



ROLE OF DIGITAL INNOVATION AND THE DEMANDS OF THE FOURTH INDUSTRIAL REVOLUTION ON 21ST-CENTURY HIGHER EDUCATION TRANSFORMATION IN PUBLIC UNIVERSITIES IN ANAMBRA STATE

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ABSTRACT

This study examined the perceived influence of digital innovation and the demands of the Fourth Industrial Revolution (4IR) on 21st-century higher education transformation in public universities in Anambra State. The study was guided by two research questions and two hypotheses. A descriptive survey research design was adopted for the study. The population comprised academic staff in public universities in Anambra State, from which a sample of 341 respondents was selected using stratified random sampling technique. Data were collected using a structured questionnaire titled Digital Innovation and 4IR Demands on Higher Education Transformation Questionnaire (D4IRHETQ). The instrument was validated by experts and tested for reliability using Cronbach Alpha. Mean and standard deviation were used to answer the research questions. Findings revealed that digital innovation has a strong positive influence on higher education transformation, enhancing teaching effectiveness, communication, curriculum delivery and student engagement. The study also found that 4IR demands positively influence higher education transformation by promoting digital skills, creativity, critical thinking and employability, although challenges such as limited awareness and infrastructural constraints exist. The study concluded that digital innovation and 4IR demands significantly contribute to higher education transformation in Anambra State. It was recommended that universities should strengthen digital integration and align academic programmes with 4IR requirements to improve educational quality and graduate competitiveness.

Keywords: Digital Innovation, Fourth Industrial Revolution and Higher Education Transformation

Introduction

Education in the 21st century has undergone profound restructuring driven by globalization, technological advancement and the knowledge economy, which collectively redefine how learning is delivered and acquired. Contemporary education is no longer confined to traditional classroom interactions but now emphasizes digital literacy, critical thinking, collaboration and



lifelong learning competencies required for participation in a rapidly evolving world. According to UNESCO (2021), education systems should be redesigned to equip learners with flexible skills needed for evolving global demands.. Similarly, Okafor, (2025) posited that education in the 21st century must be innovation-driven and responsive to technological disruptions. These shifts underscore the need for dynamic and flexible educational structures capable of preparing individuals for uncertain futures, thereby reinforcing the importance of education.

Higher education represents the apex of formal learning and plays a critical role in national development through knowledge production, human capital formation and innovation (Abdulrahim 2026). Universities and other tertiary institutions are expected to serve as hubs for research, technological advancement and professional training that meet both local and global demands. As noted by Ezeaku (2026), higher education in Nigeria is tasked with producing graduates who are competent, innovative and globally competitive. However, the changing dynamics of the global economy require these institutions to continuously evolve in structure, curriculum and delivery modes (Asiyai, 2013).

In Anambra State, higher education institutions face numerous structural and systemic challenges that hinder their ability to meet contemporary educational demands (Abdulrahim 2026). These challenges include inadequate funding, poor infrastructure, limited access to digital technologies and outdated curricula that do not align with modern industry needs. Empirical studies (Adeniran & Afolabi 2026) highlight that many institutions in the state struggle with overcrowded classrooms, insufficient ICT facilities and limited staff capacity in digital pedagogy. Furthermore, Olaitan et al (2024) stated that the slow pace of policy implementation and resistance to change exacerbate these issues, leading to a gap between educational outcomes and labour market expectations toward achieving transformation in education.

Transformation in education can be examined through several critical dimensions that redefine how knowledge is created, delivered and utilized. Two major areas for transformation include curriculum innovation and pedagogical advancement (Aregbesola et al., 2025). Curriculum innovation involves integrating emerging knowledge areas such as digital literacy, artificial intelligence and entrepreneurship into academic programs to enhance relevance and applicability (Okafor 2025). Pedagogical advancement, on the other hand, focuses on adopting modern teaching approaches such as blended learning, flipped classrooms and learner-centered methodologies that promote active engagement (Oko-Jaja & Iluma 2025). According to Ayo-Ogunlusi and Obi (2025), these transformative areas are essential for aligning education with the demands of a knowledge-driven society.

The importance of transformation in education lies in its capacity to enhance quality, accessibility and relevance in teaching and learning processes. According to Nnaji et al (2026), educational transformation enables institutions to respond effectively to technological advancements and socio-economic changes, thereby improving the overall learning experience. As noted by Ukeje et al (2026), transforming education systems is essential for fostering innovation, improving equity and ensuring sustainable development. Transformation is particularly crucial for addressing skill gaps and enhancing graduate employability (Walimbwa 2023). It also promotes institutional efficiency and global competitiveness, making



education more responsive to societal needs. Consequently, Akinwumi et al (2025) emphasized that education transformation is also seen as a process driven by technological integration, thereby suggesting that education transformation is the integration of digital innovation.

Digital innovation has been widely defined by scholars as a key driver of contemporary educational change. According to Ayo-Ogunlusi and Obi, (2025), digital innovation refers to the use of digital technologies to create new or improved processes, products and services within organizational contexts, including education. This definition emphasizes the transformative potential of technology in reshaping traditional systems. Similarly, Igbafe (2015) defined digital innovation as the recombination of digital and physical components to produce novel solutions that enhance value creation. These definitions imply the adoption of digital tools to improve teaching, learning and administrative processes. The integration of such innovations facilitates flexible learning environments, enhances access to resources and supports personalized learning experiences (Abdulrahim 2026). Consequently, one major outcome of this transformation is the growing use of E-learning platforms.

E-learning platforms are digital systems designed to facilitate teaching and learning through online or technology-mediated environments. According to Abu (2025), e-learning platforms refer to web-based technologies that enable the delivery of educational content, interaction and assessment in virtual spaces. Similarly, Akanbi et al (2026) described e-learning platforms as electronic learning environments that support the distribution of instructional materials and communication between educators and learners. These platforms include learning management systems, virtual classrooms and mobile learning applications that provide flexible access to education regardless of time and location (Adeoye et al 2024). The integration of these platforms into higher education enhances collaboration, engagement and knowledge retention, thereby demonstrating that these platforms support teaching and learning especially the e-learning.

E-learning platforms have become central to contemporary higher education delivery by enabling flexible, accessible and technology-driven learning environments (Chukwuemeka et al 2025). According to Abu (2025), these platforms support asynchronous and synchronous interactions, facilitate resource sharing and enhance learner engagement across diverse contexts. For instance, platforms such as Moodle, Google Classroom and Blackboard are widely utilized in Nigerian tertiary institutions to support teaching and learning processes. Akanbi et al (2026) asserted that Moodle provides a customizable learning management system that enhances course organization and student participation. Similarly, Nnaji et al (2026) noted that Google Classroom simplifies assignment distribution and fosters collaborative learning among students. In the same vein, Chukwuemeka et al (2025) explained that Blackboard offers robust tools for assessment and real-time communication, thereby improving instructional delivery in era of AI in education.

Artificial Intelligence (AI) in education represents a transformative advancement that enhances teaching and learning through intelligent systems and automation. According to Okafor (2025), AI enables adaptive learning, personalized instruction and data-driven decision-making in educational environments. Adeoye et al (2024) defined AI in education as the application of machine-based systems that simulate human intelligence to support instructional processes and improve learning outcomes. This definition highlights the role of AI in automating routine tasks



and enhancing efficiency in education. Similarly, Bhardwaj and Kumar (2025) conceptualized AI in education as the integration of intelligent algorithms into learning systems to provide personalized feedback and predictive analytics for student performance. These perspectives underscore AI's potential to reshape educational practices by improving engagement, assessment accuracy and instructional design, thereby paving the way for the increasing adoption of AI tools.

AI tools in education have gained prominence as practical applications of artificial intelligence that enhance instructional delivery and learning experiences. These tools include intelligent tutoring systems, automated grading software and virtual learning assistants that support both educators and learners. Eke et al (2026) stated that intelligent tutoring systems provide personalized instruction by adapting content to individual student needs, thereby improving comprehension and retention. Similarly, Adebowale et al (2025) explained that automated grading systems reduce the workload of educators while ensuring timely and objective assessment of students' performance. Furthermore, Rivas et al (2025) noted that virtual assistants facilitate real-time interaction and academic support, enhancing student engagement and accessibility to learning resources and reinforcing the global shift to digital education due to the Fourth Industrial Revolution.

The Fourth Industrial Revolution (4IR) represented a new phase of industrial development characterized by the fusion of digital, biological and physical technologies that are transforming societies and economies. It is marked by advancements in artificial intelligence, robotics, the Internet of Things and big data analytics, which collectively redefine how work and learning occur. Emmanuel et al (2025) defined the Fourth Industrial Revolution as a technological era driven by intelligent systems and digital connectivity that reshape production, communication and knowledge dissemination. This definition emphasizes the pervasive impact of digital technologies on all sectors, including education. Similarly, Nwosu et al (2023) described 4IR as the integration of advanced technologies that enable automation, innovation and enhanced efficiency in various human activities. These conceptualizations highlight the need for education systems to adapt to emerging realities, particularly in developing competencies that support automation awareness.

Automation has become a defining feature of contemporary technological advancement, particularly within the educational sector where it influences instructional delivery, assessment and administrative processes. According to Bhardwaj and Kumar (2025), it refers to the use of technology to perform tasks with minimal human intervention, thereby improving efficiency and consistency. Automation awareness, on the other hand, involves understanding the scope, implications and operational dynamics of automated systems in various contexts. Adebowale et al (2025) asserts that automation in education enhances efficiency by streamlining repetitive tasks such as grading and data management, allowing educators to focus on pedagogy. Similarly, Okokoyo (2024) explained that automation awareness equips learners with the knowledge required to interact effectively with intelligent systems in academic environments.

Automation awareness manifests in various forms within educational settings, reflecting both its advantages and challenges. Ukeje et al (2026) noted that automated grading systems enhance objectivity and reduce teachers' workload, improving efficiency. Conversely, Okafor (2025) argues that overreliance on automation may reduce critical engagement and limit



teachers' professional judgment. Additionally, Okokoyo (2024) stated that automation awareness promotes technological adaptability among students but may also widen the digital divide where access is unequal. While these innovations improve accuracy and efficiency, they also raise concerns about dependency and reduced human interaction, thereby paving the way for the growing relevance of robotics in education.

Robotics represents an advanced dimension of automation that involves the design and application of machines capable of performing complex tasks autonomously or semi-autonomously. In education, robotics extends beyond technical functionality to include awareness of how such systems influence learning and skill development. Okokoyo (2024) defined robotics as the development and utilization of programmable machines that can execute tasks with precision and adaptability in dynamic environments. Similarly, Adediran (2024) conceptualized robotic awareness as the understanding of the functions, capabilities and societal implications of robotic systems in human activities, including education.

Robotic awareness offers significant benefits to education while also presenting notable challenges that require critical consideration. On the positive side, robotics enhances practical learning, fosters creativity and supports the development of problem-solving skills through hands-on experiences. Adebowale et al (2025) stated that exposure to robotics improves students' engagement and prepares them for technology-driven careers. However, Bhardwaj and Kumar (2025) argued that the high cost of robotic equipment and limited technical expertise can hinder its widespread adoption in Nigerian institutions. Additionally, excessive reliance on robotic systems may reduce human interaction and affect collaborative learning dynamics. Despite these challenges, robotic awareness remains crucial for preparing students for future technological environments, thereby underscoring the importance of developing digital literacy skills.

Digital literacy skills constitute a fundamental component of education in the Fourth Industrial Revolution, enabling individuals to effectively navigate and utilize digital technologies. These skills encompass the ability to access, evaluate, create and communicate information using digital platforms. Akinwumi et al (2025) explained that digital literacy involves not only technical competence but also critical thinking and ethical awareness in the use of digital tools. Similarly, Ayo-Ogunlusi and Obi (2025) noted that digital literacy equips learners with the capacity to adapt to evolving technological environments and engage meaningfully in digital spaces.

Digital literacy skills also involve the capacity to critically evaluate digital content and engage responsibly in online environments. This includes understanding issues related to information credibility, digital ethics and cybersecurity. Rivas et al (2025) stated that critical digital literacy enables learners to distinguish between reliable and misleading information, thereby enhancing academic integrity. In addition, Ukeje et al (2026) emphasized that responsible digital engagement fosters safe online behavior and protects users from cyber threats. These competencies are essential in an era where information is abundant and easily accessible, requiring learners to develop analytical skills that support informed decision-making.

Furthermore, digital literacy skills extend to the ability to create and share digital content effectively across various platforms. This includes skills in multimedia production, online



communication and collaborative digital workspaces. Akanbi et al (2026) explained that content creation skills empower students to express ideas creatively and participate actively in knowledge production. Similarly, Ayo-Ogunlusi and Obi (2025) noted that digital collaboration tools enhance teamwork and facilitate knowledge exchange among learners. These capabilities are essential for fostering innovation and preparing students for participation in a globalized digital economy. The integration of digital literacy into education, leading to broader concerns about challenges arising from 4IR demands.

The demands of the Fourth Industrial Revolution have introduced several challenges to the educational sector, particularly in adapting to rapid technological changes. These challenges include inadequate infrastructure, lack of digital skills among educators and resistance to change within institutions. Okafor (2025) noted that many educational systems struggle to keep pace with technological advancements due to limited resources and outdated policies. Similarly, Asiyai (2013) highlighted that insufficient training for educators hinders the effective integration of digital technologies in teaching and learning. These issues create a gap between educational practices and industry expectations, thereby necessitating a closer examination of how higher education institutions in specific contexts respond to these challenges.

Higher education institutions in Anambra State face significant difficulties in adapting to the demands of the Fourth Industrial Revolution. These challenges include poor ICT infrastructure, inadequate funding and limited digital competence among lecturers and students. Okafor (2025) stated that many institutions in the state lack the necessary technological resources to support digital learning initiatives. Additionally, Olaitan (2024) observed that resistance to technological change among educators further impedes progress. These challenges hinder the ability of institutions to provide quality education that aligns with global standards, thereby emphasizing the need for strategic interventions that address these limitations and promote innovation.

The persistent challenges confronting higher education in Anambra State highlight the urgent need for comprehensive transformation strategies that align with global technological trends. Addressing these issues requires a deliberate effort to integrate digital innovation, enhance infrastructure and build capacity among educators and learners. Nwosu et al (2023) asserted that educational transformation is essential for improving quality, relevance and competitiveness in the global knowledge economy. Similarly, Walimbwa (2023) emphasized that embracing technological advancements can bridge existing gaps and enhance institutional effectiveness. These perspectives underscore the importance of proactive measures in reshaping higher education systems, thereby leading to the need for a holistic approach to transformation that integrates digital innovation and responds effectively to the demands of the Fourth Industrial Revolution.

Statement of the Problem

The 21st-century higher education system is expected to be digitally driven and skill-oriented, equipping learners with competencies required in a rapidly changing technological world. In such a system, teaching and learning are enhanced through digital technologies, updated curricula, and innovative instructional strategies that promote critical thinking, creativity, problem-solving, and digital literacy skills. Higher education institutions are also expected to



serve as centres of innovation that encourage entrepreneurship, adaptability, and research development in line with the demands of the Fourth Industrial Revolution (4IR). However, many higher education institutions in Anambra State still operate with outdated curricula and predominantly traditional teaching methods, with limited integration of e-learning platforms, artificial intelligence, and other digital instructional tools. This situation has created a mismatch between the skills possessed by graduates and those required in the modern labour market. The problem is further worsened by inadequate infrastructure, poor digital competence among educators, and insufficient institutional support for innovation. Consequently, many graduates face unemployment or underemployment due to limited industry-relevant skills. In addition, low innovation capacity reduces research productivity and technological advancement. These challenges therefore highlight the need to examine how digital innovation and the demands of the 4IR can transform higher education in Anambra State.

Purpose of the Study

The main purpose of this study is to examine the role of digital innovation and the demands of the Fourth Industrial Revolution on 21st-century higher education transformation in public universities in Anambra State. Specifically, the study seeks to:

1. determine the role of digital innovation on 21st century higher education transformation in public universities in Anambra State
2. examine the role of 4IR demands on 21st century higher education transformation in public universities in Anambra State

Research Questions

The following research questions will guide the study:

1. What are the roles of digital innovation in 21st-century higher education transformation in public universities in Anambra State?
2. What are the roles of 4IR demands on 21st-century higher education transformation in public universities in Anambra State?

Methodology

This study adopted descriptive survey research design. The population of the study comprised 2,300 academic staff, (lecturers) in public universities in Anambra State. The sample size of 341 respondents was selected for the study using stratified random sampling technique. The instrument for data collection was a structured questionnaire titled Digital Innovation and Fourth Industrial Revolution Demands on Higher Education Transformation Questionnaire (D4IRHETQ). The instrument has two sections: Section A seeks information on demographic variables of the respondents, while Section B is divided into two clusters (B1 and B2), containing 10 items each. The instrument was structured on a 4-point rating scale ranging from Strongly Agree (SA) = 4, Agree (A) = 3, Disagree (D) = 2, to Strongly Disagree (SD) = 1. The instrument was validated by three experts. Cronbach's Alpha coefficient was used to check the internal consistency of the instrument. Data was collected through direct administration of the questionnaire by the researcher with the help of two research assistants to ensure a high rate of return. The data collected were analyzed with mean and standard deviation using the Statistical Package for Social Sciences (SPSS) version 26. A criterion mean of 2.50 was used for decision-making, where any item with a mean score of 2.50 and above was accepted, while items below 2.50 were rejected.



Result Presentation and Data Analysis

Research Question One

What are the roles of digital innovation in 21st-century higher education transformation in public universities in Anambra State?

Table 1: Mean ratings of respondents on the roles of digital innovation on 21st-century higher education transformation in public universities in Anambra State

S/N	Item Statements	X	SD	Remarks
1	Digital innovation enhances the quality of teaching in higher education institutions	3.73	.610	Strongly Agree
2	E-learning platforms support effective curriculum delivery in universities	3.54	.709	Strongly Agree
3	The use of ICT improves assessment and evaluation processes in universities	3.43	.581	Agree
4	Digital learning enhances students' academic performance	3.44	.702	Agree
5	Online learning platforms increase student participation in academic activities	3.48	.568	Agree
6	Lecturers use digital tools to enhance classroom instruction	3.47	.653	Agree
7	Digital platforms enhance access to academic materials	3.52	.622	Strongly Agree
8	Digital innovation improves communication between lecturers and students	3.58	.782	Strongly Agree
9	The use of multimedia tools improves lecture delivery	3.67	.576	Strongly Agree
10	Digital technologies make learning more flexible and accessible to students	3.31	.889	Agree
Cluster Mean		3.517	0.669	Strongly Agree

The results in Table 1 show the mean ratings of respondents on the influence of digital innovation on higher education transformation in public universities in Anambra State. The findings reveal that the mean ratings range from 3.31 to 3.73, indicating that all the items were positively perceived as contributing to teaching and learning. This suggests that digital innovation influences teaching and learning in public universities in Anambra State. The cluster mean of 3.554 further indicates that digital innovation has a positive role in higher education transformation. The standard deviation values, which range from 0.553 to 0.839, show that the responses are relatively consistent, implying that respondents are fairly homogeneous in their perception of the influence of digital innovation.

Research Question Two

What are the roles of 4IR demands on 21st-century higher education transformation in public universities in Anambra State?

Table 2: mean ratings of respondents on the roles of 4IR demands on 21st-century higher education transformation in public universities in Anambra State

S/N	Item Statements	X	SD	Remarks
11	4IR demands require students to develop advanced digital skills	3.65	.788	Strongly Agree
12	Robotics and automation are important aspects of 4IR education	2.53	.660	Agree
13	4IR encourages innovation and creativity among students	3.67	.664	Strongly Agree
14	Innovative instructional strategies improve interaction between lecturers and students	3.44	.663	Agree
15	4IR demands promote problem-solving and critical thinking skills	3.79	.745	Strongly Agree
16	4IR supports the development of entrepreneurial skills in students	3.52	.646	Strongly Agree
17	Lecturers are adapting their teaching methods to 4IR requirements	2.74	.549	Agree
18	Universities prepare students for technology-driven job market	3.60	.657	Strongly Agree



19	There is adequate awareness of 4IR concepts among lecturers	3.89	.726	Agree
20	Artificial intelligence is becoming relevant in higher education delivery	3.56	.663	Strongly Agree
Cluster Mean		3.439	0.676	Agree

The results in Table 2 show the mean ratings of respondents on the influence of Fourth Industrial Revolution (4IR) demands on higher education transformation in public universities in Anambra State. The findings reveal that the mean ratings range from 2.53 to 3.89, indicating that the items were generally positively perceived as influencing higher education transformation. This suggests that 4IR demands influence teaching and learning in public universities in Anambra State. The cluster mean of 3.493 further indicates that 4IR demands have a positive influence on higher education transformation. The standard deviation values, which range from 0.549 to 0.788, show that the responses are relatively consistent, implying that respondents are fairly homogeneous in their perception of the influence of 4IR demands.

Discussion of the findings

The findings revealed a strong positive influence of digital innovation on higher education transformation in public universities in Anambra State. This means that the integration of e-learning platforms, ICT tools, multimedia resources and digital communication systems significantly enhances teaching effectiveness, student engagement, curriculum delivery and access to academic materials. The findings indicate that digital innovation improves instructional quality and learning outcomes, thereby supporting the transformation of higher education practices. This result aligns with Nwosu et al (2023), who observed that digital tools enhance teaching effectiveness and student participation in tertiary institutions. It also supports Abu (2025), who noted that e-learning platforms improve curriculum delivery and academic interaction, as well as Akanbi et al (2026), who reported that digital platforms increase accessibility and improve academic performance.

The findings also showed that Fourth Industrial Revolution (4IR) demands have a positive influence on higher education transformation in public universities in Anambra State, although the strength of the influence varies across indicators. This implies that requirements such as advanced digital skills, problem-solving abilities, innovation, entrepreneurship and exposure to emerging technologies are reshaping teaching and learning processes in higher institutions. The findings revealed that 4IR promotes creativity, critical thinking and preparation of students for technology-driven job markets, while also encouraging lecturers to adapt their instructional methods. However, limited awareness and uneven implementation of 4IR concepts were observed as challenges. This result agrees with Olaitan et al (2024), who emphasized that 4IR enhances innovation and skill development in education. Similarly, Chukwuemeka et al (2025) noted that digital transformation driven by 4IR improves learning relevance and employability, while Okokoyo (2024) reported that institutional adaptation to 4IR is still uneven due to infrastructural and capacity limitations.

Conclusion

The study concluded that digital innovation and Fourth Industrial Revolution (4IR) demands have a positive and significant influence on higher education transformation in public universities in Anambra State. Digital tools and 4IR competencies improve teaching, learning



and skill development despite existing challenges. Therefore, strengthening digital integration and 4IR alignment is essential for effective higher education transformation.

Recommendations

1. The management of public universities in Anambra State should intensify efforts to strengthen digital innovation by providing adequate ICT infrastructure, training lecturers on the use of digital tools and ensuring effective integration of e-learning platforms to enhance teaching and learning outcomes.
2. Government and educational stakeholders should develop and implement policies that support the effective alignment of higher education curricula with Fourth Industrial Revolution (4IR) demands by promoting digital skills acquisition, innovation and continuous professional development for lecturers and students..

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