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# EFFECT OF COMPUTER-ASSISTED INSTRUCTION ON STUDENTS' PERFORMANCE IN LONGITUDE AND LATITUDE AMONG SECONDARY SCHOOLS IN KATSINA STATE

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**ABSTRACT**
This study investigated the effect of Computer-Assisted Instruction (CAI) on students' academic performance in longitude and latitude among senior secondary school students in Mani Zonal Education Quality Assurance, Katsina State, Nigeria. The study adopted a quasi-experimental design involving pre-test, post-test, using a non-equivalent control group. A sample of 117 SSII students was purposively selected from a population of 6,910 students using intact classes. The instrument used for data collection was the Longitude and Latitude Performance Test (LLPT), which was validated by experts and yielded a reliability coefficient of 0.746 using Pearson Product Moment Correlation (PPMC). Data were analyzed using mean and standard deviation to answer research questions, while independent samples t-test was used to test hypotheses at 0.05 level of significance. The findings revealed that students taught using CAI performed significantly better than those taught using the lecture method. Furthermore, no significant difference was found between the performance of male and female students exposed to CAI. The study concluded that CAI is an effective and gender-friendly instructional strategy for improving students' understanding of longitude and latitude.

**Keys:** Computer-Assisted Instruction, Mathematics Performance, longitude and latitude, Secondary School Students and Gender.

## Introduction

Mathematics is a core subject in the Nigerian secondary school curriculum and plays a pivotal role in preparing students for science, technology, engineering, and mathematics (STEM) careers (Federal Republic of Nigeria, 2013). Despite its importance, students consistently demonstrated poor performance in mathematics, particularly in topics that require spatial reasoning and conceptual understanding, such as longitude and latitude. These topics involve interpreting coordinate systems, measuring angles, and applying computations to determine precise locations. Reports from the West African Examinations Council (WAEC) over the last decade indicate that many students fail to correctly solve problems in longitude and latitude, reflecting persistent difficulties in conceptual understanding and visualization (WAEC Chief Examiners' Reports, 2025).

One major factor contributing to poor performance in mathematics is the predominance of traditional teaching methods, which emphasize rote learning and teacher-centered instruction (Adeyemi, 2012; Olatoye, Babalola, & Adeyemo, 2015). These approaches offer limited opportunities for students to engage actively with mathematical concepts or to visualize spatial relationships, resulting in low achievement and poor retention. In response to these limitations, innovative instructional approaches such as computer-assisted instruction have been introduced.

Computer-Assisted instruction (CAI) refers to the computer-based technologies and software applications to facilitate interactive teaching and learning processes. Computer-Assisted Instruction (CAI) has been defined in various ways by scholars. It is described as an interactive instructional approach that uses computer systems to present learning content and provide immediate feedback to learners (Gambari et al., 2014). It also involves the use of technology to support individualized and self-paced learning, thereby improving retention and understanding (Hussaini et al., 2025). Furthermore, CAI integrates multimedia and simulation tools into instruction to enhance students' comprehension of abstract concepts (Awofala & Uwajuwua, 2023).

Computer-Assisted Instruction (CAI) is defined as an instructional approach that utilizes computer technologies, including educational software and multimedia tools, to present learning materials, facilitate learner interaction, and provide instant feedback, thereby promoting individualized and self-paced learning (Raja R & Nagasubramani P C, 2018). To address these challenges, Computer-Assisted Instruction (CAI) has emerged as an effective instructional strategy. CAI uses computers and educational software to deliver content interactively, provide immediate feedback, and enable learners to work at their own pace (Raja & Nagasubramani, 2018; Hussaini, Abdullahi, & Bello, 2025).

In mathematics education, CAI supports the visualization of abstract concepts, promotes active engagement, and allows learners to explore problems dynamically. Studies have shown that CAI can significantly improve students' achievement in mathematics topics involving spatial reasoning and geometry (Awofala & Uwajuwua, 2023; Gambari, Ezenwa, & Anyanwu, 2014; Muhammed-Raji & Azeez, 2024).

Beyond improving academic performance, research also indicates that CAI may contribute to gender-equitable learning outcomes. Female students, who often face challenges in spatially oriented tasks due to lower confidence and anxiety, can benefit from CAI's self-paced and interactive features, which provide opportunities to practice and visualize mathematical concepts without fear of immediate judgment (Hussaini et al., 2025; Okwuoza & Olajumoke, 2023).

**Statement of the Problem**

Despite these reported benefits, the extent to which CAI improves students' understanding of longitude and latitude in the study area remains unclear. Many students struggle with reading and applying coordinate systems, resulting in poor scores in both practical and theoretical components of the subject.

Traditional teacher-centered methods appear insufficient to address these challenges, as they provide limited opportunities for students to engage actively with mathematical concepts or visualize spatial relationships (Adeyemi, 2012; Olatoye, Babalola, & Adeyemo, 2015). Although Computer-Assisted Instruction (CAI) has been shown to improve mathematics achievement through interactive learning and immediate feedback, its effect on longitude and latitude performance in Katsina State secondary schools remains under-researched (Raja & Nagasubramani, 2018; Hussaini, Abdullahi, & Bello, 2025).

This study therefore seeks to investigate the effect of CAI on students' academic performance in longitude and latitude, while also examining the influence of gender on learning outcomes. Addressing this problem is essential to improving mathematics performance, promoting gender equity, and guiding the integration of technology into secondary school mathematics instruction in Katsina State.

**Objectives of the Study**

The study is guided by the following objectives:

1. To determine the effect of Computer-Assisted Instruction on students' academic performance in longitude and latitude in mathematics.
2. To examine the difference in performance between male and female students taught longitude and latitude using CAI.

**Research Questions**

This study seeks to answer the following research questions:

1. What is the effect of Computer-Assisted Instruction (CAI) on students' academic performance in longitude and latitude in mathematics?
2. Is there a significant difference in the performance of male and female students taught longitude and latitude using CAI?

**Hypotheses**

The following null hypotheses will be tested at a 0.05 level of significance:

$H0_1$: There is no significant difference in the academic performance of students taught longitude and latitude using CAI and those taught using traditional teaching methods.

$H0_2$: There is no significant difference in the academic performance of male and female students taught longitude and latitude using CAI.

**Methodology**

The study adopted a quasi-experimental research design employing a pre-test, post-test, and delayed post-test non-equivalent control group approach. This design was considered appropriate because random assignment of participants to groups was not feasible; hence, intact classes were used. The design nevertheless permits meaningful comparison of learning outcomes between students exposed to Computer Assisted Instruction (CAI) and those taught using the conventional lecture method, while controlling for initial group differences through pre-testing (Creswell, 2014). The population for the study consisted of all Senior Secondary School II (SSII) students in public secondary schools within Mani Zonal Education Quality Assurance, Katsina State, Nigeria. The total population was 6,910 students at the time of the study. A sample of 117 SSII students was selected using a combination of purposive sampling technique. Two public

secondary schools with comparable characteristics and functional computer facilities were purposively selected. Intact classes from the selected schools were assigned to experimental (n = 52) and control (n = 65) groups. The use of intact classes ensured minimal disruption to the normal school timetable and enhanced the ecological validity of the study.

Data were collected using the Longitude and Latitude Performance Test (LLPT), a researcher developed performance test designed in accordance with the SSII mathematics curriculum. The instrument comprised structured and objective test items aimed at assessing students' conceptual understanding and computational skills in longitude and latitude. The LLPT was subjected to content and face validation by experts in mathematics education and educational measurement to ensure adequacy of coverage, clarity, and relevance to the study objectives. Reliability of the instrument was established using the Pearson Product Moment Correlation Coefficient (PPMC) through a test–retest method. A reliability coefficient of 0.746 was obtained.

Prior to the commencement of the treatment, a pre-test was administered to both the experimental and control groups to determine their equivalence in terms of prior knowledge of longitude and latitude. The experimental group was taught using Computer-Assisted Instruction, which involved the use of interactive computer-based learning packages, visual animations, guided practice, and immediate feedback. The control group was taught the same content using the conventional lecture method. The treatment lasted for the same duration for both groups to control for time-on-task effects. At the end of the treatment, a post-test was administered, followed by a delayed post-test to assess retention of learning. Descriptive statistics, including mean and standard deviation, were used to answer the research questions. Inferential statistics comprising independent samples t-test were employed to test the null hypotheses at a 0.05 level of significance.

**Result**

**Table 1:** Independent Sample t-Test of Equivalency between Experimental and Control Groups Based on Pretest Scores

| Group | N | Mean | Std. | Df | t-value | p-value | Remark |
|---|---|---|---|---|---|---|---|
| Male | 25 | 17.43 | 2.371 | 50 | 0.933 | 0.355 | Not Significant |
| Female | 27 | 16.76 | 2.760 | | | | |

An independent sample t-test was conducted to determine whether there was a significant difference between pre-test scores of the experimental and control groups. The result presented in table 1 showed that there is no significant difference between the experimental group (M = 17.43, SD = 2.371) and the control group (M = 16.76, SD = 2.760), t(50) = 0.933, p = 0.355. Since the p-value is greater than 0.05, the two groups were considered statistically equivalent before the treatment.

**What is the effect of Computer-Assisted Instruction (CAI) on students' academic performance in longitude and latitude in mathematics?**

Table 2: Descriptive statistics of academic scores of experimental and control groups

| Groups | N | Mean | Std. | Std. Error Mean | Mean difference |
|---|---|---|---|---|---|
| Experimental | 52 | 25.60 | 5.751 | o.797 | 8.135 |
| Control | 65 | 17.46 | 3.985 | 0.494 | |

Table 2 show that the mean scores of student's performance taught longitude and latitude using computer assisted instructional is (M =25.60,SD=0.797) and those taught using lecture method is ( M=17.46 SD=0.494) and the mean difference is 8.135, and the standard deviation is 8.135.

**Is there a significant difference in the performance of male and female students taught longitude and latitude using CAI?**

Table 3: Descriptive statistics of student's performance between male group and female

| | Gender | N | Mean | Std. Deviation | Std. Error Mean | |
|---|---|---|---|---|---|---|
| Posttest | Male | 25 | 25.84 | 5.367 | 1.073 | 0.470 |
| | Female | 27 | 25.37 | 6.178 | 1.189 | |

Table 3 shows the mean and standard deviation of male students scores is (M=25.84 SD=5.367) and the mean and standard deviation of female students is (M=25.37, SD=6.178) and the difference between the two mean scores is 0.470.

**$H0_1$: There is no significant difference in the academic performance of students taught longitude and latitude using CAI and those taught using traditional teaching methods.**

Table 4: t-test Result on Students Performance between Computer Assisted Instructional strategy and Lecture Method.

| Group | N | Mean | Std. | Df | t-value | p-value | Remark |
|---|---|---|---|---|---|---|---|
| C.A.I. strategy | 52 | 25.60 | 5.751 | 115 | 9.019 | 0.000 | Significant |
| Lecture Method | 65 | 17.46 | 3.985 | | | | |
| Total | 117 | | | | | | |

** Significant at $p \leq 0.05$*

Table 4 showed that the difference between the mean academic performance score of students taught longitude and latitude using computer assisted instructional strategy is significant [ t(115)=9.019.p<0.05]. Therefore, the null hypothesis is rejected (HO1) which states that: "There is no significant difference between the mean performances scores of the students taught longitude and latitude using Computer Assisted Instructional Strategy and those taught without computer assisted instructional strategy" is rejected. This means there exist statistically significant difference between Experimental Group (Computer Assisted Instructional Strategy) and the Control Group (traditional teaching Method). Hence, there is significant difference between the mean performances scores of the students taught longitude and latitude using Computer Assisted Instructional Strategy and those taught without computer assisted instructional strategy.

**$H0_2$: There is no significant difference in the academic performance of male and female students taught longitude and latitude using CAI.**

Table 5: t-test Result on Performance in longitude and latitude between Male and Female Students.

| Group | N | Mean | Std. | df | t-value | t-critical | p-value | Remark |
|---|---|---|---|---|---|---|---|---|
| Male | 25 | 25.84 | 5.367 | 50 | 0.292 | 1.676 | 0.772 | Not Significant |
| Female | 27 | 25.37 | 6.178 | | | | | |

** Significant at $p \leq 0.05$*

Table 5 shows that, [t (0.292) < t (1.676)] t-calculated (0.292) is less that t-critical (1.676) and the degree of freedom is 50. The null hypothesis two which stated that "There is no significant difference between academic performance of male and female students taught longitude and latitude using computer assisted instructional strategy." is retained with p-value (0.772) which is greater than alpha value (0.05) and alternative hypothesis is rejected. Hence, there is no significant difference between academic performance of male and female students taught longitude and latitude using computer assisted instructional strategy.

**Discussion of Findings**

The findings of this study revealed that students taught longitude and latitude using Computer-Assisted Instruction (CAI) performed significantly better than those taught using the conventional lecture method. This is clearly reflected in Table 4, where the experimental group obtained a higher mean score (M = 25.60) compared to the control group (M = 17.46), with a statistically significant difference, $t(115) = 9.019$, $p < 0.05$. This result indicates that CAI had a positive and significant effect on students' academic performance.

The improved performance of students in the experimental group may be attributed to the interactive and visual nature of CAI, which enhances understanding of abstract concepts such as longitude and latitude. The use of animations, guided practice, and immediate feedback likely supported students in developing better conceptual understanding compared to the lecture method. This finding agrees with previous studies which reported that CAI enhances students' achievement in mathematics and related subjects by promoting active engagement and visualization of concepts (Gambari et al., 2014; Awofala & Uwajuwua, 2023). However, the magnitude of improvement observed in this study suggests that the effectiveness of CAI may also depend on proper implementation and availability of adequate technological resources.

Furthermore, the results in Table 5 showed that there was no significant difference in the performance of male and female students taught using CAI, as $t(50) = 0.292$, $p > 0.05$. This implies that both male and female students benefited equally from the instructional strategy. The absence of gender difference may be due to the learner-centered nature of CAI, which allows students to learn at their own pace and reduces anxiety often associated with traditional classroom settings. This finding supports earlier studies that reported that technology-based instruction can minimize gender disparities in learning outcomes (Okwuoza & Olajumoke, 2023; Hussaini et al., 2025).

**Conclusion**

This study examined the effect of Computer-Assisted Instruction (CAI) on students' academic performance in longitude and latitude among secondary school students in Mani. Based on the findings, it was concluded that CAI significantly improves students' academic performance compared to the conventional lecture method. This conclusion is supported by the significant difference observed between the experimental and control groups. The study also concluded that there is no significant difference in the academic performance of male and female students taught using CAI, indicating that the instructional approach is gender-neutral and equally beneficial to all students. Therefore, the study establishes that CAI is an effective and inclusive instructional strategy for teaching longitude and latitude in secondary schools. This study examined the effect of Computer-Assisted Instruction (CAI) on students' academic performance in longitude and latitude among secondary school students in Mani, with particular attention to differences between experimental and control groups, as well as gender differences. Based on the findings, it was concluded that the use of Computer-Assisted Instruction significantly improved students' academic performance in longitude and latitude when compared to the conventional teaching method. Students exposed to CAI (experimental group) demonstrated higher mean scores and better conceptual understanding than those in the control group. This indicates that CAI is an effective instructional approach for enhancing the teaching and learning of geographical concepts that require visualization and spatial understanding. Furthermore, the study revealed that there was no statistically significant difference in the academic performance of male and female students taught using Computer-Assisted Instruction. This suggests that CAI is gender-friendly and provides equal learning opportunities for both male and female students. The instructional

approach appears to minimize gender disparities commonly associated with traditional teaching methods.

**Recommendations**

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

1. Use of CAI in Teaching Longitude and Latitude: Mathematics teachers should adopt Computer-Assisted Instruction (CAI) when teaching longitude and latitude, as the study revealed that students exposed to CAI performed significantly better than those taught using the lecture method.
2. Provision of Functional ICT Facilities: School administrators and government should ensure the provision of functional computer laboratories and reliable electricity in secondary schools, particularly in areas such as Mani, to facilitate effective implementation of CAI.
3. Training of Teachers on CAI Usage: Teachers should be trained through workshops and seminars on how to effectively integrate CAI into classroom instruction, since its effectiveness depends on proper implementation.
4. Encouragement of Equal Participation: Teachers should encourage both male and female students to actively participate in CAI-based learning, as the study found no gender difference in performance, indicating that the method benefits all students equally.

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