

Case Study

## **Effect of ICT Infrastructure, Spatial Location, and Resource Allocation on Teaching and Learning Outcomes in North-Central Colleges of Education, Nigeria**

**James Yahaya<sup>1</sup>, Garba Suleiman<sup>2\*</sup>, Iliyas Ibrahim<sup>3</sup>**

<sup>1</sup> Economics Department, FCT College of Education, Zuba-Abuja, jamesyahaya76@gmail.com

<sup>2</sup> Computer Science Department, FCT College of Education, Zuba-Abuja,

<sup>3</sup> Economics Department, FCT College of Education, Zuba, Abuja, kpotagison@gmail.com

**ORCID:**  [GS: 0000-0001-7937-2816<sup>2</sup>](https://orcid.org/0000-0001-7937-2816)

Correspondence should be addressed to Garba Suleiman: [sulgarba@gmail.com](mailto:sulgarba@gmail.com)

**Article No:** 029 | **Accepted:** 26 June 2026 | **Published:** 10 July 2026

**Abstract:** Colleges of Education in Nigeria are central to teacher preparation and national human capital development. However, many institutions in North-Central Nigeria continue to experience weak teaching and learning outcomes due to inadequate ICT infrastructure, locational disadvantages, and poor resource allocation. Although prior studies examined these factors separately, limited empirical research has integrated them within a single framework, particularly in Colleges of Education. This study determined the effect of ICT infrastructure, spatial location, and resource allocation on teaching and learning outcomes in North-Central Colleges of Education, Nigeria. The study adopted a quantitative approach using a descriptive survey design. The study population comprised lecturers, students, administrators, and ICT personnel from selected public Colleges of Education in North-Central Nigeria. Using Cochran's sample size formula, a sample size of 600 respondents was determined from the study population through multistage sampling techniques, while 572 valid questionnaires were retrieved and analyzed. Data were analyzed using descriptive statistics, multiple regression, and ANOVA at 0.05 level of significance. Results showed that ICT infrastructure in the institutions was moderate (grand mean = 3.03), spatial location influence was high (grand mean = 3.55), while resource allocation was generally low (grand mean = 2.97). Regression results revealed that ICT infrastructure ( $\beta = 0.418$ ), spatial location ( $\beta = 0.271$ ), and resource allocation ( $\beta = 0.356$ ) had significant positive effects on teaching and learning outcomes. Multiple regression results indicated that the three predictors jointly explained 61.0% of the variance in outcomes ( $R^2 = 0.610$ ). ICT infrastructure was the strongest predictor ( $\beta = 0.418$ ), followed by resource allocation ( $\beta = 0.356$ ) and spatial location ( $\beta = 0.271$ ). The study concluded that institutional performance is shaped by the interaction of technological capacity,

geographic context, and equitable funding. It recommends increased ICT investment, improved internet and electricity supply, equitable funding formulas, targeted support for rural institutions, staff digital training, and data-driven policy planning.

**Keywords:** Colleges of Education, ICT infrastructure, Nigeria, North-Central Nigeria, resource allocation, spatial location, teaching outcomes.

---

## 1. Introduction

### 1.1 Background

Education remains a vital sector for national development, particularly in developing countries where human capital formation drives economic growth and technological advancement. In Nigeria, Colleges of Education play a crucial role in training teachers for the basic education sector, making the quality of instruction in these institutions essential to improving overall educational standards. In recent years, Information and Communication Technology (ICT) has transformed higher education globally through the use of computers, digital libraries, virtual learning platforms, projectors, and internet-enabled devices that enhance teaching, learning, and access to educational resources (Mhlongo, Mbatha, Ramatsetse, & Dlamini, 2023). Studies have shown that effective ICT integration improves student engagement, collaborative learning, instructional delivery, and flexibility in accessing knowledge resources (Sabri, Ismail, Annuar, Rahman, Abd Hamid, & Abd Mutalib, 2024; Abubakar, Ogunlade, & Ibrahim, 2024). However, ICT adoption in many Nigerian tertiary institutions remains constrained by infrastructural challenges such as poor internet connectivity, inadequate computer laboratories, obsolete equipment, unstable electricity supply, and limited technical support (Yusuf & Ibrahim, 2024; Ademola-Popoola & Adesina, 2025); Okunoye & Okunoye (2022). As a result, many lecturers continue to rely on conventional teaching methods, while students have limited opportunities for technology-assisted learning.

Apart from ICT infrastructure, spatial location and resource allocation significantly influence institutional effectiveness and teaching outcomes. Institutions located in urban areas often benefit from better electricity supply, internet access, road networks, and availability of qualified personnel, whereas rural institutions frequently face geographical isolation and infrastructural deficiencies. Empirical evidence suggests that urban institutions generally perform better in ICT accessibility and academic outcomes than rural counterparts (Luo, Zuo, & Wang, 2022). Resource allocation, including funding, staffing, instructional materials, ICT investments, and maintenance support, also determines the capacity of institutions to sustain quality education. Inequitable distribution of these resources often widens developmental disparities among public institutions. The North-Central region of Nigeria, comprising states such as Benue, Kogi, Kwara, Nasarawa, Niger, Plateau, and the Federal Capital Territory, provides an important setting for examining these issues due to variations in infrastructural development and educational

investment. Although previous studies have separately examined ICT adoption, funding, and educational inequality, limited studies have integrated ICT infrastructure, spatial location, and resource allocation into a unified framework for explaining teaching and learning outcomes in Colleges of Education (Yu, Appiah, Zulu & Adu-Poku, 2024; Mishra, Mishra, & Pandey, 2023). Therefore, this study investigates the combined effects of these factors on teaching and learning outcomes in North-Central Colleges of Education, Nigeria, with the aim of providing evidence-based recommendations for policymakers and educational administrators.

## **1.2 Problem Statement**

Existing literature has extensively examined ICT adoption, lecturer readiness, digital learning tools, and funding challenges in Nigerian higher education. However, most studies focus on universities rather than Colleges of Education. Additionally, prior studies often examine ICT infrastructure, spatial location, or resource allocation separately rather than as interacting predictors of teaching and learning outcomes.

Hence, there exists a gap of limited empirical evidence specifically addressing North-Central Colleges of Education, where institutions differ considerably in geography, funding access, and infrastructural development.

This study fills that gap by providing a data-driven integrated analysis of how ICT infrastructure, spatial location, and resource allocation jointly influence teaching and learning outcomes in Colleges of Education in North-Central Nigeria.

## **1.3 Research Objectives**

The research is guided by the following objectives

1. To determine the effect of ICT infrastructure on students' learning outcomes in Colleges of Education in North-Central Nigeria.
2. To examine the effect of spatial location on students' learning outcomes in Colleges of Education in North-Central Nigeria.
3. To assess the effect of resource allocation on students' learning outcomes in Colleges of Education in North-Central Nigeria.
4. To determine the joint effect of ICT infrastructure, spatial location, and resource allocation on students' learning outcomes in Colleges of Education in North-Central Nigeria.

## **1.4 Research Questions**

1. What is the effect of ICT infrastructure on teaching and learning outcomes?
2. What is the effect of spatial location on teaching and learning outcomes?
3. What is the effect of resource allocation on teaching and learning outcomes?
4. What is the joint effect of ICT infrastructure, spatial location, and resource allocation on teaching and learning outcomes?

## 1.5 Research Hypotheses

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

H<sub>01</sub>: ICT infrastructure does not have any significant effect on students' outcomes.

H<sub>02</sub>: Spatial location does not have any significant effect on students' learning outcomes.

H<sub>03</sub>: Resource allocation has no significant effect on students' outcomes.

H<sub>04</sub>: ICT infrastructure, spatial location, and resource allocation have no significant joint effect on students.

## 2. Literature Review

### 2.1 Empirical Literature Review

Information and Communication Technology (ICT) infrastructure refers to the physical and digital facilities that support teaching, learning, research, and administration in educational institutions, including computers, internet connectivity, digital libraries, smart classrooms, software platforms, and technical support services. In higher education, ICT infrastructure has become a critical factor in improving instructional delivery, student engagement, and academic performance. Edward & Muraina (2024) found that technology-integrated curriculum resources significantly improved student engagement and academic achievement in tertiary institutions in Sokoto State, while infrastructural readiness remained essential for successful ICT adoption. Similarly, Kondoro, Maro & Mtebe (2025) reported that although lecturers acknowledged the usefulness of technology-enhanced learning tools, inadequate infrastructure and limited training constrained effective utilization. Tolorunleke et al. (2024) also observed that ICT tools such as Google Classroom and internet-enabled learning resources positively influenced students' academic performance, despite persistent challenges relating to poor connectivity and inadequate facilities. Furthermore, Mardiana & Yakub (2025) established a significant relationship between ICT literacy and lecturers' job productivity, concluding that digital competence enhances teaching effectiveness, student engagement, and professional efficiency in tertiary institutions.

Spatial location and resource allocation also play significant roles in determining the effectiveness of teaching and learning in Colleges of Education. Spatial location refers to the geographical setting and environmental conditions surrounding an institution, including urban-rural classification, accessibility, electricity supply, internet penetration, and proximity to economic and academic centers. Institutions in urban areas often enjoy better infrastructure and stronger digital preparedness than rural institutions. Idhalama, Oredo, & Makori (2025) found that universities located in more connected and urbanized areas in North-Central Nigeria demonstrated stronger readiness for digital transformation compared to institutions in less accessible locations. Resource allocation, on the other hand, involves the distribution of financial, human, material, and technological resources required for institutional development and academic quality. Ogwuche (2025) argued that effective ICT management in Nigerian tertiary institutions depends largely on proper administrative

planning and adequate budgetary support, while Islam & Ali Khan (2023) emphasized that sustainable investment in infrastructure and staff training is necessary for maximizing technology benefits in education. These studies collectively suggest that adequate ICT infrastructure, favorable spatial location, and effective resource allocation are essential determinants of quality teaching and learning outcomes in Nigerian tertiary institutions.

## **2.2 Theoretical Framework**

This study is anchored on Systems Theory and the Technology Acceptance Model (TAM). Systems Theory views educational institutions as interconnected systems made up of inputs, processes, outputs, and feedback mechanisms. Inputs such as ICT facilities, funding, institutional location, and human resources influence internal processes like teaching delivery, staff productivity, administrative efficiency, and student learning outcomes. These processes subsequently determine outputs such as academic performance, graduate quality, and institutional effectiveness. Feedback from these outputs enables institutions to improve planning and resource allocation. Within this framework, weak ICT infrastructure or poor resource allocation can disrupt institutional performance and reduce educational effectiveness (Iibi & Igbudu, 2025)

The Technology Acceptance Model explains how users accept and use technology based primarily on perceived usefulness and perceived ease of use. Perceived usefulness refers to the degree to which a person believes technology enhances job or learning performance, while perceived ease of use relates to how effortless the technology is perceived to be. In Colleges of Education, lecturers and students are more likely to adopt digital tools when systems are reliable, accessible, and beneficial to teaching and learning activities. Recent evidence from higher education environments confirms that infrastructure availability, digital competence, and institutional support significantly predict ICT readiness and technology acceptance among students and lecturers (Ahmad, Mohd Noor, Alwan, Gulzar, Khan, & Reegu, 2023).

## **3. Methodology**

### **3.1 Research Design**

This study adopted a quantitative research approach using a cross-sectional survey design. This design was considered appropriate because it enables the researcher to collect data from a large population regarding the current status of ICT infrastructure, institutional location factors, resource allocation practices, and teaching-learning outcomes in North Central Colleges of Education.

### **3.2 Population of the Study**

The target population comprised 1,920 lecturers, 9,650 students, 620 administrators, and 290 ICT personnel in public Colleges of Education in North-Central Nigeria. These groups were selected because they possess direct knowledge of instructional delivery, infrastructure availability, budget utilization, and student academic outcomes.

### **3.3 Sample Size and Sampling Technique**

A multistage sampling procedure was adopted, which include the following: A purposive sampling technique was used to select accredited public Colleges of Education across the North-Central zone. Within each selected institution, stratified random sampling was used to group respondents into lecturers, students, administrators, and ICT personnel. Finally, simple random sampling was then used to select participants proportionately.

Using Cochran’s sample size determination principle for large populations, a minimum sample of 600 respondents was considered which is statistically adequate and distributed as follows:

**Table 1: Population and Sample of the respondents**

Category	Population	Sample Size
Lecturers	1,920	180
Students	9,650	330
Administrators	620	60
ICT Personnel	290	30
<b>Total</b>	<b>12,480</b>	<b>600</b>

### 3.4 Sources of Data

Primary data were collected through structured questionnaires administered to respondents physically and through the use of google forms. Secondary data were obtained through official school records, including budget reports, student academic performance records, ICT inventory registers, accreditation reports, and relevant government education statistics. Access to institutional records was secured through appropriate permissions from selected colleges.

### 3.5 Instrument for Data Collection

The main instrument for primary data collection was a structured questionnaire titled: ICT Infrastructure, Spatial Location, Resource Allocation and Educational Outcomes Questionnaire (ICTSLREOQ). The questionnaire was divided into five sections: Section A: Demographic Information, Section B: ICT Infrastructure, Section C: Spatial Location, Section D: Resource Allocation and Section E: Teaching and Learning Outcomes. A 5-point Likert scale was used, which consist of 1= Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree and 5 = Strongly Agree was used to design the responses in sections B, C, D and E

### 3.6 Validity and Reliability Test

The instrument was titled ICT Infrastructure, Spatial Location, Resource Allocation and Educational Outcomes Questionnaire (ICTSLREOQ) was checked for face and content validity and a reliability test was performed using Cronbach Alpha to establish face and content validity, the instrument was presented to three experts in Educational Management, Measurement and Evaluation, and ICT in Education. Based on their ratings, a Content Validity Index (CVI) of 0.89 was obtained, indicating that the instrument possessed high content validity since values above 0.80 are considered acceptable. Additionally, the

Cronbach Alpha coefficient obtained was 0.82 implying that the instrument passed the reliability test as a value of 0.70 and above is acceptable.

### 3.7 Method of Data Analysis

The data collected for this study were coded, and analysed. using descriptive statistics of frequencies, percentages, means, and standard deviations, to answer the research questions by describing the levels and patterns of ICT infrastructure, spatial location, resource allocation, and learning outcomes in Colleges of Education in North-Central Nigeria. Regression analysis was applied to test the hypotheses to determine the individual and joint effects of ICT infrastructure, spatial location, and resource allocation on student learning outcomes, while Analysis of Variance (ANOVA) was used to assess the overall significance of the model. All tests were conducted at a 0.05 level of significance, which served as the criterion for accepting or rejecting the null hypotheses.

## 4. Results and Data Analysis

This section presents the results obtained from data collected from respondents based on the study objectives, research questions, and hypotheses. A total of 600 questionnaires were distributed across selected Colleges of Education in North-Central Nigeria. Out of these, 572 questionnaires were correctly completed and returned, representing a response rate of 95.3%, which was considered adequate for statistical analysis.

### 4.1 Response Rate of Questionnaire

**Table 2: Response Rate of Questionnaire Distribution and Retrieval**

Questionnaire Status	Frequency	Percentage (%)
Distributed	600	100.0
Returned	572	95.3
Not Returned	28	4.7
Total	600	100.0

Table 2 shows that 600 questionnaires were distributed to respondents across selected Colleges of Education in North-Central Nigeria. Out of the total distributed questionnaires, 572 were correctly completed and returned, representing a response rate of 95.3%, while 28 questionnaires representing 4.7% were not returned. The response rate was considered adequate for the study

### 4.2 Demographic Characteristics of Respondents

The following tables present the demographic characteristics of the respondents used for the study.

**Table 3: Distribution of Respondents by Category**

Respondent Category	Frequency	Percentage (%)
Students	314	54.9
Lecturers	172	30.1
Administrators	58	10.1

ICT Staff	28	4.9
<b>Total</b>	<b>572</b>	<b>100.0</b>

Table 3 presents the distribution of respondents by category. The result shows that students constituted the highest number of respondents with 314 respondents representing 54.9%, followed by lecturers with 172 respondents representing 30.1%. Administrators accounted for 58 respondents representing 10.1%, while ICT staff constituted 28 respondents representing 4.9%.

**Table 4: Distribution of Respondents by Gender**

Gender	Frequency	Percentage (%)
Male	331	57.9
Female	241	42.1
<b>Total</b>	<b>572</b>	<b>100.0</b>

Table 4 shows the gender distribution of respondents. The result indicates that 331 respondents representing 57.9% were male, while 241 respondents representing 42.1% were female.

**Table 4: Distribution of Staff Respondents by Years of Experience**

Years of Experience	Frequency	Percentage (%)
1–5 Years	84	32.6
6–10 Years	93	36.0
11 Years and Above	81	31.4
<b>Total</b>	<b>258</b>	<b>100.0</b>

Table 5 presents the years of experience of staff respondents. The result shows that respondents with 6–10 years of experience constituted the highest percentage with 36.0%, followed by respondents with 1–5 years of experience representing 32.6%, while respondents with 11 years and above represented 31.4%.

### 4.3 Analysis of Research Questions

#### Research Question 1: What is the level of ICT infrastructure available in Colleges of Education?

**Table 6: Mean Analysis of ICT Infrastructure in Colleges of Education in North-Central Nigeria**

ICT Infrastructure Indicators	Mean	Std. Dev.	Decision
Availability of Computers	3.42	1.01	Moderate
Internet Connectivity	2.98	1.14	Low
Power Supply Reliability	2.76	1.18	Low

Digital Classroom Facilities	3.11	1.07	Moderate
Technical Support Services	2.89	1.09	Low
<b>Grand Mean</b>	<b>3.03</b>	<b>1.10</b>	<b>Moderate</b>

Table 6 shows the level of ICT infrastructure available in Colleges of Education in North-Central Nigeria. The result revealed a grand mean score of 3.03, indicating a moderate level of ICT infrastructure availability. Availability of computers and digital classroom facilities recorded moderate levels, while internet connectivity, power supply reliability, and technical support services were relatively low.

Research Question 2: What is the effect of spatial location on teaching and learning outcomes in Colleges of Education

Table 7: Mean Analysis of Spatial Location Influence on Teaching and Learning Outcomes

<b>Spatial Location Indicators</b>	<b>Mean</b>	<b>Std. Dev.</b>	<b>Decision</b>
Accessibility by Road	3.56	0.96	High
Urban Advantage in ICT Access	3.71	0.89	High
Ease of Staff Recruitment	3.38	1.03	Moderate
External Partnerships Access	3.47	0.95	Moderate
Student Enrolment Advantage	3.62	0.92	High
<b>Grand Mean</b>	<b>3.55</b>	<b>0.95</b>	<b>High</b>

Table 7 presents the influence of spatial location on teaching and learning outcomes. The result revealed a grand mean score of 3.55, indicating that spatial location highly influences educational outcomes. Accessibility, urban ICT advantages, and student enrolment opportunities were identified as major location-related advantages.

Research Question 3: What is the level of resource allocation adequacy in Colleges of Education

Table 8: Mean Analysis of Resource Allocation Adequacy in Colleges of Education in North-Central Nigeria

<b>Resource Allocation Indicators</b>	<b>Mean</b>	<b>Std. Dev.</b>	<b>Decision</b>
Teaching Materials Funding	3.08	1.02	Moderate
ICT Budget Support	2.94	1.11	Low
Staff Development Funding	2.88	1.15	Low
Infrastructure Maintenance	3.01	1.04	Moderate
Operational Funding Stability	2.96	1.09	Low
<b>Grand Mean</b>	<b>2.97</b>	<b>1.08</b>	<b>Low</b>

Table 8 shows the level of resource allocation adequacy in Colleges of Education in North-Central Nigeria. The grand mean score of 2.97 indicates that resource allocation was generally low across the institutions. ICT budget support, staff development funding, and operational funding stability recorded low mean scores.

Research Question 4: What is the joint effect of ICT infrastructure, spatial location, and resource allocation on teaching and learning outcomes in Colleges of Education in North-Central Nigeria?

**Table 9: Multiple Regression Analysis Showing the Joint Effect of ICT Infrastructure, Spatial Location, and Resource Allocation on Teaching and Learning Outcomes**

Variables	Unstandardized Coefficient (B)	Std. Error	Standardized Beta ( $\beta$ )	t-Statistic	Sig.	Decision
Constant	0.512	0.118	—	4.34	0.000	—
ICT Infrastructure	0.418	0.048	0.418	8.62	0.000	Significant
Spatial Location	0.271	0.051	0.271	5.31	0.001	Significant
Resource Allocation	0.356	0.048	0.356	7.48	0.000	Significant

Table 9 presents the multiple regression analysis showing the joint effect of ICT infrastructure, spatial location, and resource allocation on teaching and learning outcomes in Colleges of Education in North-Central Nigeria. The result revealed that ICT infrastructure had a significant positive effect on teaching and learning outcomes ( $\beta = 0.418$ ,  $p < 0.05$ ). Spatial location also significantly influenced teaching and learning outcomes ( $\beta = 0.271$ ,  $p < 0.05$ ), while resource allocation had a significant positive effect on teaching and learning outcomes ( $\beta = 0.356$ ,  $p < 0.05$ ). The findings imply that improvements in ICT facilities, favorable institutional location, and adequate resource allocation contribute significantly to enhanced teaching and learning outcomes.

**Table 10: Summary of the Joint Effect of Predictor Variables on Teaching and Learning Outcomes**

Model Statistic	Value
R	0.781
R-Squared	0.610
Adjusted R-Squared	0.606
Standard Error of Estimate	0.822
F-Statistic	105.72
Prob(F-Statistic)	0.000
Number of Observations	572

Table 10 presents the summary of the regression analysis. The R-squared value of 0.610 indicates that ICT infrastructure, spatial location, and resource allocation jointly explained 61.0% of the variation in teaching and learning outcomes in Colleges of Education in North-Central Nigeria, while the remaining 39.0% could be attributed to other factors not included in the model. The F-statistic value of 105.72 with probability value less than 0.05 indicates that the model was statistically significant.

**Table 11: ANOVA Result for the Joint Effect of ICT Infrastructure, Spatial Location, and Resource Allocation on Teaching and Learning Outcomes**

Source	Sum of Squares	df	Mean Square	F	Sig.
Regression	214.621	3	71.540	105.72	0.000
Residual	384.113	568	0.676		
<b>Total</b>	<b>598.734</b>	<b>571</b>			

Table 11 presents the ANOVA result of the regression model. The result showed that the regression model was statistically significant ( $F = 105.72, p < 0.05$ ). This indicates that ICT infrastructure, spatial location, and resource allocation jointly had a significant effect on teaching and learning outcomes in Colleges of Education in North-Central Nigeria. Therefore, the null hypothesis stating that ICT infrastructure, spatial location, and resource allocation do not jointly have significant effect on teaching and learning outcomes was rejected.

#### 4.4 Hypotheses Testing and Multiple Regression Analysis

This section presents the results of hypothesis testing using multiple regression analysis and ANOVA at 0.05 level of significance.

**Table 12: Multiple Regression Analysis Showing the Joint Effect of ICT Infrastructure, Spatial Location, and Resource Allocation on Teaching and Learning Outcomes**

Variable	Coefficient	Std. Error	t-Statistic	Prob.	Decision
Constant	0.512	0.118	4.34	0.000	
ICT Infrastructure	0.418	0.048	8.62	0.000	Reject H01
Spatial Location	0.271	0.051	5.31	0.001	Reject H02
Resource Allocation	0.356	0.048	7.48	0.000	Reject H03

Table 12 presents the multiple regression analysis showing the effect of ICT infrastructure, spatial location, and resource allocation on teaching and learning outcomes. The result revealed that ICT infrastructure had a significant positive effect on teaching and learning outcomes ( $\beta = 0.418, p < 0.05$ ). Spatial location also had a significant positive effect ( $\beta = 0.271, p < 0.05$ ), while resource allocation significantly influenced teaching and

learning outcomes ( $\beta = 0.356, p < 0.05$ ). Therefore, hypotheses H01, H02, and H03 were rejected.

**Table 13: Model Summary of Joint Effect of Predictor Variables on Teaching and Learning Outcomes**

Statistic	Value
R-squared	0.610
Adjusted R-squared	0.606
F-statistic	105.72
Prob(F-statistic)	0.000
No. of Observations	572

Table 13 presents the model summary of the regression analysis. The R-squared value of 0.610 indicates that ICT infrastructure, spatial location, and resource allocation jointly explained 61.0% of the variation in teaching and learning outcomes. The adjusted R-squared value of 0.606 further confirmed the reliability of the model.

**Table 14: ANOVA Result for Joint Effect of ICT Infrastructure, Spatial Location, and Resource Allocation on Teaching and Learning Outcomes**

Source	Sum of Squares	df	Mean Square	F	Sig.
Regression	214.621	3	71.540	105.72	0.000
Residual	384.113	568	0.676		
Total	598.734	571			

Table 14 presents the ANOVA result for the regression model. The result revealed that the overall regression model was statistically significant ( $F = 105.72, p < 0.05$ ). This implies that ICT infrastructure, spatial location, and resource allocation jointly had a significant effect on teaching and learning outcomes in Colleges of Education in North-Central Nigeria. Therefore, hypothesis H04 was rejected.

## 5. Discussion of Findings

The study examined the influence of ICT infrastructure, spatial location, and resource allocation on teaching and learning outcomes in Colleges of Education in North-Central Nigeria. The findings revealed that all three variables significantly influenced institutional performance both independently and collectively. ICT infrastructure emerged as the strongest predictor of teaching and learning outcomes, indicating that institutions with better access to computers, internet facilities, digital classrooms, stable electricity supply, and technical support systems recorded better academic performance. Although the level of ICT infrastructure was found to be moderate, deficiencies still existed in internet access, power supply, and technical support services. The study further revealed that spatial location significantly affected institutional outcomes, as colleges situated in more accessible or urbanized areas demonstrated better staff attraction, student enrollment, ICT readiness, and partnership opportunities compared to institutions located in remote areas. These findings support existing studies which emphasize the importance of digital

infrastructure and geographical accessibility in improving educational quality and institutional effectiveness.

The study also found that resource allocation had a significant positive effect on teaching and learning outcomes, implying that institutions with adequate and stable funding performed better in infrastructure maintenance, staff development, instructional delivery, and academic support services. However, the low level of resource allocation observed in many institutions reflected persistent challenges of underfunding, irregular budget releases, and limited investment in ICT and staff capacity development. The regression analysis further showed that ICT infrastructure, spatial location, and resource allocation jointly explained 61.0% of the variation in teaching and learning outcomes, indicating substantial explanatory power of the model. The findings support Systems Theory, which explains that institutional performance results from the interaction of multiple interconnected factors rather than a single variable. Based on these findings, the study emphasized the need for increased ICT investment, equitable funding distribution, strategic institutional planning, lecturer ICT training, and targeted government intervention for institutions located in underserved areas to improve teaching and learning outcomes in Colleges of Education in North-Central Nigeria

### **Acknowledgement**

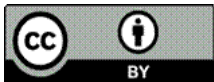
The authors sincerely appreciate and thank Tertiary Education Trust Fund of Nigeria (TetFund) for sponsoring and supporting this research work

---

### **References**

1. Abubakar, U., Ogunlade, O. O., & Ibrahim, H. A. (2024). The influence of technology-integrated curriculum resources on student engagement and academic achievement in higher education. *Advances in Mobile Learning Educational Research*, 4(2), 1208-1223.
2. Ogwuche, A. O. (2025). Assessing ICT Infrastructure and its Impact on Academic Planning and Administrative Effectiveness Among Nigerian University Lecturers. *Education Annals*, 2(7).
3. Iibi, J., & Igbudu, J. N. (2025). Effective Resource Utilization in Revitalising Educational Productivity in Nigeria: Challenges and Strategies. *International Journal of Educational Management*, Rivers State University., 1(2), 339-351.
4. Islam, Q., & Ali Khan, S. M. F. (2023). Integrating IT and sustainability in higher education infrastructure: Impacts on quality, innovation and research. *International Journal of Learning, Teaching and Educational Research*, 22(12), 210-236.
5. Mhlongo, S., Mbatha, K., Ramatsetse, B., & Dlamini, R. (2023). Challenges, opportunities, and prospects of adopting and using smart digital technologies in learning environments: An iterative review. *Heliyon*, 9(6).
6. Mardiana, H., & Yakub, Y. (2025). The impact of digital literacy and digital competence on online teaching productivity: the moderating role of work behavior. *Asian Association of Open Universities Journal*, 20(2), 104-121.
7. Mishra, A., Mishra, A., & Pandey, G. (2023). Spatial inequality and education: unraveling the geographical dimensions of educational disparities. *Techno Learn*, 13(1), 29-43.
8. Kondoro, A., Maro, S., & Mtebe, J. (2025). Adoption of Technology-Enhanced Pedagogical Methods in Higher Education: Faculty Engagement, eSkills and Barriers. In *2025 IST-Africa Conference (IST-Africa)* (pp. 1-11). IEEE.
9. Idhalama, O. U., Oredo, J. O., & Makori, E. O. (2025). Evaluating the availability and accessibility of digital resources and services in public university libraries in Nigeria. *Alexandria*, 35(1-2), 89-103.

10. Yu, Y., Appiah, D., Zulu, B., & Adu-Poku, K. A. (2024). Integrating rural development, education, and management: Challenges and strategies. *Sustainability*, 16(15), 6474.
11. Sabri, S. M., Ismail, I., Annuar, N., Rahman, N. R. A., Abd Hamid, N. Z., & Abd Mutalib, H. (2024). A conceptual analysis of technology integration in classroom instruction towards enhancing student engagement and learning outcomes. *Integration*, 9(55), 750-769.
12. Edward, M. O., & Muraina, K. O. (2024). The adoption of ICT tools for collaborative learning among students in Kenyan higher education institutions. *Seybold Report Journal*, 19(7), 71-95.
13. Luo, H., Zuo, M., & Wang, J. (2022). Promise and reality: Using ICTs to bridge China's rural-urban divide in education. *Educational technology research and development*, 70(3), 1125-1147.
14. Ademola-Popoola, D. S., & Adesina, J. A. (2025). Exploring the status and challenges of ICT network services and broadband utilization in revolutionizing Nigerian university. *Nigerian Journal of Technological Development*, 22(1), 39-50.
15. Okunoye, O., & Okunoye, O. (2022). Assessing level of availability and hindrances to adequacy of ICT facilities for the provision of E-resources services in university libraries in Southwest Nigeria. *Library Philosophy and Practice*, 7146.
16. Ahmad, S., Mohd Noor, A. S., Alwan, A. A., Gulzar, Y., Khan, W. Z., & Reegu, F. A. (2023). eLearning acceptance and adoption challenges in higher education. *Sustainability*, 15(7), 6190.
17. Yusuf, A. R., & Bello, M. I. (2024). Sampling adequacy in institutional survey studies within Nigerian higher education. *Journal of Quantitative Educational Studies*, 5(3), 140-156.
18. Yusuf, S., & Ibrahim, M. A. (2024). Educational services in Nigerian universities: Prospect, challenges and way forward. *Fuoye Journal of Educational Management*, 1(1).



© 2026 by the authors. Submitted for possible open access publication under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by-nc-sa/4.0/>).