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Impacts of Artificial Intelligence Training and Upskilling for Industrial Technology Education Lecturer's Effectiveness in Nigeria for Industry 4.0 and Beyond

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Abstract

This study examined the impacts of Artificial Intelligence training and upskilling for Industrial Technology Education lecturers' effectiveness in Nigeria for industry 4.0 and beyond. Two research questions and two hypotheses guided the study. The study adopted a descriptive survey research design. Population for the study was 55 respondents comprising 45 male lecturers and 10 female lecturers in the Departments of Industrial Technology Education in Michael Okpara University of Agriculture, Umudike Abia state and Technical Education in Ignatius Ajuru University of Education, Rivers State. No sampling was employed as the population was manageable in size. A 54-item structured questionnaire titled: "Lecturers' Effectiveness and Artificial Intelligence Questionnaire (LEAIQ)" was used to collect data for the study. The instrument was validated by two experts from the department of ITE and one expert from Measurement and Evaluation unit in the department of Science Education all in Michael Okpara University of Agriculture, Umudike Abia State. A reliability coefficient of .86 was obtained using Cronbach Alpha formula. Mean and standard deviation were used to answer the research questions while t-test was used to test the hypotheses at .05 level of significance. Findings of the study revealed that while ITE lecturers demonstrated high effectiveness in teaching activities, their effectiveness in research outputs and academic productivity was relatively low. The study also identified essential AI skills necessary for enhancing lecturers' effectiveness, including computing, programming, machine learning, data analytics, and natural language processing skills. Furthermore, no significant gender-based differences were found in the lecturers' effectiveness or perceived AI skill requirements. The authors recommend targeted AI capacity-building programs, curriculum reforms, and continuous professional development to bridge the identified skill gaps and improve lecturers' overall effectiveness.

Keywords: Artificial Intelligence, Industrial Technology Education, Industry 4.0, Lecturers' Effectiveness

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INTRODUCTION

The education sector in addition to other sectors across the globe is currently undergoing a remarkable revolution due to the emergence of the fourth industrial revolution, popularly known as Industry 4.0. This revolution is marked by the introduction of innovative digital technologies such as the Internet of Things, artificial intelligence, cloud computing, and cellular communication (Singh et al., 2025). The transformative value of Industry 4.0 lies in its ability to integrate digital and physical systems, driving unique efficiency and innovation across industries (Khan & Emon, 2025). This unveils the multifaceted role of Industry 4.0 as it cuts across various sectors including the education sector. Ghobakhloo et al. (2025) noted that the digital transformation under Industry 4.0 involves the collective implementation of innovative digital technologies, such as augmented reality, Artificial Intelligence (AI), big data

analytics, cloud computing, block-chain, Internet of Things (IoT), robotic systems, and simulation tools. From the forgoing, it could be noted that AI is one of those innovative technologies which emerged from Industry 4.0.

Artificial Intelligence (AI) has been a trending concept of interest by several researchers in diverse fields including education. AI is a broad field of computer science that involves the development of intelligent computers capable of carrying out tasks that require human intelligence (Slimi, 2023). According to Almasri (2024), AI is a vast field involving innovative technologies that have been developed over the past 50 years to enable machines perform tasks traditionally requiring human intelligence, such as perceiving, reasoning, learning, and interacting. Okorieocha and Ugwunali (2025) see AI as a tool created to enhance human capabilities and not to replace them. Therefore, AI is a multifaceted concept that cuts across various sectors that involves computers assisting humans in carrying out complex tasks. Thus, with the help of AI, computers try to solve problems by carrying out intelligent tasks meant to be done by human beings. As the world keeps advancing technologically, the education sector has not been left behind as these global innovations have impacted education recently.

Education could be referred to as the process of imparting knowledge, attitudes, values, and skills to individuals with the aim of empowering them to be useful to themselves and their society. It is a training that involves inculcating knowledge in individuals that will guide them towards self-actualisation and help develop their potentials and innate abilities for the overall development of their nation. It is often popularly noted that no nation can indeed grow above the education of its citizens. In addition, education empowers most individuals to be self-reliant and employable, having valuable services to render to their society (Okorieocha & Ugwunali, 2025). One specific form of education that gainfully empowers individuals with requisite skills and knowledge to become self-reliant is Technical and Vocational Education and Training (TVET).

Technical Vocational Education and Training (TVET) is a special form of education given to individuals to inculcate in them necessary skills, values, attitudes and knowledge to become self-reliant (Okorieocha & Ugwunali, 2025). TVET is designed to tackle the challenges of manpower thereby fostering sustainable economic growth and industrial development (Jamaludin et al., 2023). The Federal Republic of Nigeria (FRN) (2013), describes TVET as an all-inclusive term dealing with those aspects of the educational process involving in addition to general education, the study of related sciences and the acquisition of practical skills and values related to occupations in various sectors of economic and social life. Therefore, TVET is very important in empowering individuals with the skills needed to be employed and also contribute to the economic development of their country in a sustainable manner. Some of the academic disciplines under TVET are Industrial Technology Education, Agricultural Science Education, Home Economics Education, and Business Education among others.

Industrial Technology Education (ITE) is a very important and integral part of TVET. It is a formal and well organised area of study offered in various Nigerian universities, polytechnics and colleges of education. Okorieocha and Ugwunali (2025) viewed ITE as that part of education involving the acquisition of practical skills in various technological areas as well as basic scientific knowledge, attitude and values. According to Ochogba and Isiodu (2024), ITE is an academic programme introduced in the Nigerian education system to help in transferring skills from one generation to another. In the views of Anametemfiok and Oluwafemi (2024), ITE is a type of education aimed at inculcating relevant practical skills in individuals as well as contributing to industrial development. The philosophy behind ITE is

the development human resources directed towards a national pool of skilled and self-reliant craftsmen, technicians and technologists in technical and vocational education fields (FRN, 2013). Thus, ITE is designed to produce skilled graduates in relevant technical areas that are expected to be useful to themselves and also contribute to the manpower needs and boost economic development of the nation.

Industrial Technology Education as a course of study offered in most Nigerian Universities is expected to contribute its own quota to the country's technological development by expanding their programmes so as to provide for the manpower needs of the country's diverse economic sectors (Udoudo & Udoetuk, 2020). Consequently, ITE is made up of five specific areas of specialisation. These areas include Automobile Technology, Building Technology, Electrical/Electronic Technology, Metalwork Technology, and Woodwork Technology. ITE is taught by lecturers who have been trained in the respective areas to meet the aims and objectives of the programme and the overall goals of education in Nigeria. Therefore, with the significant global transformation today due to the advent of Industry 4.0, it is quite necessary that Nigerian ITE lecturers ethically incorporate AI into their teaching methodologies to prepare ITE students for the globally evolving job market. However, this can be attainable if the lecturers undergo further training and upskilling.

Training could be referred to as the experience, knowledge, values, and skills obtained by an individual. Training is a period of undergoing practical experience or instruction in an individual's professional career (Merriam Webster, 2025). Training according to Gupta (2023) is the process of providing individuals with the skills, tools, and expertise they need to do their jobs efficiently, incorporate developments in technology and procedures, and positively contribute to the growth and success of their organisations. Consequently, training is aimed at making and individual competent for a particular role, task or position. However, following the recent technological advancements that have emerged in the education sector such as AI and big data analytics, it is necessary that ITE lecturers who have already undergone relevant training in their various respective areas of specialisation undergo upskilling to enable them meet up with current realities in the sector.

Upskilling refers to the act of providing an individual with more advanced skills often through extra training and education. Gupta (2023) defined upskilling as the process by which employees learn new skills and acquire relevant knowledge and expertise needed for their current work environments and in the nearest future. It concentrates on improving employees' skills, particularly through constant training programs, to assist them progress in their careers. Upskilling could also imply learning new skills or improving on the existing ones in order to stay abreast with latest improvements in technology and changing employment demands within the same field of work. Gupta (2023) emphasized that upskilling mostly concentrates on career advancement instead of change, with a focus on increasing employees' proficiency, efficiency, and value in their existing role. According to Wirnani et al. (2024), upskilling focuses on developing existing skills to accommodate changes and new technologies. Such recent technologies include AI, Internet of Things and big data analytics among others which have made significant impacts on several sectors including education.

Impacts refer to the positive or negative changes of a development intervention on its surroundings and the various components that influence development (Australian Department of Foreign Affairs & Trade Office of Development Effectiveness as cited in Hearne & Buffardi, 2016). The United Nations Development Group (UNDG, 2015) referred to impact as the changes in the lives of individuals, including changes in knowledge, skill, behaviour, health, or living conditions for children, adults, families, or communities as a result of a development

initiative or action, directly or indirectly, intended or unintended. Consequently. AI has brought about tremendous changes in education as reported by several researchers (Almasri, 2024; Slimi, 2023). Thus, for the purpose of this study, impact is referred to as the change or results brought about by a programme, in this case, AI.

The impact of AI on education is transformative and multifaceted (Vieriu & Petrea, 2025). Thus, ITE lecturers should be upskilled to enable them perform satisfactorily as professionals in their various areas of specialisation as AI can improve lecturers' effectiveness. Lecturer effectiveness is a critical element in ensuring the quality of teaching, research, and other academic contributions (Cindrakasih et al., 2024). Thus, the productivity of lecturers in Higher Institutions can significantly impact their teaching activities, research, community services and also the quality of graduates they produce.

Lecturer effectiveness is the degree to which teaching staff successfully carryout their duties which include; teaching, research and community service (Adebayo, 2024). Teaching entails planning and delivering lectures, assessing students through tests and examinations, supervising students in industrial training and teaching practice, and final year project supervision. Other responsibilities include developing creative teaching methods, consulting with students, and providing students with relevant educational content and resources. Research includes conducting studies in identified problems, presenting the outcomes of such studies at conferences/seminars, and publishing the results in journals or textbooks. Community service entails providing services to both the school and the community at large. These services include but are not limited to; leading a department, college, committee, external examiner, staff adviser to student societies, and serving other recognised committees at the departmental, faculty, and university levels, such as sports, matriculation, and convocation (Agbionu et al., 2018).

Lack of AI knowledge among lecturers is a crucial challenge to AI adoption as many lecturers who may not have an in-depth understanding of AI find it difficult to incorporate these tools into their instruction (Adebakin, 2025). In this global era of technological advancement, lecturers are expected to be proficient in using a variety of these tools to improve their effectiveness in teaching, research and even community services. Cleopas (2023) opined that AI is one of the rapidly increasing technologies that can improve lecturers' performance. Some impacts of artificial intelligence to lecturer effectiveness in education include; capacity to monitor students' works, monitor performance and learning progress, special education for special learners, acts as interface between students and lecturers, enables students to access relevant knowledge that improve and facilitate teaching and learning; it helps to assess lecturers' works, reduces lecturers' workload and stress; it encourages group and collaborative learning, saves time and enhances lecturer performance which ensures efficiency and higher quality delivery in education (Adebayo, 2024; Cleopas, 2023; Chaudhuri, 2023). This indicates the numerous impacts of AI in education which could be attainable by ITE lecturers if they are trained and upskilled with Artificial intelligence skills which can improve their efficiency in discharging their professional duties

It is important for ITE lecturers to acquire AI skills to help them effectively discharge their teaching, research and community service roles. AI skills include a wide variety of competencies, ranging from technical expertise to socio-emotional abilities. Technical Skills are the foundational skills required to develop and work with AI systems. They include programming languages such as Python, R, and Java, as well as expertise in machine learning, natural language processing, and data analysis (El-Hadi, 2022; Organisation for Economic Cooperation and Development, 2023). Further, Sneha and Raja (2019), and El-Hadi (2022)

argued that data Science Skills are very crucial for lecturers as data is the fuel for AI systems. According to them, skills in data collection, cleaning, and analysis are essential for training AI models and making data-driven decisions.

Another important AI skill is critical thinking and problem-Solving. ITE lecturers should have the ability to think rationally and proffer solutions to challenges in their field. Giraud et al. (2022) posited that AI systems rely on human oversight to ensure ethical and effective decision-making. Thus, critical thinking and problem-solving skills are crucial for designing and implementing AI solutions that align with human values (Kumar, 2023). Similarly, AI technologies can enhance human creativity by automating routine tasks and providing new tools for creative expression (Trisnawati et al., 2023). Therefore, ITE lecturers should imbibe creativity which is essential for working with AI applications.

Collaboration and communication skills are vital for working effectively with both humans and machines (Kumar, 2023). ITE lecturers should be possess good communication skills and should be able to collaborate effectively in their various working environments. Furthermore, as AI becomes more integrated into society, ethical considerations such as privacy, bias, and accountability become increasingly important (Sengsri & Khunratchasana, 2024). Thus, ITE lecturers should have a clearer understanding of the ethical implications of AI to help them apply its tools efficiently and also discharge their duties effectively.

Artificial intelligence training and upskilling is very important for ITE lecturers as they have crucial roles to play towards teaching, research, and community service. Consequently, ITE lecturers should be trained and upskilled to integrate AI ethically and effectively into their teaching and research, as well as to use technology as a means of improving human abilities and obtaining improved educational outcomes. Lecturers are therefore expected to maintain their roles as masters in their respective fields instead of servants, facilitators in instructional delivery, and to positively utilise the multifaceted benefits and prospects of AI for the welfare of individuals while reducing the challenges it presents to our society. Considering the technological advancements in education coupled with the need for lecturers to align with current global practices related to effective teaching, research, and community service as required, there is an urgent need to examine the impacts of artificial intelligence training and upskilling for industrial technology education lecturers' effectiveness in Nigeria for industry 4.0 and beyond. It is based on this background that this study becomes imperative.

Statement of the Problem

The Federal Republic of Nigeria (2013) emphasizes that the goals of Industrial Technology Education include; to develop a skilled workforce, promote technological innovation, equip individuals with practical skills for both employment and self-reliance, and contribute to the nation's industrial and economic growth. Moreover, building solid technological skills by ITE lecturers is important for incorporating technology into teaching and making sure students are well-prepared for the digital age. Nigerian universities offering ITE programmes are therefore expected to train individuals in line with these goals. Thus, Universities' performances and actions towards attaining the goals of ITE as stated above may be attributed to the extent of lecturers' effectiveness.

However, despite the several positive impacts AI in education, ITE lecturers in Nigerian universities are still struggling to fully integrate AI in their academic and research activities (Nannim, 2018; Onah et al., 2020; Thomas, 2022). This issue has led to low effectiveness in lecturers towards discharging their official duties. This problem could be attributed to lack of

AI training and upskilling in the effective and ethical application of these tools available in education.

This problem of low level of lecturer effectiveness as regards teaching and research if not urgently addressed could lead to poor quality of university education and lack of global recognition, production of half-baked graduates who may lack employability skills, high rate of graduate unemployment, and high risk of insecurity and other societal vices among others. This study therefore sought to examine the impacts of artificial intelligence training and upskilling for industrial technology education lecturers' effectiveness in Nigeria for industry 4.0 and beyond.

Purpose of the Study

The purpose of the study was to examine the impacts of Artificial Intelligence training and upskilling for ITE lecturers' effectiveness in Nigeria for industry 4.0 and beyond. Specifically, the study sought to:

1. examine the extent of ITE lecturers' effectiveness in Nigeria for industry 4.0 and beyond.
2. ascertain the Artificial Intelligence skills for ITE lecturers' effectiveness in Nigeria for industry 4.0 and beyond.

Research Questions

The following research questions guided the study:

1. What is the extent of ITE lecturers' effectiveness in Nigeria for industry 4.0 and beyond?
2. What are the Artificial Intelligence skills required for ITE lecturers' effectiveness in Nigeria for industry 4.0 and beyond?

Hypotheses

HO_1: There is no significant difference between the mean responses of male and female ITE lecturers on their level of effectiveness in Nigeria for industry 4.0 and beyond.

HO_2: There is no significant difference between the mean responses of male and female ITE lecturers on the Artificial Intelligence skills required for ITE lecturers' effectiveness in Nigeria for industry 4.0 and beyond.

METHODOLOGY

Descriptive survey research design was adopted for the study. The design is appropriate for the study since the study involved the use of questionnaire for collecting data from the respondents to examine the impacts of AI training and upskilling for ITE lecturers' effectiveness in Nigeria for industry 4.0 and beyond. The population for the study comprised 55 respondents consisting 45 male lecturers and 10 female lecturers in the Departments of Industrial Technology Education in Michael Okpara University of Agriculture, Umudike Abia state and Technical Education in Ignatius Ajuru University of Education, Rivers State. Since the population was manageable in size, census sampling was adopted as the entire population was used for the study. A 54-item structured questionnaire titled: Lecturers' Effectiveness and Artificial Intelligence Questionnaire (LEAIQ) was used to generate data for the study. The

instrument was validated by two experts from the department of Industrial Technology Education and one expert from Measurement and Evaluation unit in the department of Science Education all in Michael Okpara University of Agriculture, Umudike Abia State. The reliability of the instrument was estimated using the Cronbach's Alpha Method which yielded an internal consistency value of .86. The questionnaire was administered to the respondents using Google forms which ensured automatic recording of the responses. Mean and standard deviation were used to answer the research questions while t-test was used to test the null hypotheses at .05 level of significance. Thus, any item with p-value greater than .05, the hypothesis of no significant difference was upheld at .05 level of significance, but where the p-value is less than .05, the hypothesis of no significant difference was rejected. The data analysis was computed with a computer software programme; statistical package for the social sciences (SPSS).

RESULTS

Research Question 1

What is the extent of ITE lecturers' effectiveness in Nigeria for industry 4.0 and beyond?

Table 1: Mean Scores and Standard Deviation of Male and Female ITE lecturers on their level effectiveness in Nigeria for industry 4.0 and beyond

S/No	Item Statements	Male Lecturers N_1=45		Female Lecturers N_2 = 10		Decision
		X_1	SD_1	X_2	SD_2	
1.	I ensure proper planning before teaching my students	3.71	0.78	3.69	0.88	HE
2.	I strictly adhere to the lecture timetable	2.39	0.82	2.40	0.81	LE
3.	I do not miss my lectures except under situations beyond control	3.48	0.71	3.51	0.70	HE
4.	I give out a comprehensive course outline to the students while introducing each course	2.64	0.71	2.67	0.71	HE
5.	I make students understand the importance of each course I teach them	2.42	0.64	2.41	0.65	LE
6.	I ensure students understand the relevance of each course I teach them to their profession	3.12	0.73	3.15	0.73	HE
7.	I ensure that students comprehend the objectives for each particular lecture	2.65	0.70	2.66	0.71	HE
8.	At the beginning of each topic, I teach students concepts from known to unknown and from simple to complex	1.21	0.80	1.22	0.82	LE
9.	I relate all concepts I teach in the classroom to real life experiences	1.93	0.62	1.99	0.61	LE
10.	I develop and use creative and relevant teaching methods during lectures	1.21	0.74	1.29	0.75	LE
11	I carry out formative evaluation during lectures	2.65	0.70	2.66	0.71	LE
12	I ensure an effective flow of communication with my students during lectures	1.21	0.80	1.22	0.82	LE
13.	I ensure that the instructional objectives for each lecture are achieved	1.93	0.62	1.99	0.61	LE
14.	I ensure that content I teach is updated	2.21	0.74	2.29	0.75	LE
15.	I make use of relevant and current textbooks for teaching	1.93	0.62	1.99	0.61	LE
16.	I deliver all courses allocated to me each semester	1.21	0.74	1.29	0.75	LE
17.	My lectures are very interactive	2.65	0.70	2.66	0.71	HE
18.	I frequently give assignments to my students	2.39	0.82	2.40	0.81	LE
19.	I ensure prompt submission of assignments	1.71	0.78	1.69	0.88	LE

20.	I mark assignments and return to students on time	2.39	0.82	2.40	0.81	LE
21.	I offer revision lectures to students in preparation for examinations	1.48	0.71	1.51	0.70	LE
22.	I set examination questions at the end of every semester	1.64	0.71	1.67	0.71	LE
23.	I ensure that my examination questions adequately cover the content I taught the students	1.42	0.64	1.41	0.65	LE
24.	I invigilate examinations when scheduled	2.12	0.73	2.15	0.73	LE
25.	I mark my students' examination scripts on time	1.65	0.70	1.66	0.71	LE
26.	I submit my students' continuous assessment, examination scores and grades latest two weeks after examinations	1.21	0.80	1.22	0.82	LE
27.	I am always in touch with students as their academic adviser	1.93	0.62	1.99	0.61	LE
28.	I supervise students during their teaching practice	1.21	0.74	1.29	0.75	LE
29.	I supervise students during their industrial training	2.39	0.72	2.41	0.73	LE
30.	I supervise final year students' research projects allocated to me as scheduled	1.48	0.70	1.51	0.72	LE
31.	I conduct research regularly in my area of specialisation	1.64	0.31	1.67	0.34	LE
32.	I regularly present the outcomes of my research at conferences/seminars	2.41	0.48	2.43	0.49	LE
33.	I often publish my research works in relevant journals and textbooks	2.13	0.71	2.16	0.72	LE
34.	I am content with the research works so far conducted by me	1.15	0.79	1.19	0.75	LE
35.	I am satisfied with the articles I have published	1.21	0.78	1.22	0.87	LE
36.	I am content with the chapters I have written in textbooks	1.93	0.82	2.97	0.91	LE
37.	I am happy with the number of textbooks I have authored	2.75	0.79	2.19	0.75	LE
38.	I am satisfied with the papers I have presented at conference	3.21	0.78	1.22	0.87	LE
39.	I often attend AI trainings and workshops	2.93	0.82	2.53	0.91	LE
	Cluster Mean/Standard Deviation	**2.08**	**0.72**	**2.05**	**0.73**	**LE**

Key: X = Mean, SD = Standard Deviation, N = Number, HE = High Extent, LE = Low Extent

The result presented in Table 1 indicates the mean and standard deviation of the responses of both male and female ITE lecturers regarding their extent of effectiveness in Nigeria for industry 4.0 and beyond. The mean scores for the 39 items ranged from 1.21 to 3.71, with a cluster mean of 2.08, indicating a generally low extent of lecturer effectiveness among them. Furthermore, the standard deviation values ranged between .72 and .91, indicating a relatively low dispersion and a high level of agreement among respondents. Based on these findings, it can be inferred that the extent of ITE lecturers' effectiveness in Nigeria for industry 4.0 and beyond is low.

Research Question Two

What are the Artificial Intelligence skills required for ITE lecturers' effectiveness in Nigeria for industry 4.0 and beyond?

Table 2: Mean scores and standard deviation of responses of male and female ITE lecturers on Artificial Intelligence skills required for lecturers' effectiveness in Nigeria for industry 4.0 and beyond.

S/No	Item Statements	Male Lecturers N_1=45		Female Lecturers N_2 = 10		Decision
		M_1	SD_1	M_2	SD_2	
40.	Technical Skills	2.65	0.81	2.62	0.82	HE
41.	Basic computing skills	3.22	0.74	3.25	0.74	LE
42.	Programming skills such as Python, R, and Java	3.29	0.77	3.21	0.76	HE
43.	Machine learning skills	2.75	0.74	2.81	0.75	HE
44.	Database modelling skills	3.21	0.83	3.11	0.84	LE
45.	Intelligent User Interface (IUI) skills	3.27	0.88	3.14	0.87	LE
46.	Natural Language Processing (NLP) skills	3.16	0.88	3.01	0.87	LE
47.	Data analytics skills	3.18	0.60	3.19	0.61	LE
48.	Data Science skills	3.19	0.76	3.11	0.75	LE
49.	Problem-Solving skills	3.28	0.76	3.11	0.74	LE
50.	Critical thinking skills	3.24	0.76	3.15	0.74	LE
51.	Creativity skills	3.21	0.73	3.25	0.75	LE
52.	Communication skills	3.19	0.81	3.11	0.82	LE
53.	Collaboration skills	3.13	0.74	3.05	0.75	LE
54.	Ethical and social skills	2.61	0.77	2.75	0.36	LE
	Cluster Mean/Standard Deviation	**3.11**	**0.77**	**3.06**	**0.75**	**LE**

Key: M = Mean, SD = Standard Deviation, N = Number, HE = High Extent, LE = Low Extent

Table 2 presents the mean and standard deviation of responses from male and female ITE lecturers on the Artificial Intelligence skills required for ITE lecturers' effectiveness in Nigeria for industry 4.0 and beyond. The mean scores for the 15 items ranged from 2.61 to 3.27, with a cluster mean of 3.09, indicating a general acceptance of the items as Artificial Intelligence skills required for ITE lecturers' effectiveness in Nigeria for industry 4.0 and beyond. Further, the standard deviation values ranged from .36 to .88, indicating that the responses were relatively consistent and clustered around the mean. Based on these findings, it can be concluded that all the items in the table are Artificial Intelligence skills required for ITE lecturers' effectiveness in Nigeria for industry 4.0 and beyond.

Ho_1: There is no significant difference between the mean responses of male and female ITE lecturers on their level of effectiveness in Nigeria for industry 4.0 and beyond.

Table 3: Summary of t-test results of mean responses of male and female ITE lecturers on their level of effectiveness in Nigeria for industry 4.0 and beyond.

Hypotheses	Groups	N	X	SD	Df	t	P-value	95% CI	Decision
Ho_1	Male Lecturers	45	2.08	.72	53	.12	.91	-0.48 - 0.54	Accept
	Female Lecturers	10	2.05	.73					

Key: N= Number, X= Mean, SD= Standard Deviation, Df= Degree of freedom, CI= Confidence interval

Table 3 shows the t-test analysis of mean responses of male and female ITE lecturers on their level of effectiveness in Nigeria for industry 4.0 and beyond. Based on the findings presented in the table, it can be observed that at 53 degrees of freedom, the p-value was .91 which exceeded the predetermined significance level of 0.05 for this study. Consequently, the null hypothesis is accepted. This signifies that there is no significant difference between the mean responses of male and female ITE lecturers on their level of effectiveness in Nigeria for industry 4.0 and beyond.

Ho_2: There is no significant difference between the mean responses of male and female ITE lecturers on the Artificial Intelligence skills for ITE lecturers' effectiveness in Nigeria for industry 4.0 and beyond.

Table 4: Summary of t-test results of mean responses of male and female ITE lecturers on the Artificial Intelligence skills for ITE lecturers' effectiveness in Nigeria for industry 4.0 and beyond.

Hypotheses	Groups	N	M	SD	Df	t	P-value	95% CI	Decision
	Male Lecturers	45	3.11	.77					
Ho_2					53	.19	.85	-0.48 - 0.58	Accept
	Female Lecturers	10	3.06	.75					

Key: N= Number, M= Mean, SD= Standard Deviation, Df= Degree of freedom, CI= Confidence interval

Table 4 shows the t-test analysis of mean responses of male and female ITE lecturers on the Artificial Intelligence skills for ITE lecturers' effectiveness in Nigeria for industry 4.0 and beyond. Findings as shown in the table indicate that at 53 degrees of freedom, the computed p-value was .85, which is greater than the established significance level of.05. As a result, the null hypothesis is accepted. This implies that there is no significant difference between the mean responses of male and female ITE lecturers on the Artificial Intelligence skills for ITE lecturers' effectiveness in Nigeria for industry 4.0 and beyond.

Discussion

The findings of the study revealed a low extent of ITE lecturers' effectiveness in Nigeria for industry 4.0 and beyond. The respondents revealed that they are not satisfied with; their research outputs so far, the articles they have published, the chapters they have written in textbooks, the number of textbooks they have authored and the papers they have presented at conferences among others. However, the study also revealed that there is a high extent of effectiveness in teaching activities. The finding is in line with that of Adebayo (2024) who also found a low extent of lecturers' job effectiveness in the Ogun State universities. Furthermore, the result of hypothesis one corroborates the findings of research question one given that no significant difference exists in the mean responses of male and female ITE lecturers in on their extent of effectiveness in Nigeria for industry 4.0 and beyond.

Furthermore, the study identified several artificial intelligence skills required for ITE lecturers' effectiveness in Nigeria for industry 4.0 and beyond. According to the respondents, key AI skills include: Technical Skills, basic computing skills, programming skills such as Python, R, and Java, machine learning skills, database modelling skills, Intelligent User Interface (IUI) skills, Natural Language Processing (NLP) skills, data analytics skills, data science skills among others. This implies that for lecturers' job effectiveness to be attained using AI, lecturers' need to acquire some specific skills as discussed in this study. These findings align with the study of Odigwe and Owan (2020), which revealed that lecturers' attributes, including computing and language skills, significantly influence their use of ICT tool such as Artificial Intelligence for teaching, conducting research, and managing academic records in higher education. Further analysis indicated that there was no significant difference between the mean responses of male and female ITE lecturers on the artificial intelligence skills for ITE lecturers' effectiveness in Nigeria for industry 4.0 and beyond. This indicates that gender does not play a significant role in determining the artificial intelligence skills for ITE lecturers' effectiveness in Nigeria for industry 4.0 and beyond.

CONCLUSION

The study examined the impacts of Artificial Intelligence training and upskilling on the effectiveness of Industrial Technology Education lecturers in Nigeria for Industry 4.0 and beyond. The Findings revealed a generally low level of effectiveness among ITE lecturers in research-related activities such as publications, authorship, and conference presentations, although their teaching effectiveness remains relatively high. Moreover, the study identified a

range of essential AI-related skills such as programming, machine learning, data analytics, and natural language processing as critical for enhancing lecturers' effectiveness in adapting to Industry 4.0 demands. Importantly, the study found no significant gender-based differences in perceptions of both job effectiveness and AI skills requirements. This suggests a unified need for capacity development across both male and female ITE lecturers to bridge the digital competence gap and align with global educational and technological standards.

RECOMMENDATIONS

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

1. Government agencies, professional bodies, and university administrators should endeavour to organize regular AI training and upskilling programs tailored specifically for ITE lecturers to boost their effectiveness in research, teaching, and innovation.

2. Universities offering Industrial Technology Education should integrate essential AI competencies such as data analytics, machine learning, and data science into the curriculum for both pre-service and in-service lecturers.

3. Universities should invest in modern AI-powered tools and infrastructure that support smart teaching, digital research, and automated academic services to foster an AI-ready academic environment.

4. To address the low level of research effectiveness, universities and funding bodies should provide incentives, grants, and mentorship opportunities that encourage lecturers to engage in impactful, AI-driven research and publications.

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