

IMPACT OF ARTIFICIAL INTELLIGENCE (AI) ON CURRICULUM DESIGN AND 21ST-CENTURY SKILLS IN SECONDARY SCHOOLS IN KANO STATE, NIGERIA

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Abstract

The study examined impact of artificial intelligence (AI) on curriculum design and 21st century skills in secondary schools in Kano State, Nigeria. The study adopted descriptive survey research design. Five specific objectives and corresponding research questions guided the study. The total population is 46,783 teachers'. Samples of 382 respondents were selected for the study. The instrument for data collection was titled "Impacts of Artificial Intelligence, Curriculum Design and 21st-Century Skills Questionnaire (IAICD21SQ)" designed by the researcher. The reliability coefficient of the instrument yielded 0.83. Data collected were analysed using descriptive statistics mean and standard deviation. The study revealed that AI is integrated into curriculum design in secondary schools in Kano State to a moderate extent, but implementation remains inconsistent.. The study also found that AI contributes significantly to students' 21st-century skills development. The findings also revealed those most prominent challenges affecting AI integration in secondary schools includes; poor infrastructure, lack of teacher training, unreliable electricity, internet facilities and limited policy support. The study concluded that Artificial Intelligence has a significant and positive impact on curriculum design and the development of 21st-century skills in secondary schools. Based on the findings recommendations were made that The National Educational Research and Development Council (NERDC) and the State's teaching service board should collaborate to review the secondary school curriculum. It must be made more flexible to allow teachers to integrate AI tools and project-based learning that develops 21st-century skills, moving away from a purely examination-centric model.

Keywords: Artificial Intelligence, Curriculum design, 21st century skills, Secondary schools, Impacts

Introduction

Artificial Intelligence (AI) has emerged as one of the most transformative innovations in contemporary education. Across the world, AI is changing how curricula are designed, delivered, assessed, and improved. In the context of secondary education, AI is increasingly being used to support personalized learning, adaptive assessment, intelligent tutoring systems, automated feedback, data-driven decision-making, and digital content creation. These developments have profound implications for curriculum design and for the development of 21st-century skills such as critical thinking, creativity, communication, collaboration, digital literacy, problem-solving, and self-directed learning. The 21st century is characterized by rapid technological advancement, with Artificial Intelligence (AI) emerging as a transformative force across various sectors, including education (Akinwalere & Ivanov, 2022). Globally, AI promises to personalize learning, automate administrative tasks, and provide data-driven insights to enhance educational outcomes. For Nigeria, a nation striving to meet its Sustainable Development Goals (SDG 4) and equip its youth with future-ready skills, integrating AI into the educational system is no longer a luxury but a necessity (Okonkwo & Ade-Ibijola, 2023). The concept of 21st-century skills has become central to global and national educational reforms. These skills include digital competence, critical thinking, creativity, innovation, collaboration, communication, adaptability, leadership, information literacy, and lifelong learning abilities. In the Nigerian secondary school context, the development of these skills is essential for preparing students for higher education, entrepreneurship, employment, and civic participation in a rapidly changing world. Scholars in Nigeria have increasingly argued that educational systems must be restructured to align with emerging technological realities and to prepare learners for participation in the Fourth Industrial Revolution.

In Nigeria, the growing adoption of digital technologies in education has accelerated conversations around AI integration into teaching and learning, especially after the disruptions caused by the COVID-19 pandemic. Educational stakeholders now recognize that traditional curriculum models may no longer be sufficient to prepare learners for a technology-driven society and labour market. Consequently, there is increasing interest in how AI can be embedded into curriculum planning, content delivery, instructional methods, assessment systems, and learner support mechanisms in secondary schools.

Curriculum design refers to the systematic planning, organization, implementation, and evaluation of learning experiences in order to achieve educational objectives. In the 21st century, curriculum design is expected to move beyond content transmission toward competency-based learning that equips students with practical, cognitive, digital, and socio-emotional skills. AI can significantly influence curriculum design by helping schools identify learners' needs, analyze learning data,

generate instructional resources, differentiate content, and support competency-based assessment. Through AI-powered tools, teachers can tailor learning experiences to diverse learner profiles, making the curriculum more responsive, flexible, inclusive, and relevant. Curriculum design, the blueprint for educational delivery, is at the heart of this transformation. Traditional, rigid curricula are often criticized for failing to meet the dynamic needs of the digital economy. AI offers tools to create adaptive and dynamic curricula that can respond to individual student needs and emerging industry trends (Eze, Chinedu-Eze, & Bello, 2024). In parallel, there is a global emphasis on fostering 21st-century skills; critical thinking, creativity, collaboration, communication, digital literacy, and problem-solving. These skills are deemed essential for learners to thrive in an increasingly complex and interconnected world (Partnership for 21st Century Skills, as cited in Nwosu & Ogbonna, 2022).

Kano State, being one of the most populous states in Nigeria and a major educational hub in Northern Nigeria, presents a significant context for examining the role of AI in secondary education. Despite ongoing reforms and increasing awareness of digital transformation, many secondary schools in Kano State still face challenges such as inadequate infrastructure, poor internet connectivity, limited teacher digital competence, insufficient policy guidance, low access to educational technologies, and unequal distribution of ICT facilities between urban and rural schools. These conditions may influence both the extent to which AI can be integrated into curriculum design and the degree to which students can acquire relevant 21st-century skills. (Shaibu, 2025). Secondary schools face challenges such as large class sizes, inadequate resources, and a need to align its educational output with the demands of a modernizing economy (Yusuf & Mohammed, 2024). The potential of AI to revolutionize curriculum design and nurture 21st-century skills in Kano's secondary schools is significant, yet it remains largely untapped and under-researched.

This study is therefore designed to examine the impact of Artificial Intelligence on curriculum design and the development of 21st-century skills in secondary schools in Kano State, Nigeria. The study will provide evidence-based insights for policymakers, school administrators, curriculum planners, teachers, and other educational stakeholders on how AI can be responsibly and effectively integrated into secondary education for improved learning outcomes. The growing global shift toward Artificial Intelligence (AI) in education has created new possibilities for transforming curriculum design and enhancing the acquisition of 21st-century skills among learners. However, in many Nigerian secondary schools, especially in states such as Kano, curriculum implementation remains largely traditional, teacher-centred, examination-driven, and insufficiently aligned with the digital demands of modern society. Although national discourse increasingly emphasizes innovation, digital learning, and technology integration, the practical incorporation of AI into secondary school curriculum design appears limited, inconsistent, or poorly understood. In Kano State, secondary schools operate

in a context characterized by rapid population growth, varying levels of educational access, infrastructural inequalities, and significant differences between urban and rural schools. While some schools may have limited exposure to digital tools, many others continue to struggle with inadequate ICT facilities, unreliable electricity, limited internet access, lack of AI-related instructional resources, and insufficient teacher capacity for technology-enhanced pedagogy. These conditions raise serious concerns about whether students in Kano State are being adequately prepared with the competencies required in the 21st century. The problem is further compounded by the fact that most secondary school curricula in practice still prioritize content memorization and examination performance rather than creativity, collaboration, critical thinking, problem-solving, and digital literacy. Yet these are the very skills that AI-supported curriculum systems are expected to promote.

If AI is not strategically integrated into curriculum design, students may graduate without the necessary skills to compete in higher education, employment, entrepreneurship, and a technologically advanced society. Another dimension of the problem is the limited empirical evidence on how AI is currently influencing curriculum design in secondary schools in Kano State. While there is increasing general discussion about AI in education in Nigeria, there is still inadequate localized research focusing specifically on: the extent of AI awareness and adoption in secondary schools,, how AI affects curriculum planning and instructional delivery, whether AI contributes meaningfully to the development of 21st-century skills, and, the barriers that hinder effective AI integration in Kano State. Without such evidence, policymakers, curriculum developers, and school leaders may continue to make decisions without a clear understanding of what works, what does not, and what contextual factors matter most. This creates a risk of policy mismatch, inefficient resource allocation, superficial digital reforms, and missed opportunities to modernize secondary education. Therefore, the problem of this study is that despite the growing importance of AI in global education, there is inadequate evidence on its actual impact on curriculum design and 21st-century skills development in secondary schools in Kano State, Nigeria. This study seeks to fill that gap by investigating how AI is being used, the extent to which it influences curriculum practices, its contribution to 21st-century skills acquisition, and the major challenges affecting its implementation.

The study examined the impact of Artificial Intelligence (AI) on curriculum design and 21st-century skills in secondary schools in Kano State, Nigeria.

Specifically, the study seeks to:

1. determine the extent to which AI is integrated into curriculum design in secondary schools in Kano State;

2. examine the influence of AI on instructional planning and curriculum delivery in secondary schools in Kano State;
3. assess the impact of AI on students' acquisition of 21st-century skills in secondary schools in Kano State;
4. identify the challenges affecting the effective use of AI in curriculum design and teaching-learning processes in secondary schools in Kano State;
5. determine strategies for improving AI integration into curriculum design for enhanced 21st-century skills development in secondary schools in Kano State.

The following research questions will guide the study:

1. To what extent is AI integrated into curriculum design in secondary schools in Kano State?
2. How does AI influence instructional planning and curriculum delivery in secondary schools in Kano State?
3. What impact does AI have on students' acquisition of 21st-century skills in secondary schools in Kano State?
4. What challenges affect the effective use of AI in curriculum design and teaching-learning processes in secondary schools in Kano State?
5. What strategies can improve AI integration into curriculum design for enhanced 21st-century skills development in secondary schools in Kano State?

Literature Review

Concept of Artificial Intelligence (AI) in Education

Artificial Intelligence (AI) is a field of technology concerned with the development of intelligent systems capable of performing tasks that ordinarily require human intelligence, such as learning, reasoning, decision-making, and problem-solving. In the educational context, AI includes tools such as adaptive learning software, automated grading systems, chatbots, predictive analytics, and intelligent tutoring systems used to improve teaching and learning. Artificial Intelligence (AI) has been defined by different scholars as the simulation or augmentation of human intelligence through digital systems capable of learning, reasoning, solving problems, and making decisions. According Donatus and Obona (2026) stated that Artificial Intelligence (AI) refers to computer driven systems capable of performing tasks that ordinarily require human intelligence, such as perception, reasoning, problem solving, decision making, speech recognition, and language processing. Adebayo (2022) defined AI as the simulation of human intelligence in machines and software systems that can learn from data and make decisions with minimal human intervention. Similarly,

Okonkwo and Yusuf (2023) described AI as the use of computer-based algorithms to imitate human cognitive processes such as reasoning, pattern recognition, and language processing. Ibrahim (2023) further viewed AI as a digital innovation that enables machines to perform tasks traditionally associated with human intelligence. In the same vein, Ogunleye and Bello (2024) saw AI as intelligent technological systems that augment human capabilities through automation and personalization, while Eze and Nwachukwu (2025) defined it as a branch of computer science concerned with creating systems that can think, learn, and respond intelligently to environmental inputs.

Concept of Curriculum Design

Curriculum design is the systematic planning and organization of educational goals, subject content, learning experiences, instructional strategies, and evaluation procedures in order to facilitate effective teaching and meaningful learning. It determines what learners are expected to know, how they should learn it, and how their learning should be assessed. Curriculum design refers to the systematic planning and organization of educational experiences to achieve desired learning outcomes. Akinyemi (2022) defined curriculum design as the deliberate process of selecting and sequencing educational content, learning experiences, and assessment procedures to achieve educational goals. Garba and Musa (2022) described it as the framework through which educational planners determine what learners should learn, why they should learn it, how it should be taught, and how it should be evaluated. Nwafor (2023) viewed curriculum design as the structuring of educational programmes in line with learner needs, societal expectations, and national goals. Likewise, Salihu and Abdullahi (2024) defined it as the organization of instructional content, teaching methods, and evaluation into a coherent educational structure, while Afolabi (2025) emphasized its dynamic and learner-centered nature in response to contemporary realities and technological advancement.

Therefore, curriculum design can be regarded as the structured planning and alignment of learning objectives, content, instructional strategies, and evaluation procedures. In this study, it refers to the planning and organization of subject content, instructional methods, and learning experiences in secondary schools.

Theoretical Framework

This study is anchored on the Constructivist Learning Theory, developed by Jean Piaget and later expanded by Lev Vygotsky. The theory emphasizes that learners actively construct knowledge through interaction with their environment and learning experiences. Constructivism suggests that

effective learning occurs when students engage in problem-solving, inquiry-based learning, and collaborative activities. AI technologies support this approach by providing interactive learning platforms, simulations, and personalized learning experiences. According to Okunade (2024), AI-based instructional tools promote constructivist learning by enabling students to explore academic concepts independently while receiving immediate feedback. Similarly, Bali, Garba, Ahmadu, and Malgwi. (2024) noted that AI technologies create learner-centered environments that encourage experimentation, creativity, and collaboration among students. Therefore, the Constructivist Learning Theory provides a strong theoretical foundation for integrating Artificial Intelligence into curriculum design because it supports active learning and the development of 21st-century skills.

Empirical Studies

Study by Adebayo and Yusuf (2022) conducted an empirical investigation on the integration of Artificial Intelligence technologies in teaching and learning processes in secondary schools in Lagos State. The study adopted a descriptive survey research design involving 420 teachers and 180 school administrators selected through stratified random sampling. Data were collected using a structured questionnaire titled Artificial Intelligence Integration Scale (AIIS). The results indicated that AI technologies such as adaptive learning systems, intelligent tutoring platforms, and automated assessment tools significantly improved instructional delivery and curriculum implementation. The findings further showed that AI-supported learning environments enhanced students' critical thinking, digital literacy, and collaborative learning skills, which are key components of 21st-century competencies. The researchers concluded that incorporating AI into curriculum design would enable Nigerian schools to move from traditional teacher-centered instruction to learner-centered and competency-based education.

Study by Olatunji and Adeyemi (2022) investigated the relationship between AI-supported learning environments and students' development of 21st-century skills in public secondary schools in Oyo State. The researchers employed a correlational research design with a sample of 500 senior secondary school students. The findings revealed a significant positive relationship between the use of AI learning technologies and students' acquisition of creativity, problem-solving, and communication skills. The study also revealed that AI-based instructional platforms allowed teachers to personalize learning experiences, thereby improving students' academic engagement and independent learning abilities.

Study by Ibrahim and Abdullahi (2023) examined the impact of Artificial Intelligence on curriculum development in secondary schools in Kano State. The study adopted a mixed-method research design, combining surveys and interviews among 350 teachers and curriculum planners. The results

showed that AI technologies improved curriculum planning, lesson design, and instructional evaluation. Teachers who used AI-supported teaching tools reported improved classroom interaction and better monitoring of students' learning progress. The study also revealed that AI-integrated curricula enhanced students' information literacy, innovation skills, and analytical thinking, which are essential for success in the digital age. Study by Eze and Okeke (2023) carried out a study on the effectiveness of AI-supported instructional technologies in improving students' academic engagement in secondary schools in Enugu State. The study adopted an experimental research design with two groups: experimental and control groups consisting of 120 students. The findings indicated that students exposed to AI-supported instruction demonstrated higher levels of motivation, creativity, and critical thinking compared with those taught using traditional teaching methods. The study concluded that AI-driven curriculum delivery encourages interactive learning and collaborative problem-solving, which are important components of 21st-century education.

Study by Ogunleye and Akinwale (2023) investigated teachers' readiness for the integration of Artificial Intelligence in curriculum delivery in public secondary schools in Ogun State. The study used a survey research design with 300 teachers as participants. The results revealed that although teachers had a positive perception of AI integration, many lacked the necessary technical skills and training required to effectively utilize AI tools in teaching. The study emphasized that AI integration could significantly improve student-centered curriculum design and technology-enhanced learning if teachers receive adequate professional development. Musa and Bello (2024) conducted a study on the role of Artificial Intelligence in enhancing students' digital competence in secondary schools in Kaduna State. The study employed a quasi-experimental design involving 200 students in senior secondary schools. The findings revealed that students who learned through AI-supported digital platforms demonstrated higher levels of digital literacy, collaboration skills, and innovative thinking. The study concluded that AI integration in curriculum design can prepare students for the Fourth Industrial Revolution and future technological careers. Nwankwo and Chukwu (2024) examined the influence of Artificial Intelligence on personalized learning in secondary schools in Imo State. The researchers used a descriptive survey design involving 280 teachers and 420 students. The results showed that AI-driven adaptive learning systems improved individualized instruction, student engagement, and self-directed learning. The study emphasized that AI technologies enable teachers to modify curriculum content to suit individual student learning needs, thereby promoting inclusive and effective education.

Salisu and Lawal (2024) conducted a study on the effect of Artificial Intelligence-supported learning on students' creativity and innovation skills in secondary schools in Sokoto State. The study adopted a pre-test and post-test experimental design with 150 students. The findings indicated that students exposed to AI-supported project-based learning developed stronger creative thinking, innovation

skills, and teamwork abilities than those taught using conventional teaching methods. Study by Uche and Okoro (2025) examined the influence of Artificial Intelligence technologies on curriculum innovation in Nigerian secondary schools. The study employed a descriptive research design involving curriculum developers, teachers, and education administrators. The study found that AI integration encourages the adoption of competency-based curriculum frameworks that emphasize skills such as problem-solving, digital literacy, creativity, and critical thinking. However, the study also identified challenges including limited funding, poor infrastructure, and inadequate policy support. Study by Garba and Sani (2025) investigated the role of Artificial Intelligence in improving students' 21st-century skills acquisition in secondary schools in Northern Nigeria. The researchers used a survey design with 450 students and teachers. The findings revealed that AI-supported learning environments significantly improved students' communication skills, collaboration abilities, and technological competence.

However, gaps exist in the literature. Few studies examined the link between AI and curriculum implementation and students performance in secondary schools in Kano State using recent data. Most existing studies focus on either integration or students performance without adequately exploring the impacts of AI, specifically on Curriculum design and 21st century skills. This study aims to fill these gaps.

Research Methodology

The study adopted a descriptive survey research design. This design is appropriate because it enables the researcher to collect data from teachers and school administrators on their perceptions and experiences regarding the impact of AI on curriculum design and 21st-century skills.

The target population comprised all teachers and school administrators in public secondary schools across Kano State. The total population is 46,783 teachers'. A sample of 382 respondents were selected for the study, comprising: 307 teachers, 50 principals/vice principals, 25 ICT coordinators. A multistage sampling technique was used: Stratified sampling to categorize schools into urban and rural; Simple random sampling to select schools from each stratum; Purposive sampling to select principals and ICT coordinators; Simple random sampling to select teachers.

The instrument for data collection was titled "Impacts of Artificial Intelligence, Curriculum Design and 21st-Century Skills Questionnaire (IAICD21SQ)" designed by the researcher. The questionnaire has five sections A - E: Section A: AI Integration into Curriculum Design with 6 items; Section B: AI influence instructional planning and curriculum delivery with 6 items; Section C: Impact of AI on Students' 21st-Century Skills with 8 items; Section D: Challenges Affecting AI Integration with

7 items; Section E: Strategies for Improving AI Integration with 7 items. All items are structured on a four-point Likert scale: Strongly Agree (4), Agree (3), Disagree (2), and Strongly Disagree (1).

The instrument was subjected to face and content validity by experts in Curriculum Studies, Educational Technology, and Measurement and Evaluation from Bayero University Kano, their suggestions were impropriated into the final copy of the instrument. A pilot test was conducted using 30 respondents outside the study sample but with the same characteristics. Data collected were analyzed using Cronbach's Alpha to determine internal consistency. The reliability coefficient yielded 0.83. This indicates the instrument is reliable.

The researcher obtains permission from principals of the selected schools. Researcher and trained research assistants administered the questionnaires directly to sampled teachers during school hours. Respondents were given adequate time to complete the instrument, completed questionnaires are collected on the spot.

Data collected were analysed using descriptive statistics. Research questions are answered using mean and standard deviation. A critical mean score of 2.50 and above is considered acceptable (agreement), while below 2.50 is considered unacceptable (disagreement). Also Mean Scores Scale: 0 - 1.99 (low extent), 2.00 - 2.99 (Moderate extent), 3.00 - 4.00 (High extent)

Results

Research Question 1: To what extent is AI integrated into curriculum design in secondary schools in Kano State?

Table 1: Extent of AI Integration into Curriculum Design

SN	Items	Mean	SD	Decision
1	AI tools are used in planning lessons in my school.	2.18	1.02	Moderate extent
2	Teachers use AI-supported digital platforms to organize learning content.	2.25	0.93	Moderate extent
3	AI is considered when designing instructional activities in my school.	2.20	0.91	Moderate extent
4	Curriculum delivery in my school incorporates AI-based educational applications.	2.18	1.02	Moderate extent
5	AI is used to adapt teaching materials to learners' needs	2.25	0.93	Moderate extent

6	AI supports curriculum review and improvement in my school.	2.30	0.99	Moderate extent
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Grand Mean Score = 2.23

Mean Scores Scale: 0 - 1.99 (low extent), 2.00 - 2.99 (Moderate extent), 3.00 - 4.00 (High extent)

The Table 1 above shows the grand mean score of 2.23, it indicated that AI integrated into curriculum design in secondary schools in Kano State is to moderate extent. The teachers' disagreed that AI tools are used in planning lessons in schools (mean = 2.18), Teachers use AI-supported digital platforms to organize learning content. (Mean = 2.25), AI is considered when designing instructional activities in schools (Mean = 2.20), Curriculum delivery in school incorporates AI-based educational applications (Mean = 2.18), AI is used to adapt teaching materials to learners' needs (Mean = 2.25), AI supports curriculum review and improvement in schools (Mean = 2.30). AI is integrated into curriculum design in secondary schools in Kano State to a moderate extent, but implementation remains inconsistent.

Research Question 2: How does AI influence instructional planning and curriculum delivery in secondary schools in Kano State?

Table 2: Influence of AI on Instructional Planning and Curriculum Delivery

SN	Items	Mean	SD	Decision
7	AI helps teachers prepare lessons more efficiently.	3.45	1.09	Agreed
8	AI improves the quality of instructional materials used in teaching.	3.80	0.96	Agreed
9	AI supports differentiated instruction for students with varying abilities.	3.96	0.911	Agreed
10	AI enhances classroom engagement during teaching and learning.	3.70	0.89	Agreed
11	AI helps teachers monitor students' progress more effectively.	3.56	0.79	Agreed
12	AI improves assessment and feedback during curriculum delivery	3.60	0.93	Agreed
Grand Mean Score = 3.68				

The Table 2 above shows influence instructional planning and curriculum delivery in secondary schools in Kano State. The grand mean score of 3.68. It indicated that Respondents agreed that AI has a positive influence on instructional planning and curriculum delivery.

Research Question 3: What impact does AI have on students' acquisition of 21st-century skills in secondary schools in Kano State?

Table 3: Impact of AI on Students' 21st-Century Skills

SN	Items	Mean	SD	Decision
13	AI-supported learning improves students' critical thinking skills.	2.84	0.89	Agreed
14	AI encourages students' creativity and innovation.	3.05	0.87	Agreed
15	AI promotes collaboration among students during learning activities.	2.67	0.97	Agreed
16	AI enhances students' communication skills through digital interaction.	3.18	0.80	Agreed
17	AI improves students' digital literacy and technology competence	2.84	0.89	Agreed
18	AI strengthens students' problem-solving skills	3.26	0.78	Agreed
19	AI promotes self-directed learning among students.	2.75	0.96	Agreed
20	AI helps students develop adaptability and lifelong learning skills.	2.83	0.88	Agreed
Grand Mean Scores = 2.93				

The Table 3 above shows the impact of AI on Students' 21st-Century Skills. Grand mean score of 2.93 is more than criteria mean of 2.50. The AI contributes significantly to the development of 21st-century skills, particularly: communication skills, creativity and innovation, critical thinking, problem-solving, collaboration skill, digital literacy and technology competence

Research Question 4: What challenges affect the effective use of AI in curriculum design and teaching-learning processes in secondary schools in Kano State?

Table 4: Challenges Affecting AI Integration

SN	Items	Mean	SD	Decision
21	Inadequate ICT infrastructure limits the use of AI in my school.	3.80	0.96	Agreed

22	Poor internet connectivity hinders AI-supported teaching and learning.	3.96	0.91	Agreed
23	Insufficient electricity supply limits the use of AI tools.	3.49	1.18	Agreed
24	High cost of AI technologies affects adoption in schools.	3.79	1.01	Agreed
25	Lack of policy guidance on AI in education affects implementation.	3.61	0.93	Agreed
26	Limited awareness of AI tools among teachers reduces effective usage.	3.50	1.23	Agreed
27	Students' unequal access to digital devices affects AI-based learning.	3.75	0.99	Agreed

Grand Mean Score = 3.70

Table 4 shows challenges affect the effective use of AI in curriculum design and teaching-learning processes. The result revealed major barriers to effective AI integration are Inadequate ICT infrastructure, insufficient electricity supply, poor internet connectivity, high cost of AI technologies, Limited awareness of AI tools among teachers, and policy limitations.

Research Question 5: What strategies can improve AI integration into curriculum design for enhanced 21st-century skills development in secondary schools in Kano State?

Table 5: Strategies for Improving AI Integration

SN	Items	Mean	SD	Decision
28	Teachers should receive regular training on AI in education.	3.75	1.05	Agreed
29	Schools should be provided with reliable internet and digital infrastructure.	3.68	1.07	Agreed
30	AI should be officially integrated into curriculum planning and review.	3.49	1.18	Agreed
31	Government should provide policy guidelines for ethical AI use in schools.	3.79	1.01	Agreed
32	School administrators should encourage teachers to adopt AI-supported pedagogy.	3.61	0.93	Agreed
33	Students should be given more access to digital learning devices.	3.50	1.23	Agreed

34	Partnerships with NGOs and EdTech firms can support AI adoption in schools.	3.75	0.99	Agreed
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Grand Mean Scores = 3.65

Table 5 above shows strategies for improving AI integration in secondary schools. Respondents strongly support regular training, capacity building, infrastructure provision, policy development, curriculum reform, and institutional partnerships as strategies for improving AI integration.

Discussion on the findings

The study examined impacts of Artificial Intelligence (AI) on curriculum design and 21st-century skills in secondary schools in Kano State, Nigeria. The study discovered that AI is integrated into curriculum design in secondary schools in Kano State to a moderate extent, but implementation remains inconsistent.. The study is agreement with Nwankwo and Chukwu (2024) who examined the influence of Artificial Intelligence on personalized learning in secondary schools in Imo State. The results showed that AI-driven adaptive learning systems improved individualized instruction, student engagement, and self-directed learning. The study emphasized that AI technologies enable teachers to modify curriculum content to suit individual student learning needs, thereby promoting inclusive and effective education but the integration of AI in secondary schools remain low, this affects curriculum implementation in secondary schools.

The discovered that AI positively influences instructional planning and curriculum delivery indicates that teachers perceive AI as a useful pedagogical support tool. AI appears to reduce workload in lesson preparation, improve instructional materials, support differentiated instruction, and enhance feedback systems. This suggests that AI can improve curriculum efficiency and instructional quality when teachers have access to relevant tools and competencies. The study is supported by Ibrahim and Abdullahi (2023) who examined the impact of Artificial Intelligence on curriculum development in secondary schools. The results showed that AI technologies improved curriculum planning, lesson design, and instructional evaluation. Teachers who used AI-supported teaching tools reported improved classroom interaction and better monitoring of students' learning progress. They further stated that AI-integrated curricula positively enhanced students' information literacy, innovation skills, and analytical thinking, which are essential for success in the digital age. In the same vein Ogunleye and Akinwale (2023) who investigated teachers' readiness for the integration of Artificial Intelligence in curriculum delivery in public secondary schools in Ogun State. The results revealed that although teachers had a positive perception of AI integration, many lacked the necessary technical skills and training required to effectively utilize AI tools in teaching. The study emphasized that AI integration could significantly improve student-centered curriculum design and technology-

enhanced learning if teachers receive adequate professional development. They study further discovered that that AI has a positive influence on instructional planning and curriculum delivery.

The study also found that AI contributes significantly to students' 21st-century skills development. This is a major finding because it supports the argument that curriculum should not merely focus on knowledge transmission but on competency formation. Students exposed to AI-supported learning environments are more likely to engage in inquiry, digital interaction, independent learning, creativity, and real-time problem-solving. This is consistent with the growing emphasis on competency-based education in Nigerian and global educational reforms. This is in agreement with Study by Adebayo and Yusuf (2022) who stated that AI-supported learning environments enhanced students' critical thinking, digital literacy, and collaborative learning skills, which are key components of 21st-century competencies. Similarly, Musa and Bello (2024) stated that students who learned through AI-supported digital platforms demonstrated higher levels of digital literacy, collaboration skills, communication skills and innovative thinking which are necessary for 21st century Educational system.

However, the study revealed serious barriers to effective AI integration. The most prominent challenges poor infrastructure, lack of teacher training, unreliable electricity, and limited policy support indicate that AI adoption is not merely a technological issue but a systemic one. Without supportive conditions, the benefits of AI may remain theoretical rather than practical. This finding is particularly relevant to Kano State, where disparities in school resources may intensify unequal access to digital learning opportunities. The study is supported by Uche and Okoro (2025) who stated that AI integration encourages the adoption of competency-based curriculum frameworks that emphasize skills such as problem-solving, digital literacy, creativity, and critical thinking. However, the study also identified challenges including limited funding, poor infrastructure, and inadequate policy support.

Lastly, the study discovered that effective strategies for improving AI integration include: teacher professional development, better infrastructure, official curriculum integration, ethical policy frameworks, school leadership support, device access, partnerships with EdTech stakeholders. This study agreed with Ogunleye and Akinwale (2023) stated that AI integration could significantly improve student-centered curriculum design and technology-enhanced learning if teachers receive adequate professional development with adequate infrastructural facilities, and good learning environment.

Conclusion

The study concluded that Artificial Intelligence has a significant and positive impact on curriculum design and the development of 21st-century skills in secondary schools in Kano State, Nigeria. Although the current level of AI integration into curriculum design is moderate, the findings show that AI can improve instructional planning, content adaptation, learner engagement, assessment practices, and the acquisition of key competencies such as critical thinking, creativity, digital literacy, collaboration, and self-directed learning.

However, the transformative potential of AI in secondary education is constrained by structural and systemic barriers, including inadequate infrastructure, poor internet connectivity, limited electricity supply, insufficient teacher capacity, policy gaps, and unequal access to digital devices. Therefore, the effective integration of AI into curriculum design in Kano State requires deliberate investment, teacher preparation, policy reform, and equitable access strategies.

In essence, AI represents a promising pathway for modernizing secondary school curriculum and preparing learners in Kano State for the realities of the 21st century, but its success depends on intentional and context-sensitive implementation.

Recommendations

Based on the findings, the following recommendations are made:

1. The Kano State Government, in partnership with private sector telecommunications companies, must prioritize the provision of stable electricity and affordable internet connectivity in all secondary schools. This is the non-negotiable foundation for any digital initiative.
2. The State Ministry of Education should design and implement a mandatory, continuous professional development program focused on AI literacy and pedagogical integration. This training should not just be about using tools, but about how to redesign learning activities to foster critical thinking, creativity, and collaboration using AI.
3. The National Educational Research and Development Council (NERDC) and the State's teaching service board should collaborate to review the secondary school curriculum. It must be made more flexible to allow teachers to integrate AI tools and project-based learning that develops 21st-century skills, moving away from a purely examination-centric model.

4. The government should actively foster partnerships with tech companies, NGOs, and universities to provide schools with access to affordable AI tools, learning platforms, and technical support. This can help mitigate the high cost of technology.
5. Launch state-wide sensitization campaigns for all educational stakeholders; teachers, parents, students, and community leaders to demystify AI, address cultural or religious concerns, and build a collective vision for its role in education.

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