THE APPLICATION OF ARTIFICIAL INTELLIGENCE IN TEACHINGGEOGRAPHY EDUCATION IN FEDERAL UNIVERSITIES, NIGER STATE

[1]Iwalaiye Elizabeth Mayokun, PhD, [2]Shu'aibu Dabo, Ph.D,[3]Mohammed Baba Jibril, [4]Suberu Habibat, [5]Murjanatu Garba Ayawa, [6]Abubakar Sani

[123456]Department of Social Science Education (Geography Section), Federal University of Education, Kontagora, Niger State.

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Abstract

The integration of artificial intelligence (AI) in geography education is reshaping pedagogical approaches globally, yet its adoption in some federal higher institutions, in Niger state remains limited and underexplored. This study examines the application of AI in teaching geography education across universities in the Niger State, focusing on Federal University of Technology Minna and Federal University of Education Kontagora. Employing a mixed-methods design, data were gathered through archival review of university curricula and literatures, semi-structured interviews with both academic staff and students. A total of 43 respondents were interviewed. The findings reveal that AI application can be examined through instructional support, spatial data analysis and modeling, immersive visualization, and assessment and feedback.However, challenges persist, including low level of awareness in the field of geography, the application are informal and at a basic level, inadequate internet connectivity, limited access to licensed software, inconsistent power supply, and insufficient training for lecturers on AI pedagogies. The study concludes that strategic investment in infrastructure, targeted faculty development programs, and partnerships with technology firms can facilitate the effective adoption of AI in geography teaching. Recommendations include integrating AI literacy into geography curricula, establishing university AI-GIS labs, and developing context-specific datasets for Niger State higher institutions. These measures can bridge the digital divide, improve learning outcomes, and prepare graduates for data-driven geospatial careers within and beyond the region.

Keywords: Artificial Intelligence, Geography, Universities, Teaching, Education

Introduction

Geography as an academic discipline examines the spatial relationships between people, places, and environments. In the 21st century, the teaching of geography has shifted from descriptive, map-centric instruction toward data-driven, analytical, and problem-solving approaches. A major catalyst for this transformation is Artificial Intelligence [AI], defined as the capacity of computational systems to perform tasks that typically require human intelligence, such as pattern recognition, prediction, and decision-making (Luckin, Holmes, Griffiths, &Forcier, 2016). In Nigerian higher education, and particularly in universities within the North Central geopolitical zone, the integration of AI into geography teaching presents an opportunity to modernize pedagogy, bridge resource gaps, and align training with labor market demands in geospatial technology and environmental management.

Federal Universities in Niger state have active geography departments and they offer courses that cover climatology, geomorphology, population geography, Geographic Information Systems [GIS], and remote sensing. Despite this coverage, geography instruction in the region faces persistent challenges that undermine effective teaching and skill development. First, there is a mismatch between curriculum delivery and the demands of the geospatial labor market. Employers increasingly require graduates who can apply AI-driven tools for land use classification, flood risk modeling, and environmental monitoring, yet most students graduate with minimal hands-on experience in these technologies (Oloke, Daramola, & Ayodele, 2021). This gap contributes to graduate unemployment and underemployment in the region.

Second, infrastructural and resource constraints limit exposure to AI applications. Many geography departments lack reliable internet connectivity, high-performance computing facilities, and licensed software required to run AI algorithms on large spatial datasets (Neteler&Mitasova, 2008). While open-source platforms such as QGIS and Google Earth Engine offer alternatives, their adoption remains low due to limited faculty training and institutional support. Consequently, students are often taught theoretical concepts without engaging in practical exercises that reflect real-world data analysis workflows (Chaka, 2020)

Third, faculty capacity poses a critical barrier. Most lecturers in Nigeria were trained before the rapid diffusion of AI in geosciences and lack formal training in machine learning, data science, and AI ethics (Zawacki-Richter, Marín, Bond, & Gouverneur, 2019). Without structured professional development, instructors are unable to integrate AI tools into course design, assessment, and feedback processes. This results in underutilization of available technologies and reinforces traditional pedagogical approaches that are less responsive to student needs and industry expectations.

Fourth, the absence of empirical evidence on the effectiveness of AI-enhanced geography teaching in the Nigerian context hinders policy and curricular reforms. While studies in Europe, Asia, and North America document improved student engagement, spatial reasoning, and analytical skills through AI integration (Huang, Rauch, & Liaw, 2020; Holmes, Bialik, & Fadel, 2019), there is a paucity of context-specific research in North Central Nigeria. Without localized data on adoption levels, challenges, and learning outcomes, university administrators and the National Universities Commission lack the evidence needed to guide investment and policy decisions.

The consequence of these gaps is a geography education system that remains disconnected from technological advancements and regional developmental needs. In Niger state, where issues such as desertification, flooding, urban sprawl, and farmer-herder conflicts require data-driven solutions, graduates are inadequately prepared to contribute to evidence-based planning and policy. If this problem persists, universities risk producing graduates who are ill-equipped for the digital economy, while opportunities to leverage AI for regional problem-solving remain unrealized.

Therefore, there is a need to investigate the application of AI in geography, the current state of AI application in geography teaching in the Federal Universities, identify the barriers to adoption, and examine its perceived impact on teaching effectiveness and student learning outcomes. Addressing this problem will provide empirical grounding for curriculum redesign, faculty training programs, and institutional investment in AI infrastructure.

Methodology

To conduct this study, the researcher mainly used the method of archival review, and interview method. The archival review helped to synthesis, analyze and evaluate existing research on AI in education to understand the current context in educational AI research. The study covers public Federal Universities in Niger State in that offer B.Sc./B.Sc Ed. programs in Geography. These include the Federal University of Technology (FUTH) Minna and Federal University of Education (FUE) Kontagora.The target population consists of Lecturers in geography departments and students in geography department. For sampling, first, purposive sampling to select the lecturers and students in geography departments, second, ethnography interview, sample size depends entirely on data saturation. However, as a general rule of thumb, key, in-depth informants or a broader pool of 30 to 50 participants across a larger study. Interviews were conducted face-to-face, recorded with consent, and transcribed verbatim. Data collection was taken within 4 weeks from 43 respondents.

Data Analysis was descriptive statistics using frequency counts. The thematic analysis was adopted for the interview highlights. It is highly flexible and commonly used fields in social science and education to interpret unstructured text, audio of visual data.

Results and Discussions

Archival Insights

The application of AI in geography teaching can be examined across four areas: instructional support, spatial data analysis and modeling, immersive visualization, and assessment and feedback.

1. AI for Instructional Support and Personalized Learning

AI-powered systems function as intelligent tutors and content assistants. Natural Language Processing (NLP) models can summarize complex texts, translate materials into local languages, and generate simplified explanations for students at different proficiency levels (Zawacki-Richter et al., 2019). In Niger State, where English is the medium of instruction but students often speak Hausa, Nupe, and Gbagyi as first languages, AI translation and paraphrasing tools can improve comprehension and reduce language barriers. Chatbots and virtual assistants can provide immediate responses to student queries on topics such as soil classification, urbanization processes, or climate change impacts, thereby reducing the burden on lecturers who manage high student-to-staff ratios. Research in sub-Saharan Africa shows that AI-driven adaptive learning platforms increase student engagement and retention by adjusting content difficulty based on learner performance. For geography departments with limited teaching assistants, such systems offer a scalable way to support individualized learning (Chaka, 2020).

2. AI in Spatial Data Analysis and Predictive Modeling

Modern geography relies heavily on quantitative analysis of satellite imagery, climate records, census data, and social media geotags. Machine learning algorithms can classify land cover, detect changes over time, and predict environmental outcomes faster than manual methods (Lary, Alavi, Gandomi, & Walker, 2016). In a teaching context, this allows students to work with real datasets on issues relevant to North Central Nigeria, such as mapping deforestation around Kontagora, analyzing flood risk in Shiroro dam, or modeling urban expansion in Minna. Tools like Google Earth Engine and open-source Python libraries integrate AI algorithms that students can apply with minimal coding background. Predictive modeling using AI also enables scenario-based learning. For example, students can simulate the impact of rainfall variability on agricultural productivity or model the spread of

desertification in Niger State. This approach moves instruction from memorization toward analytical reasoning and prepares graduates for roles in environmental consulting, disaster management, and urban planning (Oloke et al., 2021).

3. AI-Enhanced Visualization and Immersive Learning

Traditional geography teaching depends on static maps and atlases, which limit students' ability to visualize dynamic spatial processes. AI integrated with GIS platforms generates interactive dashboards, 3D terrain models, and automated cartographic outputs. Augmented Reality [AR] and Virtual Reality [VR] applications powered by AI can simulate field excursions to inaccessible or hazardous locations, such as coastal erosion sites or volcanic landscapes. For universities in Niger State where funding for fieldwork is constrained, these technologies provide a partial substitute that maintains the experiential component of geography education. Studies indicate that immersive learning environments improve spatial cognition and conceptual understanding in physical geography courses (Huang, et al., 2020). Moreover, AI-driven visualization tools can make complex data, such as climate projections from IPCC models, more accessible to undergraduate students (Goodchild, 2018).

4. AI in Assessment, Feedback, and Learning Analytics

AI transforms assessment by automating grading of objective tests, essays, and map interpretation exercises using NLP and image recognition (Holmes et al., 2019). Learning analytics platforms track student interactions with online materials, identify common misconceptions, and recommend remedial resources. For a lecturer teaching population geography at the University of Jos, analytics could reveal that a majority of students struggle with demographic transition concepts, prompting targeted revision. This data-informed approach supports formative assessment and timely intervention, which is critical in large classes. However, ethical considerations around data privacy, algorithmic bias, and academic integrity must be addressed through clear institutional policies (Williamson, 2017).

Current AI application in Department of Geography

The level of AI application is currently low and fragmented. Most geography departments in Niger State higher Institution use AI tools informally and at a basic level.

1. **Instructional support**: Lecturers and students mainly use free AI tools like ChatGPT, Grammarly, and Google Translate for lesson prep, summarizing texts, and language support. Structured AI-based learning platforms are rare.
2. **Spatial data analysis**: AI-enhanced GIS and remote sensing is limited to postgraduate students and a few staff with external training. Undergraduates mostly use manual classification in QGIS/ArcGIS. Google Earth Engine and Python-based machine learning are rarely taught.
3. **National University Commission (NUC) Benchmark Minimum Academic Standards (BMAS):** NUC already gives a baseline curriculum for the universities. The students are required to offer Remote Sensing (RS) and Geographic Information System (GIS) from 200-400 level but have not integrated AI in GIS.
3. **Visualization**: Static maps and PowerPoint dominate. AI-driven 3D terrain models, interactive dashboards, and VR/AR tools are not used due to lack of hardware, bandwidth, and training.

4. **Assessment**: Automated grading and learning analytics are not adopted. Lecturers rely on manual marking. Plagiarism checks are done using Turnitin, not AI-integrated systems.

The likely cause is limited infrastructure, low faculty training in AI/data science, and absence of institutional policy supporting AI integration.

Areas where AI is used in Department of Geography

- Geographic Information Systems (GIS): AI helps analyze spatial data and predict trends.
- Remote Sensing: AI processes satellite images for weather forecasting, land-use analysis, and disaster management.
- Urban Planning: AI models population growth and city expansion.
- Climate Studies: AI predicts climate change patterns and environmental risks.
- Teaching & Learning: AI tools (like virtual simulations and tutoring systems) improve understanding of geographical concepts.

Challenges and Contextual Constraints

Despite its potential, the adoption of AI in geography teaching in the institutions faces structural barriers. Inconsistent electricity supply and limited broadband connectivity restrict the use of cloud-based AI tools. Many departments lack high-performance computing infrastructure and licensed software, though open-source alternatives like QGIS with AI plugins offer low-cost options (Neteler&Mitasova, 2008). Faculty capacity is another constraint; most lecturers were trained before the proliferation of AI and require professional development in data science, machine learning, and AI ethics. Without targeted training, there is a risk of superficial adoption or resistance to change. Additionally, over-reliance on AI-generated outputs can undermine critical thinking if students fail to evaluate data quality, model assumptions, and spatial uncertainty core competencies in geography.

Interview Highlights

The application of AI in Geography in FUEK

The application of AI in Geography in FUEK is still at its preliminary stage. For now its application is restricted to GIS, spatial analysis & satellite imagery analysis. Even at this its usage is limited to staff.

Level of Awareness

Many students are not aware of AI tools like ChatGPT and GIS software. However, awareness is often basic and informal, mostly from social media. The use of AI in education is just about to be introduced in the curriculum.

Challenges identified:

1. Infrastructure: limited advanced infrastructure, Erratic power supply, poor internet, and lack of high-performance computers restrict use of cloud-based AI tools.
2. Capacity gap: Most lecturers lack training in machine learning, Python, and AI ethics. This creates low confidence in using and teaching AI tools.Limited specialized & skilled personnel
3. Cost and access: Licensed software and datasets are expensive. Open-source options exist but require technical skills students/staff don't have.

4. Curriculum rigidity: Current NUC-approved curricula have limited room for AI/data science modules in geography programs.

The application of AI in Geography in FUTH Minna

The level of AI application in FUTH Minna in the field of Geography in the institution is widely used in school of engineering, environmental sciences and Education. The current application of AI in Geography Department in the institution is still skeletal and not being used by a lot of Academic staff.

Level of Awareness

The challenge of AI application in Geography is inadequate awareness and support from the management. Many students are aware of AI tools like ChatGPT and GIS software. However, awareness is often basic and informal, mostly from: Social media, Online courses, Personal exploration. Formal integration into Geography curriculum is still limited in many Nigerian universities as well as FUTH Minna.

Challenges identified:

a. Poor Infrastructure: Unreliable electricity supply, Limited internet access and Lack of modern computer labs and AI tools.

b. Lack of Skilled Personnel: Many lecturers are not trained in AI tools, as many of them attended school when Ai is yet to be invented which makes teaching difficult, infact many lecturers have to go and learn on their own about the use of AI and GIS. There are Limited technical support staffs; this reduces effective teaching and implementation

c. High Cost of Implementation: AI software, hardware, and maintenance are expensive

d. Low Digital Literacy: Some students and lecturers lack basic ICT skills and there are difficulties in using AI tools effectively

e. Inadequate Curriculum Integration: AI is not fully included in Geography courses, most Teaching remains mostly theoretical

f. Academic Misuse of AI: Some students may use AI to cheat in assignments and avoid independent research

g. Policy and Institutional Gaps: There is lack of clear policies guiding AI usage and weak digital education strategies

h. Resistance to Change*:* Some lecturers prefer traditional teaching methods

Discussion of Findings

The application of Artificial Intelligence in geography teaching within North Central Nigeria universities presents both significant opportunity and substantial structural challenge. Geography as a discipline is inherently spatial, data-intensive, and dynamic. AI tools such as machine learning for remote sensing analysis, natural language processing for processing indigenous geographic knowledge, automated cartography, and AI-driven tutoring systems align directly with these needs.

Findings from current practice across the universities indicate that awareness of AI's potential is about to start growing among lecturers and students, this findings align with Patrick (2025), stating that Nigerian higher education institution, universities, polytechnics and colleges, are still at early stages of integrating artificial intelligence (AI) into their

curriculum and teaching. If access exists, AI will enhanced GIS platforms and improve students' ability to analyze land use change, flood risk, and climate variability using real datasets from the region. This will made abstract concepts more concrete and increased student engagement. AI also enables the handling of large, unstructured datasets that manual methods cannot process efficiently, which is critical given the region's complex terrain, climate shifts, and socio-economic dynamics.

However, the adoption remains fragmented and constrained. The primary barriers are infrastructural and human. Inconsistent electricity and internet connectivity disrupt the use of cloud-based AI tools. Most departments lack dedicated AI-GIS laboratories and rely on outdated computers that cannot run modern models. Licensing costs for advanced software limit access to open-source alternatives, which many lecturers are not trained to use. Digital literacy among faculty varies widely, with senior lecturers often lacking exposure to AI pedagogies. There is also a scarcity of locally contextualized datasets, forcing reliance on global data that may not reflect the realities of Niger state. Without deliberate intervention, the risk is that geography teaching will fall further behind global standards, producing graduates unprepared for data-driven roles in urban planning, environmental management, and geospatial analysis.

Despite these gaps, the region's academic institutions possess key advantages: active field sites for data collection, diverse ecological zones, and strong indigenous knowledge systems that can enrich AI models. If leveraged correctly, AI can transform geography departments from theory-focused units into applied research hubs that address local problems such as desertification, farmer-herder conflict mapping, and urban sprawl.

Perceived impact if adopted:

1. Positive on teaching effectiveness: Lecturers expect AI to reduce workload in grading, improve visualization of complex concepts like climate change, and enable case studies using local data from Benue Valley, Kainji Lake, Abuja, etc.
2. Positive on learning outcomes: Students anticipate better understanding of spatial analysis, improved data handling skills, and higher employability in GIS, urban planning, and environmental consulting.
3. Risk of over-reliance: Both staff and students express concern that AI could reduce critical thinking and fieldwork skills if not well managed.

Conclusion

The application of AI in geography teaching in Niger State Federal Universities is both feasible and necessary for modernizing the discipline. By enhancing instructional support, enabling advanced spatial analysis, improving visualization, and refining assessment, AI can help bridge resource constraints and align curricula with 21st-century demands. Realizing this potential requires investment in infrastructure, faculty training, curriculum redesign, and a pedagogical approach that uses AI to augment rather than replace core geographical skills such as fieldwork, spatial reasoning, and critical evaluation. As the region's universities navigate digital transformation, AI offers a pathway to make geography education more relevant, accessible, and impactful for students and their communities.

Nigeria's National Digital Economy Policy and Strategy 2020–2030 and the National Universities Commission's ICT integration guidelines create a supportive policy environment for AI adoption in higher education. Student interest in geospatial technology is growing due to employment opportunities in urban planning, environmental NGOs, and international development agencies. Universities in Niger State can position themselves as centers for AI-

enabled geography education that addresses local challenges such as farmer-herder conflicts, flooding, and land degradation while producing graduates with transferable digital skills.

Recommendations

1. **Invest in AI-GIS Infrastructure and Access:** Universities should establish dedicated AI-GIS laboratories equipped with high-performance computers, stable power solutions such as solar backups, and reliable internet. Federal and state governments, through TETFund and NUC, should prioritize funding for these labs. Departments should also adopt open-source platforms like QGIS, GRASS GIS, and Python-based libraries to reduce licensing costs.
2. **Develop Faculty Capacity Systematically**: Regular workshops and short courses on AI applications in geography should be mandated for lecturers. Partnerships with institutions like NASRDA, NIMET, and tech firms can provide training on machine learning, remote sensing automation, and data science. Peer mentoring programs within departments can help spread skills faster.
3. **Integrate AI Literacy into the Curriculum:** Undergraduate and postgraduate geography curricula should include compulsory modules on GIS, remote sensing, and introductory AI for geospatial analysis. Final-year projects should encourage the use of AI tools to solve regional problems, ensuring students graduate with practical skills.
4. **Build Contextualized Local Datasets**: Universities should collaborate with state ministries, traditional institutions, and communities to collect and digitize local geographic data. Participatory mapping and interviews can supply labeled datasets for training AI models on land use, erosion, and conflict. This reduces dependence on generic global data and improves model accuracy.
5. **Foster Industry and Research Partnerships**: Departments should establish linkages with geospatial firms, NGOs, and government agencies operating in the region. These partnerships can provide internship opportunities, real-world datasets, and funding for AI-driven research projects.
6. **Address Policy and Ethical Frameworks:** Universities should develop clear guidelines on data privacy, ethical AI use, and academic integrity as these tools are adopted. Students must be trained not only to use AI but to critically evaluate its outputs.

If implemented, these steps can position Nigeria's universities to use AI not as an imported novelty but as a tool for solving regional geographic challenges, improving teaching quality, and producing graduates competitive in the geospatial job market.

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