nature of CAI increases students' motivation and participation in learning activities. Immediate feedback mechanisms embedded within CAI systems allow students to monitor their progress and adjust their learning strategies accordingly, fostering a sense of ownership and accountability for their academic performance. Additionally, CAI facilitates personalized learning experiences through adaptive learning algorithms. Means et al. (2014) found that personalized instruction through CAI resulted in significant improvements in students' academic achievement. By tailoring instructional content to individual students' needs, preferences, and learning styles, CAI promotes deeper engagement and mastery of chemistry.

The result of hypothesis two indicated that there is no significant difference in the mean scores of academic achievements between female and male SS2 chemistry students taught

with and without computer assisted instruction. This means that gender does not influence students' academic achievement in chemistry. The reasons may be because gender does not influence students' academic achievement in chemistry because all students have equal opportunities for learning, and there are no inherent genetic differences in cognitive abilities that would affect their understanding of chemistry. Both males and females have similar interests and motivation to learn chemistry, and they have access to the same resources and facilities. Teacher expectations and bias reduction efforts also help to ensure that all students have an equal chance to succeed. Additionally, standardized assessment criteria and the objective nature of chemistry concepts mean that students are evaluated solely on their knowledge and skills, regardless of gender.

These findings are consistent with Udousoro (2011), who asserted that student gender, whether male or female, does not affect academic performance. Similarly, Igboegwu and Okonkwo (2014) found no significant gender difference in students' performance in chemistry. Additionally, Erinosho (2018) concluded that ability is not a determining factor in female participation in science, and that girls and boys perform equally well if the instructional context is fair and conducive. Busari et al. (2016) and Samuel and Okonkwo (2020) also revealed no significant gender difference in the performance of students in chemistry.

However, these findings disagree with Ezeudu and Obi (2015), who observed a significant difference in the academic achievement of male and female students in WAEC chemistry results, with male students having higher mean scores. This study also contradicts Yang (2014), who observed that gender contributes to poor achievement in chemistry and science subjects generally. Furthermore, Gonzuk and Chargok (2016) revealed that the number of females studying chemistry in secondary and tertiary institutions is smaller compared to males, creating a gender disparity in academic achievement in chemistry and science subjects as a whole.

Conclusion

As a result of the study's findings, it was concluded that computer-assisted instruction significantly affects the academic achievement of chemistry students. Both male and female chemistry students can equally benefit from computer-assisted instruction.

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Recommendations

The study's findings led to the following recommendations being made:

1. Teachers, both in-service and pre-service teachers, should be trained to properly integrate computers in their daily classroom processes.
2. The government and non-governmental agencies should equip both urban and rural schools with computers and new technologies for easy access by both teachers and students.
3. There should also be provision for regular supply of electricity to schools at all times.
4. Teachers in schools should be given free computer training by the government (State and Federal) to enable them use these new technologies when supplied to schools.
5. There is the need to develop relevant "computer assisted instructional" packages for use within the Nigerian school systems.

References

Afolabi, M. (2022). *Effect of Computer Assisted Instruction on Academic Achievements of Senior Secondary School Chemistry of Different Abilities* [Unpublished PhD thesis]. National Open University Nigeria.

Bosede, A. F. (2014). Influence of sex and location on relationship between students' problems and academic performance. *The Social Science*, 5(4), 340-345.

Busari, O. O., Ernest, S. B., & Ugwuanyi, D. N. (2016). Effects of computer-assisted instruction on senior secondary school students' achievement in chemical reactions and equilibrium in Egbeda Local Government Area of Oyo State. *International Journal of Secondary Education*, 4(4), 39-43.

Clark, R. E., & Mayer, R. E. (2019). *E-learning and the science of instruction: Proven guidelines for consumers and designers of multimedia learning.* John Wiley & Sons.

Edyburn, D. L. (2014). Would you recognize universal design for learning if you saw it? Ten propositions for new directions for the second decade of UDL. *Learning Disability Quarterly*, 33(1), 33-41.

Erinosho, Y. E. (2018). Women and science. 36th Inaugural Lecture, Olabisi Onabanjo University Ago-Iwoye.

Ezeudu, F. O., & Obi, T. N. (2015). Effect of gender and location on students' achievement in Chemistry in senior secondary schools in Nsukka Local Government Area of Enugu State, Nigeria. *Research on Humanities and Social Science*, 3(15), 50-55.

Gonzuk, S., & Chargok, H. (2016). Gender differences in science: Parallels in interest, experience, and performance. *International Journal of Science Education*, 9, 467-481.

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

Idiege, K. J., Nja, C. O., & James, P. F. (2021). Interactive activation and competition (IAC) model as a metacognitive strategy and students' academic achievement in electrochemistry in Cross River State, Nigeria. *Inter-Disciplinary Journal of Science Education*, 3(1), 95-105.

Igboegwu, E. N., & Okonkwo, I. G. A. (2014). Influence of gender and location of school on students' achievement in Chemistry. *Journal of Research in Education,* (1), 9-14.

Kissau, S. (2016). Gender difference in motivation to learn French. *Canadian Modern Language Review*, 6(3), 65-96.

Means, B., Toyama, Y., Murphy, R., Bakia, M., & Jones, K. (2014). *Evaluation of evidence-based practices in online learning: A meta-analysis and review of online learning studies*. US Department of Education.

Muftawu, H. M. & Benard, A.A. (2024). Effects of Computer Assisted Instruction on Learning Outcome in Science Subjects Among Secondary School Students in Kogi state, Nigeria. *Custech International Journal of Education,* 1(1), 300-311.

Nja, C. O., & Ideba, M. A. (2021). Home materials and academic achievements of chemistry students. *Inter-Disciplinary Journal of Science Education,* 3(1), 57-67.

Nja, C. O., Erim, C. M., Eyo, E. O., Meremikwu, A. N. & Ekon, E. E. (2023). Undergraduate students' predilection for seating pattern and their engagement in a collaborated blended learning in the science education classroom. *International Journal of Education and Practice*, 11(4), 803-819. DOI: 10.18488/61.v11i4.3508

Nja, C. O., Ademola, F. S. & Sunday, O. (2024). Relationship between Synchronous and Asynchronous Online Learning and Chemistry Students' Engagement. *Prestige Journal of Counseling Psychology*, 7(2), 150-159.

Olasehinde, K. J. & Olatoye, R. A. (2014). Comparison of male and female senior secondary school students' learning outcomes in science in Katsina State, Nigeria. *Mediterranean Journal of Social Sciences*, 5(2), 5-17.

Okereke, C. & Onwukwe, E. O. (2011). Influence of gender, school location and the use of play simulation on school achievement in Chemistry. *JORINY*, (9). Available online at www.transcampus.org/Journal.

ISSN: 2645-324X (Print)
ISSN: 2645-3223 (Online)

Samuel, N. N. C., & Okonkwo, O. I. (2020). Effects of computer assisted instruction on senior secondary school students' academic self-concept in Chemistry. *Journal of International Academic Research for Multidisciplinary*, 8(7), 13-20.

Udousoro, U. J. (2011). The effects of gender and Mathematics ability on academic performance of students in Chemistry. *African Research Reviews*, 5(4), 201-213.

Yang, D. H. (2014). Gender and classroom learning. *Psychology in the School*, 22, 208-223.