IJO –INTERNATIONAL JOURNAL OF COMPUTER SCIENCE AND ENGINEERING

(ISSN 2814-1881) Emmanuel Olorunfemi AWOLUMATE *

https://ijojournals.com/ *Volume 08 || Issue 04 || April, 2025 ||*

Smart Pedagogy 4.0: Leveraging Artificial Intelligence for Instructional Transformation in Electrical and Electronic Technology Education in Southwest Nigeria

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Abstract

This study investigated Smart Pedagogy 4.0 as an emerging instructional framework for leveraging Artificial Intelligence (AI) to transform Electrical and Electronic Technology Education (EETE) in Southwest Nigeria. The study was motivated by the growing demand for Industry 4.0–compliant technical education systems capable of improving instructional delivery, lecturer digital competence, and student employability outcomes. A descriptive survey research design with an independent group comparative approach was adopted. The study was conducted at the University of Lagos, Southwest Nigeria, using a census sample of 43 respondents comprising 15 Electrical/Electronic lecturers and 28 students. Data were collected using a researcher-developed instrument titled Smart Pedagogy 4.0 and Artificial Intelligence Instructional Transformation Questionnaire (SP4AITQ)*, validated by experts and tested for reliability using Cronbach's Alpha, which yielded a coefficient of 0.88. Mean and standard deviation were used to answer the research questions, while independent t-test was employed to test the hypotheses at 0.05 level of significance. Findings revealed that AI integration significantly enhances instructional transformation through improved lesson delivery, virtual laboratories, personalized learning, and curriculum modernization. The study also found that lecturers' digital competence is a critical requirement for the successful implementation of Smart Pedagogy 4.0. Furthermore, Smart Pedagogy 4.0 was found to positively influence students' employability skills, innovation capacity, and workforce preparedness. The hypotheses tested showed no significant difference between lecturers' and students' perceptions across all variables, indicating broad consensus on the relevance of AI-driven pedagogy. The study concluded that Smart Pedagogy 4.0 offers a transformative pathway for modernizing Electrical and Electronic Technology Education in Southwest Nigeria and recommended strategic investment in lecturer digital training, AI infrastructure, curriculum reform, and institutional policy support.*

Keywords: Smart Pedagogy 4.0, Artificial Intelligence, Instructional Transformation, Digital Competence, Employability, Electrical and Electronic Technology Education.

Introduction

The emergence of the Fourth Industrial Revolution has significantly transformed the structure of societies, industries, and educational systems across the world. In contemporary times, teaching and learning are no longer confined to conventional teacher-centered methods that depend solely on face-to-face instruction and static classroom practices. Rather, education is increasingly being shaped by digital intelligence, automation, interconnected technologies, and personalized instructional systems that redefine how knowledge is created,

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delivered, and applied (Aboderin, 2025; Hossain, 2023). Within this rapidly evolving educational environment, Smart Pedagogy 4.0 has emerged as an advanced pedagogical framework that aligns educational delivery with the realities of Industry 4.0 by incorporating modern technologies such as Artificial Intelligence (AI), the Internet of Things (IoT), augmented reality, virtual laboratories, cloud computing, and learning analytics into instructional processes (Adel, 2024). This innovative pedagogical approach moves beyond traditional teaching by creating adaptive, student-centered, and technologically responsive learning environments that foster deeper engagement, practical relevance, and instructional flexibility. In Electrical and Electronic Technology Education, Smart Pedagogy 4.0 emphasizes experiential and competency-based learning through intelligent simulations, collaborative technical problem-solving, automated instructional support, and data-informed teaching practices, all of which are essential for preparing learners for technologically dynamic industries (Chukwuemeka, Dominic, Akanbi, & Aregbesola, 2025).

Artificial Intelligence serves as the technological engine that powers Smart Pedagogy 4.0 because it enables machines and digital systems to replicate cognitive functions associated with human intelligence, including learning, reasoning, problem-solving, personalization, and predictive decision-making (Oluyemisi, 2023). Through technologies such as machine learning, deep learning, robotics, intelligent tutoring systems, expert systems, and natural language processing, AI is increasingly reshaping educational systems by enhancing instructional precision, adaptability, and efficiency. In Electrical and Electronic Technology Education, AI creates opportunities for virtual experimentation, simulation-based troubleshooting, automated content generation, predictive assessment systems, and personalized learning pathways that can accommodate learners' unique strengths, pace, and instructional needs (Adayilo, Oyefolahan, Ndunagu, Otuya, Malcolm, & Twabu, 2025). This is particularly significant in technical education, where physical laboratory limitations, equipment obsolescence, and safety concerns often hinder practical learning experiences. By enabling intelligent virtual environments and adaptive technical instruction, AI not only enhances teaching effectiveness but also modernizes educational structures to reflect contemporary industrial realities.

Instructional transformation, therefore, becomes a strategic necessity in response to these technological advancements. It refers to the systematic redesign of teaching methodologies, curriculum implementation, learning experiences, and educational outcomes through the adoption of innovative technologies and pedagogical reforms (Goswami & Kamble, 2025). This transformation involves shifting away from passive instructional models toward interactive, learner-focused, technology-supported, and competency-driven educational systems. In Electrical and Electronic Technology Education, instructional transformation is especially critical because the field requires technical precision, practical competence, and alignment with continuously evolving industrial standards. Through Smart Pedagogy 4.0 and AI integration, instructional transformation may involve virtual laboratories, predictive learning systems, simulation software, remote technical workshops, blended learning environments, and intelligent classroom management systems that collectively strengthen practical exposure and bridge the divide between theory and industrial application (Chukwuemeka, Dominic, Akanbi, & Aregbesola, 2025). Consequently, instructional transformation is not simply about introducing technology into classrooms; rather, it is about redefining educational systems to ensure sustainable relevance, efficiency, and responsiveness.

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Electrical and Electronic Technology Education (EETE) occupies a strategic position within Technical and Vocational Education and Training because it is designed to equip learners with scientific understanding, technical competencies, practical skills, and professional attitudes necessary for careers in electrical installation, electronics design, automation, telecommunications, and industrial maintenance (Okwuchukwu, 2025). This field plays a significant role in national technological growth, workforce development, and industrial productivity by producing skilled graduates capable of driving innovation and infrastructural advancement. However, traditional instructional approaches in EETE often face limitations such as inadequate practical facilities, obsolete equipment, limited exposure to emerging technologies, and poor curriculum alignment with Industry 4.0 requirements (Chiamogu & Chiamogu, 2025). Integrating Smart Pedagogy 4.0 into this field offers a pathway for overcoming these limitations by introducing AI-supported instructional resources, virtual simulations, intelligent diagnostics, and technology-enhanced practical experiences that strengthen both technical competence and digital adaptability.

The broader foundation of this transformation lies in the Fourth Industrial Revolution, which represents a global technological era characterized by the integration of intelligent systems, cyber-physical technologies, robotics, big data, cloud computing, and interconnected digital infrastructures (Aboderin, 2025). Unlike previous industrial revolutions, the 4IR fundamentally changes not only production systems but also educational priorities by demanding innovation, adaptability, critical thinking, and interdisciplinary competence (Opesemowo, Iwintolu, Odeyemi, & Opesemowo, 2025). For Electrical and Electronic Technology Education, this reality is particularly important because the profession itself is increasingly shaped by smart grids, automation systems, renewable technologies, embedded intelligence, and digitalized industrial ecosystems. Therefore, Smart Pedagogy 4.0 reflects an educational response to the demands of the 4IR by repositioning instructional practices to prepare learners for intelligent workplaces and globally competitive economies.

A major determinant of the success of Smart Pedagogy 4.0 is the digital competence of lecturers. Effective implementation depends not only on the availability of advanced technologies but also on educators' ability to strategically integrate these technologies into meaningful pedagogical practice (Stephen, Olatoye, Oluwabukola, Olaniyi, & Kolash, 2025). Digital competence includes pedagogical technology integration, digital communication, AI-supported instructional software use, virtual learning facilitation, data literacy, cybersecurity awareness, and ethical technology application. In Electrical and Electronic Technology Education, lecturers must possess both technical expertise and digital instructional proficiency to effectively support Smart Pedagogy 4.0 environments. Without such competence, technological tools may remain underutilized or ineffective, thereby limiting educational transformation (Pilot, 2025). In Southwest Nigeria, where infrastructural disparities and professional development gaps persist, lecturer digital competence becomes even more essential for ensuring that AI integration translates into meaningful instructional innovation (Nnaji, Ayanwale, Ukeje, Ekwunife, Igwe, Okwor, & Nwuzor, 2026).

Beyond instructional effectiveness, Smart Pedagogy 4.0 also has critical implications for student employability and workforce development. The integration of AI into Electrical and Electronic Technology Education is ultimately aimed at producing graduates who are technically skilled, digitally competent, innovative, adaptable, and capable of thriving in changing labor markets (Berniak-Woźny, Plebańska, & Wójcik-Jurkiewicz, 2023). In the context of Industry 4.0, workforce readiness increasingly depends on graduates' ability to

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operate within automated systems, intelligent infrastructures, and technologically advanced industries (World Economic Forum, 2020). By embedding simulation-based learning, predictive technical training, and personalized instructional systems into educational delivery, Smart Pedagogy 4.0 strengthens learners' employability, entrepreneurial capacity, and industrial relevance. This is especially important in Southwest Nigeria, where persistent unemployment and skills mismatch create an urgent need for workforce-responsive educational transformation (ILO, 2021).

Southwest Nigeria serves as a particularly important context for this study because it represents a region with significant educational concentration, industrial activities, and technological opportunities. Comprising states such as Lagos, Ogun, Oyo, Osun, Ondo, and Ekiti, the region hosts numerous universities, polytechnics, colleges of education, and technical institutions that contribute substantially to manpower development. However, despite these advantages, many institutions in Southwest Nigeria continue to face challenges such as digital inequality, inadequate infrastructure, inconsistent electricity supply, limited AI readiness, and policy implementation gaps that constrain technological advancement in education (Ayomide, 2025). Therefore, examining Smart Pedagogy 4.0 within this regional context is essential for understanding how AI-driven instructional transformation can realistically address local institutional realities while strengthening Electrical and Electronic Technology Education for sustainable technological growth.

Statement of the Problem

In the past, Electrical and Electronic Technology Education in Southwest Nigeria and many parts of the country was primarily designed to equip learners with foundational technical knowledge, practical workshop skills, and vocational competencies needed for industrial development, self-reliance, and national technological growth. Traditional pedagogical approaches, which largely depended on face-to-face instruction, manual demonstrations, physical laboratories, and teacher-centered delivery, were considered adequate during earlier industrial periods when technological changes were relatively gradual and workplace demands were less digitally complex. These conventional methods contributed significantly to manpower preparation for electrical installation, maintenance, and electronics servicing. However, as global industries evolved from mechanization to automation and intelligent systems, the traditional instructional framework that once served industrial needs began to lose its capacity to adequately prepare learners for emerging digitalized workplaces characterized by smart technologies, artificial intelligence, robotics, and interconnected systems.

At present, the rapid emergence of the Fourth Industrial Revolution has fundamentally altered the skills, competencies, and instructional demands required in Electrical and Electronic Technology Education. Modern industries increasingly require graduates who are not only technically proficient but also digitally competent, innovative, adaptable, and capable of operating within AI-driven environments. Despite this transformation, many institutions in Southwest Nigeria still rely heavily on outdated instructional practices, inadequate technological infrastructure, limited integration of artificial intelligence tools, insufficient lecturer digital competence, and curricula that may not fully align with contemporary industrial realities. While educational technologies are expanding globally, the pace of instructional transformation within many technical education settings appears uneven, creating concerns about the preparedness of graduates for evolving workforce demands. This

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situation may contribute to persistent skill gaps, reduced employability, and a widening disconnect between institutional training and the expectations of smart industries.

The existing gap, therefore, lies in the insufficient understanding of how Smart Pedagogy 4.0, powered by artificial intelligence, can be strategically leveraged to transform instructional delivery in Electrical and Electronic Technology Education within the specific context of Southwest Nigeria. Although discussions on AI in education are increasing, there remains limited context-specific evidence on how AI-driven pedagogical innovation can address regional challenges such as lecturer readiness, infrastructural limitations, instructional modernization, and workforce alignment in this specialized field. Without focused empirical and conceptual investigation, institutions may continue to struggle with fragmented technological adoption and ineffective educational reform. This study therefore seeks to fill this gap by examining the potential of Smart Pedagogy 4.0 as a transformative framework for enhancing instructional practices, strengthening technical skill acquisition, and improving the relevance of Electrical and Electronic Technology Education to contemporary industrial and socioeconomic realities in Southwest Nigeria.

Purpose of the Study

The general purpose of this study is to examine how Smart Pedagogy 4.0, through the integration of Artificial Intelligence, can be leveraged to transform instructional delivery in Electrical and Electronic Technology Education in Southwest Nigeria for improved teaching effectiveness, technical skill acquisition, and workforce relevance. The study specifically seeks to:

1. Examine the extent to which Artificial Intelligence integration influences instructional transformation in Electrical and Electronic Technology Education in Southwest Nigeria.
2. Determine the level of digital competence of lecturers required for the effective implementation of Smart Pedagogy 4.0 in Electrical and Electronic Technology Education institutions in Southwest Nigeria.
3. Assess the influence of Smart Pedagogy 4.0 on students' employability skills and workforce preparedness in Electrical and Electronic Technology Education in Southwest Nigeria.

Research Questions

1. To what extent does Artificial Intelligence integration influence instructional transformation in Electrical and Electronic Technology Education in Southwest Nigeria?
2. What is the level of digital competence of lecturers required for the effective implementation of Smart Pedagogy 4.0 in Electrical and Electronic Technology Education institutions in Southwest Nigeria?
3. How does Smart Pedagogy 4.0 influence students' employability skills and workforce preparedness in Electrical and Electronic Technology Education in Southwest Nigeria?

Hypotheses

H_{01}: Artificial Intelligence integration has no significant influence on instructional transformation in Electrical and Electronic Technology Education in Southwest Nigeria.

H_{02}: Lecturers' digital competence has no significant influence on the effective implementation of Smart Pedagogy 4.0 in Electrical and Electronic Technology Education institutions in Southwest Nigeria.

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H_{03}: Smart Pedagogy 4.0 has no significant influence on students' employability skills and workforce preparedness in Electrical and Electronic Technology Education in Southwest Nigeria.

Methodology

A descriptive survey research design with an independent group comparative approach was adopted for the study and conducted at the University of Lagos (UNILAG), Southwest Nigeria, using a census sample of 43 respondents comprising 15 Electrical/Electronic Lecturers and 28 Electrical/Electronic Students because the accessible population was manageable and directly relevant to investigating Smart Pedagogy 4.0, Artificial Intelligence integration, instructional transformation, lecturer digital competence, and workforce preparedness.

Data were collected using a researcher-developed structured questionnaire titled "Smart Pedagogy 4.0 and Artificial Intelligence Instructional Transformation Questionnaire (SP4AITQ)," organized into Sections A, B1, B2, and B3, and structured on a 5-point rating scale of Strongly Agree (5), Agree (4), Undecided (3), Disagree (2), and Strongly Disagree (1); the instrument was face and content validated by three experts from the Department of Industrial Technology Education, University of Nigeria, Nsukka (UNN), while its internal consistency reliability coefficient of 0.88 was established using Cronbach's Alpha method.

The questionnaire was administered directly to respondents for efficient retrieval, and data generated were analyzed using mean and standard deviation to answer the research questions based on a criterion mean of 3.50, while independent t-test statistics were used to test the null hypotheses at 0.05 level of significance, where null hypotheses were not rejected when t-calculated was less than t-critical and rejected when t-calculated was equal to or greater than t-critical.

Research Question One: Extent to Which Artificial Intelligence Integration Influences Instructional Transformation in Electrical and Electronic Technology Education in Southwest Nigeria

S/N	Item Statements	Elect/Elect Lecturers		Elect/Elect Students		Remarks
		Mean ($\bar{X}$)	SD	Mean ($\bar{X}$)	SD	
1	Artificial Intelligence tools improve lesson delivery effectiveness in Electrical and Electronic Technology Education.	3.62	0.58	3.55	0.61	Agree
2	AI-supported virtual laboratories enhance practical understanding of electrical and electronic concepts.	3.71	0.54	3.68	0.57	Agree
3	Intelligent tutoring systems increase students' comprehension of complex technical operations.	3.58	0.63	3.49	0.66	Agree
4	Automated assessment systems improve instructional efficiency in Electrical and Electronic Technology Education.	3.54	0.67	3.46	0.69	Agree

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S/N	Item Statements	Elect/Elect Lecturers		Elect/Elect Students		Remarks
		Mean (X̄)	SD	Mean (X̄)	SD	
5	AI integration promotes personalized learning in technical education programmes.	3.66	0.56	3.60	0.60	Agree
6	AI-driven simulations reduce dependence on obsolete laboratory equipment.	3.74	0.52	3.65	0.59	Agree
7	Artificial Intelligence enhances curriculum relevance to current industrial practices.	3.69	0.55	3.57	0.63	Agree
8	AI integration contributes significantly to instructional modernization in Electrical and Electronic Technology Education.	3.77	0.50	3.70	0.54	Agree
	Grand Total	**3.66**	**0.57**	**3.59**	**0.62**	**Agree**

Table 1 shows that Electrical/Electronic Lecturers recorded a grand mean of 3.66 with a grand standard deviation of 0.57, while Electrical/Electronic Students recorded a grand mean of 3.59 with a grand standard deviation of 0.62. The two respondent groups generally agreed that Artificial Intelligence integration significantly influences instructional transformation in Electrical and Electronic Technology Education in Southwest Nigeria. The slightly higher grand mean of lecturers suggests that lecturers perceived AI integration as more influential than students did, although both means fall within the "Agree" category. The relatively low standard deviation values indicate that responses from both groups were closely clustered around the mean, suggesting consistency in their opinions.

Research Question Two: Level of Digital Competence of Lecturers Required for Effective Implementation of Smart Pedagogy 4.0 in Electrical and Electronic Technology Education

S/N	Item Statements	Elect/Elect Lecturers		Elect/Elect Students		Remarks
		Mean (X̄)	SD	Mean (X̄)	SD	
9	Digital literacy competence is essential for effective Smart Pedagogy 4.0 implementation.	3.81	0.49	3.73	0.55	Agree
10	Competence in AI-supported instructional software enhances teaching quality.	3.75	0.53	3.69	0.58	Agree
11	Ability to operate virtual simulation tools is necessary for instructional transformation.	3.78	0.50	3.71	0.56	Agree
12	Digital classroom management skills improve Smart Pedagogy effectiveness.	3.63	0.61	3.59	0.64	Agree
13	Competence in online assessment platforms strengthens instructional delivery.	3.57	0.66	3.52	0.68	Agree

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S/N	Item Statements	Elect/Elect Lecturers		Elect/Elect Students		Remarks
		Mean (X̄)	SD	Mean (X̄)	SD	
14	Continuous digital training enhances lecturers' readiness for AI integration.	3.84	0.47	3.76	0.53	Agree
15	Knowledge of data analytics improves instructional decision-making in technical education.	3.55	0.65	3.44	0.71	Agree
16	High digital competence among lecturers determines successful Smart Pedagogy 4.0 adoption.	3.80	0.48	3.72	0.55	Agree
	Grand Total	**3.72**	**0.55**	**3.65**	**0.60**	**Agree**

Table 2 reveals that Electrical/Electronic Lecturers had a grand mean of 3.72 and a grand standard deviation of 0.55, while Electrical/Electronic Students had a grand mean of 3.65 and a grand standard deviation of 0.60. Both groups agreed that high digital competence is required for effective Smart Pedagogy 4.0 implementation in Electrical and Electronic Technology Education. The lecturers' slightly higher perception may reflect their practical awareness of the professional competencies needed for AI-driven instruction. The closeness of the standard deviation values indicates response stability and homogeneity among respondents. This finding suggests a broad consensus that lecturer digital competence is essential for successful pedagogical innovation.

Research Question Three: Influence of Smart Pedagogy 4.0 on Students' Employability Skills and Workforce Preparedness in Electrical and Electronic Technology Education

S/N	Item Statements	Elect/Elect Lecturers		Elect/Elect Students		Remarks
		Mean (X̄)	SD	Mean (X̄)	SD	
17	Smart Pedagogy 4.0 improves digital problem-solving skills required for employment.	3.72	0.54	3.66	0.58	Agree
18	AI-supported learning enhances technical adaptability to modern industrial environments.	3.76	0.51	3.70	0.55	Agree
19	Smart instructional systems improve innovation and creativity among students.	3.68	0.57	3.61	0.61	Agree
20	Exposure to intelligent technologies strengthens workplace readiness.	3.74	0.52	3.69	0.56	Agree
21	Smart Pedagogy 4.0 improves students' competence in automation-related tasks.	3.71	0.55	3.64	0.60	Agree
22	AI-enhanced technical education increases employability opportunities.	3.79	0.49	3.72	0.54	Agree

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S/N	Item Statements	Elect/Elect Lecturers		Elect/Elect Students		Remarks
		Mean (X̄)	SD	Mean (X̄)	SD	
23	Technology-driven pedagogy strengthens entrepreneurial readiness in Electrical and Electronic fields.	3.65	0.59	3.58	0.63	Agree
24	Smart Pedagogy 4.0 significantly prepares students for Industry 4.0 workforce demands.	3.83	0.46	3.75	0.52	Agree
	Grand Total	**3.74**	**0.53**	**3.67**	**0.57**	**Agree**

Table 3 indicates that Electrical/Electronic Lecturers obtained a grand mean of 3.74 with a grand standard deviation of 0.53, whereas Electrical/Electronic Students obtained a grand mean of 3.67 with a grand standard deviation of 0.57. Both categories of respondents agreed that Smart Pedagogy 4.0 positively influences employability skills and workforce preparedness among students. Lecturers demonstrated a slightly stronger perception of this impact, likely due to their broader understanding of industry expectations and educational outcomes. The low standard deviation values signify strong agreement and consistency in responses, implying that Smart Pedagogy 4.0 is widely perceived as beneficial for workforce-oriented education.

Table 4: Independent t-test Analysis of Lecturers and Students' Mean Ratings on AI Integration and Instructional Transformation (Research Question One)

Variables	N	Mean	SD	df	t-cal	t-crit	Sig. Level	Decision
Lecturers	15	3.66	0.57	41	0.38	2.02	0.05	Not Significant
Students	28	3.59	0.62					

The independent t-test result for Table 4 shows that the calculated t-value of 0.38 is less than the critical t-value of 2.02 at 41 degrees of freedom and 0.05 level of significance. Therefore, the null hypothesis is not rejected. This indicates that there is no statistically significant difference between the mean ratings of Electrical/Electronic Lecturers and Students regarding the influence of Artificial Intelligence integration on instructional transformation. Both groups share similar perceptions, suggesting broad consensus on the transformative value of AI in instructional practices.

Table 5: Independent t-test Analysis of Lecturers and Students' Mean Ratings on Digital Competence Required for Smart Pedagogy 4.0 (Research Question Two)

Variables	N	Mean	SD	df	t-cal	t-crit	Sig. Level	Decision
Lecturers	15	3.72	0.55	41	0.39	2.02	0.05	Not Significant
Students	28	3.65	0.60					

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The calculated t-value of 0.39 is less than the critical t-value of 2.02 at 41 degrees of freedom and 0.05 significance level. Therefore, the null hypothesis is retained. This means that no significant difference exists between lecturers' and students' ratings on the digital competence required for effective implementation of Smart Pedagogy 4.0. The finding implies shared recognition across both groups that lecturer digital competence is crucial for instructional modernization.

Table 6: Independent t-test Analysis of Lecturers and Students' Mean Ratings on Smart Pedagogy 4.0 and Employability Skills (Research Question Three)

Variables	N	Mean	SD	df	t-cal	t-crit	Sig. Level	Decision
Lecturers	15	3.74	0.53	41	0.42	2.02	0.05	Not Significant
Students	28	3.67	0.57					

Table 6 reveals that the calculated t-value of 0.42 is less than the critical t-value of 2.02 at 41 degrees of freedom and 0.05 significance level. Hence, the null hypothesis is not rejected. This indicates that there is no statistically significant difference between lecturers and students in their perceptions of Smart Pedagogy 4.0's influence on employability skills and workforce preparedness. The finding demonstrates strong consensus that Smart Pedagogy 4.0 is essential for preparing Electrical and Electronic Technology Education

Discussion of Findings

The findings of this study revealed that Artificial Intelligence integration significantly influences instructional transformation in Electrical and Electronic Technology Education. Both lecturers and students agreed that AI tools improve lesson delivery, practical understanding, curriculum relevance, and personalized learning opportunities. This suggests that AI is increasingly perceived not merely as a technological accessory but as a transformative instructional mechanism capable of modernizing technical education. The positive perception of AI-supported virtual laboratories and simulations indicates recognition of their value in addressing challenges such as obsolete equipment and limited practical resources. This finding aligns with contemporary educational discourse that emphasizes AI as a catalyst for improving instructional flexibility, engagement, and industrial relevance in technical disciplines.

The study also found that lecturers' digital competence is essential for the successful implementation of Smart Pedagogy 4.0. Respondents consistently agreed that competencies in digital literacy, AI-supported instructional software, virtual simulations, and online assessment platforms are foundational for instructional modernization. This implies that technology alone cannot transform education unless educators possess the professional capacity to integrate it effectively. The finding reinforces the idea that lecturers are central agents in educational innovation and that their competence significantly shapes the quality of technological adoption. In practical terms, the result highlights the urgent need for continuous professional development, institutional support systems, and strategic digital literacy enhancement for lecturers in Electrical and Electronic Technology Education.

Furthermore, the findings demonstrated that Smart Pedagogy 4.0 positively influences students' employability skills and workforce preparedness. Respondents agreed that AI-supported learning improves problem-solving skills, innovation, adaptability, automation

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competence, and entrepreneurial readiness. This indicates that Smart Pedagogy 4.0 extends beyond instructional improvement to broader socioeconomic outcomes by preparing students for modern workforce realities. In a region where youth unemployment and skills mismatch remain significant concerns, this finding suggests that technologically enhanced pedagogy can bridge the gap between institutional training and labor market demands.

The hypotheses tested further revealed no significant difference between lecturers' and students' perceptions across all three major variables. This shared consensus strengthens the credibility of the findings by showing that both instructional providers and learners recognize the relevance of Smart Pedagogy 4.0. Such agreement implies that the demand for AI-driven instructional transformation is widely acknowledged and may support institutional acceptance of reform initiatives.

Conclusion

This study concludes that Smart Pedagogy 4.0, driven by Artificial Intelligence, represents a viable and necessary framework for transforming Electrical and Electronic Technology Education in Southwest Nigeria. The integration of AI into instructional delivery has the potential to significantly modernize teaching practices, improve practical and theoretical learning experiences, strengthen lecturer effectiveness, and enhance students' employability competencies. The study further establishes that lecturer digital competence is a foundational determinant of successful implementation, while workforce preparedness remains a major educational outcome of Smart Pedagogy 4.0.

Given the realities of the Fourth Industrial Revolution, maintaining outdated instructional practices may further widen the gap between educational outputs and industrial expectations. Therefore, Smart Pedagogy 4.0 should be viewed not merely as an innovation but as an educational imperative for sustainable technological growth, workforce competitiveness, and national development.

Recommendations

Based on the findings of this study, the following recommendations are made:

1. Universities, polytechnics, and technical institutions should prioritize regular digital competence training for lecturers in AI tools, virtual simulations, learning analytics, and smart instructional systems.
2. Government and institutional administrators should invest in smart classrooms, virtual laboratories, reliable internet connectivity, and AI-supported educational technologies to enhance instructional transformation.
3. Electrical and Electronic Technology Education curricula should be revised to incorporate AI literacy, Industry 4.0 competencies, automation technologies, and smart technical applications.
4. Educational policymakers should develop strategic frameworks that promote Smart Pedagogy 4.0 adoption across technical institutions in Southwest Nigeria.
5. Institutions should strengthen partnerships with industries to ensure that Smart Pedagogy 4.0 aligns with current labor market expectations and workforce demands.

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IJO -INTERNATIONAL JOURNAL OF COMPUTER SCIENCE AND ENGINEERING

(ISSN 2814-1881) Emmanuel Olorunfemi AWOLUMATE *

https://ijojournals.com/ *Volume 08 || Issue 04 || April, 2025 ||*

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