

EFFECT OF GEOGRAPHIC INFORMATION SYSTEM LABORATORY STRATEGY ON GEOGRAPHY STUDENTS' ACADEMIC PERFORMANCE IN COLLEGES OF EDUCATION IN BAUCHI STATE, NIGERIA

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Abstract

This study investigated the effect of geographic information system (GIS) laboratory strategy on the academic performance of geography students in colleges of education in Bauchi state, Nigeria. The study was motivated by the persistent reliance on conventional teacher-centred approaches in geography instruction despite the increasing recognition of GIS as an innovative, interactive, and student-centred instructional tool. The study adopted a quasi-experimental research design. The population of the study comprised one hundred and forty-two (142) geography students from three colleges of education in Bauchi state. Two colleges of education were purposively selected as the experimental and control groups respectively. Data were collected using a Geography Performance Test (GPT) consisting of fifty (50) multiple-choice questions developed from the NCCE minimum standard 2023 curriculum. The instrument was validated by experts and pilot tested, yielding a reliability coefficient of 0.916. The findings revealed that students taught using GIS laboratory strategy recorded significant improvement in their academic performance compared with their pre-test scores. Similarly, students taught using the conventional strategy showed improvement, but the effect was relatively limited compared with the GIS-based approach. The comparison between the two groups indicated that students exposed to GIS laboratory strategy performed better than those taught using the conventional strategy. The study concluded that GIS laboratory strategy is an effective instructional approach for enhancing geography students' academic achievement by promoting practical learning, active participation, and better understanding of geographical concepts. The study recommended that government, the National Commission for Colleges of Education (NCCE), and college management should support the integration of GIS laboratories into geography education, provide necessary GIS facilities and ICT infrastructure, and organize regular training for geography lecturers to improve the effective utilization of GIS in teaching and learning.

Keywords: Geographic Information System (GIS) Laboratory Strategy, Geography Education, Academic Performance.

Introduction

Geography is a vital subject that enables learners to understand the spatial relationships between humans and their environment. It equips students with knowledge of physical features, environmental processes, and human activities across different regions. However, the teaching of Geography in many Colleges of Education in Nigeria, including Bauchi State, has largely remained teacher-centered, relying heavily on lecture methods and textbook instruction.

In recent years, the integration of technology into education has transformed teaching and learning processes globally. One such innovation is the Geographic Information System (GIS), a computer-based tool used for capturing, storing, analyzing, and displaying spatial data. GIS has been widely recognized as an effective instructional strategy in Geography because it promotes interactive, inquiry-based, and student-centered learning. This gap suggests the need for empirical studies to determine the effectiveness of GIS laboratory strategy in improving NCE Geography students' academic performance, particularly in Bauchi State.

This study is anchored on John Dewey (1859-1952) (1989) theory of progressive education (Adamu, 2021). He believes that students thrive in an environment where they are allowed to experience and interact with the curriculum and all students should have the opportunity to take part in their learning. GIS is defined as a computerized system for capture, storage, retrieval, analysis and display of spatial data describing the land attributes and environmental features for a given geographic region, by using modern information technology (Thurgood, 2018 in Ali, 2021). According to this definition, a GIS includes not only computing capability and data, but also managers and users, the organization in which they function and institutional relationships that govern their management and use of information (Sarkar, 2019).

The study by Yang, Wang, and Qian (2024) examined whether the use of GIS in Geography education produces better learning outcomes among students. The study employed a quasi-experimental design involving an experimental group taught with GIS-supported instruction and a control group taught using conventional methods. The study focused on teaching air pollution concepts through GIS applications. The findings indicated that GIS-based instruction significantly improved students' learning outcomes, particularly their higher-order cognitive abilities such as application, interpretation, and spatial analysis. The study concluded that GIS is an effective educational tool for improving students' geographical understanding and analytical skills.

This study conducted by Yağbasan and Baysal Yılmaz (2021) investigated the effect of GIS-based activities on students' perception of spatial variation and academic achievement in Geography education. The study adopted a quasi-experimental research design involving 60 secondary school Geography students in Turkey. Students were divided into experimental and control groups, where the experimental group was taught using GIS-supported activities while the control group received traditional instruction. The findings revealed that students exposed to GIS-based learning activities demonstrated higher spatial perception skills and better academic achievement than those taught through conventional methods. The researchers concluded that GIS provides an interactive learning environment that improves students' understanding of geographical concepts and enhances their ability to analyze spatial relationships.

The study of Musa (2018) investigated the Effect of Instructional Strategies on the Academic Performance of Secondary School Geography Students in Zaria Educational Zone, Kaduna State-Nigeria. It was observed that many students at senior secondary school I perceives

geography as a difficult subject and hence run away from it. The research work has three objectives is, to examine the effects of instructional strategies on academic performance of senior secondary school geography students in Zaria educational zone. The study was delimited to only class one of senior secondary school students of public senior secondary schools in Zaria. Quasi experimental research design was used with 24 public senior secondary schools located in the zone with focus on the 10 co-educational public senior secondary schools found in the area and two (2) co-educational senior secondary schools were used as sample. A Geography performance test was used as an instrument which was validated by experts and pilot tested in government secondary school Dakace Zaria. Mean and standard deviation were used to answer research questions while t-test used to answer all hypotheses at 0.05. The findings showed the mean academic performance of students was higher. The retention ability showed male had higher mean performance. Based on the findings of this study, it was recommended that, the developments of geographical models for teaching geography should be encouraged. The ministries of education and stake holders should encourage geography teachers to design and create geographical models, since they can be produced locally.

This study presented by Erena and Yağbasanb (2017), focused on an aspect or program application if Geographic Information System known as ArcGIS program, widely utilized Geographical Information System (GIS) software, was used to outline the stages of material development for Geography courses. The aim was to provide the teachers with an example on how to develop materials using GIS rather than developing materials for all topics of the geography courses. In that context, the basics of how to use the “Hyperlink” feature were provided through a step-by-step approach. The geography teachers may easily develop their own materials by following the foregoing stages explained in the paper. These materials may help improving the attention and attitudes of students towards courses significantly and ensure that the topics are better understood.

Statement of the Problem

Although GIS has been identified as a powerful instructional tool that can enhance students' learning, its application in Nigerian secondary schools remains minimal (Sarkar, 2019). There is limited empirical evidence on the effectiveness of GIS laboratory strategy in improving Geography NCE students' academic performance in Colleges of Education in Bauchi State. The research observes the non-utilization of GIS Laboratory or workstation in lecturing GIS or Map reading, therefore the researcher set to investigate the Effect of GIS Laboratory Strategy on Geography Students' Academic Performance in Bauchi State, Nigeria.

Objectives of the Study

The study aims to:

1. determine the pre-test and post-test academic performance of students' taught using GIS laboratory strategy in Colleges of Education in Bauchi State, Nigeria.
2. determine the pre-test and post-test academic performance of students' taught using conventional strategy in Colleges of Education in Bauchi State, Nigeria.

3. compare the performance of students taught using GIS and those taught using the conventional strategy in Colleges of Education in Bauchi State, Nigeria.

Research Questions

The following research questions were formulated in line with objectives of the study;

1. What is the pre-test and post-test academic performance of students' taught using GIS laboratory strategy in Colleges of Education in Bauchi State, Nigeria?
2. What is the pre-test and post-test academic performance of students' taught using conventional strategy in Colleges of Education in Bauchi State, Nigeria?
3. What is the performance of students taught using GIS and those taught using conventional strategy in Colleges of Education in Bauchi State, Nigeria?

Hypotheses

The following hypotheses were developed from the objectives of the study:

- HO₁ There is no significant difference in the pre-test and post-test Academic Performance of Students' taught using GIS Laboratory Strategy in Colleges of Education in Bauchi State, Nigeria.
- HO₂ There is no significant difference in the pre-test and post-test Academic Performance of Students' taught using Conventional Strategy in Colleges of Education in Bauchi State, Nigeria.
- HO₃ There is no significant difference in the Academic Performance of Students' taught using GIS Laboratory Strategy and those taught using Conventional Strategy in Colleges of Education in Bauchi State, Nigeria.

Methodology

The researcher used quasi experimental design with a total population of One Hundred and Forty-Two (142) NCE Geography students in from the three Colleges of Education in Bauchi State, Nigeria. Aminu Saleh College of Education, Azare with Forty-Nine (49) students and Federal College of Education, Jama'are with Forty-Five (45) students were purposely chosen as the sample of the study. One was Experimental and other Control. A Geography Performance Test (GPT) extracted from the NCCE Minimum Standard 2023 curriculum with Fifty (50) multiple choice questions. The instrument was validated by experts from Ahmadu Bello University, Zaria and a pilot study conducted in College of Education Kangere with 20 respondents and obtained a reliability of .916. Mean and Standard Deviation were used to answer the Research Questions, Paired sample t-test was used to test hypotheses 1 & 2 and Independent Sample t-test was used to test hypothesis 3.

Results

Research Question One: What is the pre-test and post-test academic performance of students' taught using GIS laboratory strategy in Colleges of Education in Bauchi State, Nigeria?

Table 1: Mean and Standard Deviation of Pre-Test and Post-Test performance of Students' taught using GIS Laboratory Strategy

Test	N	Mean	S D	Mean Difference
Pre-Test GIS Laboratory Strategy	49	13.45	4.504	18.22
Post-Test GIS Laboratory Strategy	49	31.67	8.530	

Source: Fieldwork, 2026

Table 1 above showed that the mean of Pre-test GIS Strategy was of 13.45 and a standard deviation of 4.504 while the Post-test GIS Strategy had a mean of 31.67 and a standard deviation of 8.530. The mean difference stood at 18.22, this indicated that GIS Strategy has impact on the Students' performance in Colleges of Education in Bauchi State, Nigeria.

Research Question Two: What is the pre-test and post-test academic performance of students' taught using Conventional Strategy in Colleges of Education in Bauchi State, Nigeria?

Table 2: Mean and Standard Deviation of Pre-Test and Post-Test performance of Students' taught using Conventional Strategy

Test	N	Mean	S D	Mean Difference
Pre-Test Conventional Strategy	45	12.36	4.909	13.77
Post-Test Conventional Strategy	45	26.13	6.663	

Source: Fieldwork, 2026

Table 2 above showed that Pre-test Conventional Strategy had a mean of 12.36 and a standard deviation of 4.909 while the Post-test Conventional strategy had a mean of 26.13 and a standard deviation of 6.663. The mean difference stood at 13.77, this indicated that Conventional Strategy has little impact on the Students' performance in Colleges of Education in Bauchi State, Nigeria.

Research Question Three: What is the performance of students taught using GIS and those taught using Conventional Strategy in Colleges of Education in Bauchi State, Nigeria?

Table 3: Mean and Standard Deviation of students' performance taught using GIS Laboratory Strategy and those Conventional Strategy

Test	N	Mean	S D	Mean Difference
Post-Test Conventional Strategy	45	26.13	6.663	1.867
Post-Test GIS Laboratory	49	31.67	8.530	

Source: Fieldwork, 2026

Table 3 above showed that Post-test Conventional Strategy had a mean of 26.13 and a standard deviation of 6.663 while the Post-test GIS Laboratory strategy had a mean of 31.67 and a standard deviation of 8.530. The mean difference stood at 1.867, this indicated that GIS Laboratory strategy has little impact on the Students' performance in Colleges of Education in Bauchi State, Nigeria.

HO₁: there is no significant difference in the pre-test and post-test Academic Performance of Students' taught using GIS Laboratory Strategy in Colleges of Education in Bauchi State, Nigeria.

Table 4: Results of Paired Sample t-test of Pre-Test and Post-Test Score of Students taught using GIS Laboratory Strategy

Test	N	Mean	SD	T	df	p-Value	Mean Difference	Decision
GIS Laboratory Strategy Pre-Test	49	13.45	4.505					
				-17.439	48	0.00	18.22	Retained
GIS Laboratory Strategy Post-Test	49	31.67	8.530					

Source: Field Work, 2026

Table 4 presented the pre-test and post-test scores of students taught using GIS Laboratory Strategy in Colleges of Education in Bauchi State, Nigeria. The results revealed t.cal value of 17.439 with p-value of .000. The calculated p-value was lower than alpha value of 0.05 and the hypothesis was retained. This indicated that there is no significant difference between the pre-test and post-test scores of students taught using GIS Laboratory Strategy in Colleges of Education, Bauchi State, Nigeria.

HO₂: there is no significant difference in the pre-test and post-test Academic Performance of Students' taught using Conventional Strategy in Colleges of Education in Bauchi State, Nigeria.

Table 5: Results of Paired Sample t-test of Pre-Test and Post-Test Score of Students taught using Conventional Strategy

Test	N	Mean	SD	T	Df	p-Value	Mean Difference	Decision
Conventional Strategy Pre-Test	45	12.36	4.909					
				-16.398	44	0.00	13.77	Retained
Conventional Strategy Post-Test	45	26.13	6.663					

Source: Field Work, 2026

Table 5 presented the pre-test and post-test scores of students taught using Conventional Strategy in Colleges of education in Bauchi State, Nigeria. The results revealed t.cal value of 16.123 with p-value of .000. The calculated p-value was lower than alpha value of 0.05 and the hypothesis was retained. This indicated that there is no significant difference between the pre-test and post-test scores of students taught using Conventional Strategy in Colleges of Education in Bauchi State, Nigeria.

HO₃: there is no significant difference in the Academic Performance of students' taught using GIS Laboratory Strategy and those taught using the Conventional Strategy in Colleges of Education in Bauchi State, Nigeria.

Table 6: Results of an Independent Sample t-test of Students Performance taught using GIS Laboratory Strategy and those taught using Conventional Strategy

Test	N	Mean	SD	t-cal	Df	p-Value	Mean Difference	Decision
Conventional Strategy Post-Test	49	31.67	8.530	3.488	92	.055	5.54	Accepted
GIS Laboratory Strategy Post-Test	45	26.13	6.663					

Source: Field Work, 2026

Table 6 presented the post-test scores of students taught using GIS Laboratory Conventional and those taught using Conventional Strategy in Colleges of Education in Bauchi State, Nigeria. The results revealed t.cal value of 3.488 with p-value of .055. The calculated p-value was slightly higher than alpha value of 0.05 and the hypothesis was accepted. This indicated that there is significant difference in the performance of Students taught using GIS Laboratory Strategy and those taught using Conventional Strategy in Colleges of Education in Bauchi State, Nigeria.

Discussion of Findings

GIS Strategy has impact on the Students' performance in Geography in Colleges of Education in Bauchi State, Nigeria. There is no significant difference between the pre-test and post-test scores of Geography students taught using GIS Laboratory Strategy in Colleges of Education in Bauchi State, Nigeria, p-value 0.00. This finding agreed with the finding of Musa (2018) and Yang et-al, (2024).

Conventional Strategy has little impact on the Students' performance in Geography in Colleges of Education in Bauchi State, Nigeria. There is no significant difference between the pre-test and post-test scores of Geography NCE Students taught using Conventional Strategy Colleges of Education in Bauchi State, Nigeria, p-value 0.00. This finding agreed with the finding of Erena & Yağbasanb, (2017) and Yang et-al, (2024).

GIS Laboratory Strategy performance is better than Conventional Strategy on the NCE Geography Students' performance in Colleges of Education in Bauchi State, Nigeria. There is significant difference in the performance of Geography NCE Students taught using GIS Laboratory Strategy and those taught using Conventional Strategy in Colleges of Education in Bauchi State, Nigeria, p-value 0.055. This is in agreement with the finding of Musa (2018) and Yağbasan & Baysal-Yılmaz, (2021).

Conclusion

Based on the findings of this study, it was concluded that the integration of Geographic Information System (GIS) Laboratory Strategy has a significant positive effect on the academic performance of Geography NCE students in Colleges of Education in Bauchi State, Nigeria. The study established that students exposed to GIS Laboratory Strategy demonstrated improved academic performance after instruction compared with their initial performance before the treatment.

Recommendations

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

1. Government and NCCE should encourage and support the integration of GIS laboratory strategy into the teaching of Geography in Colleges of Education in Bauchi State, Nigeria.
2. Government and School Management should ensure Lecturers minimize the exclusive use of conventional teaching methods, as the findings show they are less effective in improving students' performance.
3. Government should provide modern GIS laboratory equipment, software, and stable ICT infrastructure and be maintained by the School Management. In addition, lecturers should be regularly trained and retrained on the use of GIS tools to effectively deliver instruction and maximize students' learning outcomes.

References

- Adamu, Y. (2021). Evaluation of the Effects of Individual and Cooperative Learning Instructions on Performance of Social Studies Students; in Upper Basic, Jigawa State, Nigeria. PhD
- Ali, E. (2021). Geographic Information System (GIS): Definition, Development, Applications & Components
- Dewey, J. (1989). Theory of Progressive Education Retrieved on February (2010) from <http://www.Google.com.ng/m/q> John+Dewes+Educational+Theory
- Erena, K. & Yağbasanb, O. (2017). Development of Teaching Materials Based on Geographical Information Systems: An Example on Symbolic Sites in Turkey
- Musa, A. (2018). *Effects of Instructional Strategies on Academic Performance of Senior Secondary Schools Geography Students in Zaria Education Zone, Kaduna State, Nigeria* ABU, Zaria. M. Ed. Dissertation, Unpublished
- Sarkar, A. (2019). Practical Geography - A Systematic Approach, Orient Blackswan Private Limited, Hyderabad.
- Yağbasan, Ö. & Baysal-Yılmaz, S. (2021). Perception of spatial variation in activities prepared by GIS in Geography Education. *International Online Journal of Education and Teaching*, 8(4), 2765–2782. (iojet.org)
- Yang, D., Wang, C. & Qian, L. (2024). Does the use of GIS in geographical education yield better learning outcomes? <https://doi.org/10.1111/tgis.13142> ([Wiley Online Library](https://onlinelibrary.wiley.com/doi/10.1111/tgis.13142))
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