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IDENTIFICATION OF EMERGING TECHNOLOGIES FOR 21ST CENTURY ELECTRICAL/ELECTRONIC TECHNICAL EDUCATION STUDENTS' SKILLS DEVELOPMENT IN COLLEGES OF EDUCATION IN RIVERS STATE, NIGERIA

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Abstract: *The study investigated the artificial intelligence and green technologies for 21st century electrical/electronic technical education students' skills development in College of education in Rivers State, Nigeria. Two research questions were answered. The study was a descriptive survey design. The population was manageable, therefore, the entire population was used for the study without sampling. A self-made survey questionnaire served as the instrument for data collection. The instrument was structured in the pattern of Likert 5-point rating scale of agreement. The instrument was face validated by two experts in the Department of Electrical/electronic technology education in Federal College of Education (Technical), Omoku. The reliability of the instrument was established using Cronbach Alpha Reliability Coefficient, which gave a reliability coefficient of .84. Mean and Standard deviation were used to answer the research questions and to ascertain the homogeneity of responsest. The study found that AI based fault detection and diagnosis trainers, predictive maintenance training system, AI powered IoT home automation training kit, AI powered circuit design and simulation tools, AI Chatbot for technical support, AI in smart grid management simulators, AI driven robotics in electronic assembly training and AI + AR/VR for virtual electrical labs, Solar photovoltaic PV system, Solar inverter & battery storage systems, smart energy meters, LED & smart lighting system, energy management system, electric vehicle EV charging station, Microgrid and smart grid technology, wind energy system and Biomas/Biogas power system are AI and green emerging technologies for 21st Century Electrical/Electronic Technical Education students in colleges of education in Rivers State, Nigeria. Therefore, it was recommended amongst others that Electrical/electronic technology educators should be trained on emerging technologies for teaching so as to advance teaching and learning process in electrical/electronic technology education programme and to bridge the technology gap in electrical/electronic technology education programme.*
Keywords*: Education, Electrical, Electronic, Emerging, Skill, Technical and Technology*

Introduction

Technical education is one of the educational programmes that are currently attracting national and global attention, especially as the world is becoming more technology driven. Okoye and Okwelle (2014) defined technical education as a formal training that enables application of the techniques of applied sciences and mathematical principles for the services of humankind. Also, Ochogba and Deebom (2019) defined technical education as the education that provides the requisite skills needed for self-employment or for gainful employment in industries. Hence, in proffering solutions to technology related problems, technical education programme provides the requisite skills for technology advancement.

Skill can be defined as the ability to do something proficiently (Ochogba & Amaechi, 2018). The process of getting a skill from a more experience person, an organization or any other means such that the trainee would be able to practice the skill afterwards is known as skills development (Ochogba & Amaechi, 2018). Similarly, Musa et al (2024) defined skill development as the form of training by individuals or a group of individuals that can lead to the acquisition of practical knowledge for self-sustenance.

For technical education programmme, numerous skills are provided for students empowerment in professional areas such as Automobile, Building, Metal work, Electrical/Electronic and Wood work amongst others. These trades have contributed so much towards human and national development in Nigeria, but this study will focus on electrical/electronic technology education. According to Ogbuanya

and Oziegbunam (2012), electrical/electronics technology education is the application of scientific knowledge in the design, selection of materials, construction, operation and maintenance of electrical and electronics equipment.

Federal Republic of Nigeria (2014) stated that the main goal of electrical/electronics technology programme is to produce competent electrical/electronic technicians with sound theoretical knowledge, who should be able to perform all types of electrical installation, diagnose, and perform repairs and/or maintenance on electrical and electronic devices. It involves understanding principles of electricity, electronics, and electromagnetism to develop, troubleshoot, and maintain systems for various purposes. Electrical/electronics technology education programme covers some content areas in electrical technology and in electronics technology. Some of these contents include circuit theory and analysis, electrical installation, electrical devices and machines, digital logic circuits, electronic communication, semiconductor devices and circuits, electrical and electronics drafting, integrated circuits, microprocessors, transistors, amplifiers and electronic instruments (Chukwuedo & Omofonmwan, 2014).

Therefore, electrical and electronic technology education is designed to produce electrical and electronics personnel for power generation, transmission, distribution and utilization (Odudu & Edidiong, 2024). Upon completion of the programme, graduates will have the options to; secure employment in the industries, set up their own business, to become self-employed and be able to employ others; pursue further education (Odudu & Edidiong, 2024)

However, in recent years, the role of electrical and electronics technology in driving economic growth and sustainable development has become increasingly significant. Basically, industries are evolving and adapting to rapid technological advancements, therefore, equipping students with the skills necessary for effective participation in this field is essential for both individual career prospects and the broader economic landscape. On this note, it is paramount to develop a robust educational framework that fosters students' engagement and participation in Electrical Electronics Technology Education programmes.

Consequently, there are several emerging technologies that are introduced in teaching, learning and management of electrical/electronics technology education programme. Emerging technologies refer to new and innovative technologies that are currently being developed or will be developed within the next few years (Heo et al., 2017). Similarly, emerging technologies refers to technologies currently developing or expected to be available within the next five to ten years (Sadiku, et al, 2025). From the foregoing, emerging technologies can be defined as those technologies that are still in their infancy but have the tendencies of transforming human activities and proffering solutions to human challenges.

Examples of emerging technologies include artificial intelligence (AI), blockchain, Internet of Things (IoT), big data, quantum computing, 3D printing, and biotechnology (Sadiku et al, 2025). According to Musa et al (2024), emerging technologies such as automation, the Internet of Things (IoT), artificial intelligence (AI), machine learning (ML), and advanced semiconductor technologies significantly impact the skills needed in electrical and electronic technology. Therefore, Artificial Intelligence (AI) and Machine Learning technologies are increasingly being integrated into electrical systems for automation, predictive maintenance, and system optimization (Musa, et al., 2024). Incorporating emerging technologies such as AI and ML into electrical engineering programs ensure that students learn about the latest advancements and gain relevant skills that are increasingly demanded by employers (Brown, 2021).

However, as emerging technologies, some of these technologies have not been identified by educators as veritable instrument for teaching and learning. Meanwhile, if educators are informed about emerging technologies, it will enhance teaching/learning activities and also equipped students with relevant skills

for 21st century industries. On this note, it is necessary to inform electrical/electronic technology educators about emerging technologies for skills development. This study has been designed to fill the gap existing between conventional technologies and emerging technologies for 21st Century Electrical/Electronic Technical Education students' skills development in colleges of education in Rivers State, Nigeria.

Purpose of the Study

The study identified emerging technologies for 21st Century Electrical/Electronic Technical Education students' skills development in colleges of education in Rivers State, Nigeria. Specifically, the study sought to;

1. Identify Artificial Intelligence (AI) technologies for 21st Century Electrical/Electronic Technical Education students' skills development in colleges of education in Rivers State, Nigeria.
2. Examine green technologies for 21st Century Electrical/Electronic Technical Education students' skills development in colleges of education in Rivers State, Nigeria.

Research Questions

1. What are the AI technologies for 21st Century Electrical/Electronic Technical Education students' skills development in colleges of education in Rivers State, Nigeria?
2. What are the green technologies for 21st Century Electrical/Electronic Technical Education students' skills development in colleges of education in Rivers State, Nigeria?

Methodology

This study was carried out in federal college of education (technical), Omoku in Rivers State, which is the only college of education in Rivers State as at the time of the study. The population of the study comprised 24 electrical/electronic technology educators and 10 entrepreneurship educators in school of secondary education (technical) in federal college of education (technical), Omoku in Rivers State. The population was manageable, therefore, the entire population was used for the study without sampling. A self-made survey questionnaire titled Emerging Technologies for 21st Century Electrical/Electronic Technical Education Students (ETCETES) served as the instrument for data collection. The instrument was structured in the pattern of a 5 point Likert rating scale of Strongly Agree (SA-5), Agree (A-4), Undecided (U-3), Disagree (D-2) and Strongly Disagree (SD-1). The instrument was face validated by two experts in the Department of Electrical/electronic technology education in Federal College of Education (Technical), Omoku. Also, the reliability of the instrument was tested on 8 electrical/electronic and entrepreneurship educators who were purposefully selected outside the population of the study. The responses elicited from the pilot testing were analysed with Cronbach Alpha Reliability Coefficient, which gave a reliability coefficient of .84. The researcher administered and retrieved copies of the instruments at the point of administration. Mean and Standard deviation were used to answer the research questions and to ascertain the homogeneity of responses. The valued judgment made during the study was that Mean scores < 3.00 were rejected while Mean scores $\geq$ 3.00 were accepted.

Results and Discussion

Research Question 1: What are the AI technologies for 21st Century Electrical/Electronic Technical Education students' skills development in colleges of education in Rivers State, Nigeria?

Table 1: Mean Responses on AI Technologies for 21st Century Electrical/Electronic Technical Education students

		Elect/Elect Educators (n_1=24)			Entrepreneurship Educators (n_2=10)		
S/N	AI Technologies	$\bar{x}_1$	SD_1	Decision	$\bar{x}_2$	SD	Decision

1	AI based fault detection and diagnosis trainers	3.33	.96	Agree	3.20	1.14	Agree
2	AI powered predictive maintenance training system	3.88	1.19	Agree	3.30	1.06	Agree
3	AI powered IoT home automation training kit	3.88	1.08	Agree	3.40	1.07	Agree
4	AI powered circuit design and simulation tools	3.83	1.17	Agree	3.50	.85	Agree
5	AI Chatbot for technical support	3.96	.69	Agree	3.30	1.42	Agree
6	AI in smart grid management simulators	3.92	1.02	Agree	3.50	.85	Agree
7	AI driven robotics in electronic assembly training	3.88	1.12	Agree	3.30	1.06	Agree
8	AI + AR/VR for virtual electrical labs	3.88	.95	Agree	3.50	.85	Agree
	Total	**3.82**	**1.02**		**3.38**	**1.04**	

Source: Field Survey, 2026

Result in Table 1 shows that both electrical/electronic educators and entrepreneurship educators agreed that the AI technologies highlighted are emerging technologies for 21st Century Electrical/Electronic Technical Education students' skills development in colleges of education in Rivers State, Nigeria. This is evidence in the grand mean scores of 3.82 for electrical/electronic educators and 3.38 for entrepreneurship educators, which are both greater than the acceptable mean value of 3.00. Also, the closeness in the Standard Deviation for both groups which is 1.02 and 1.04 shows homogeneity in the responses of both groups. This is in line with Sadiku et al (2025) that found emerging technologies to include artificial intelligence (AI), blockchain, Internet of Things (IoT), big data, quantum computing, 3D printing, and biotechnology.

Research Question 2: What are the green technologies for 21st Century Electrical/Electronic Technical Education students' skills development in colleges of education in Rivers State, Nigeria?

Table 2: Mean Responses on Green Technologies for 21st Century Electrical/Electronic Technical Education students

		Elect/Elect Educators (n_1=24)			Entrepreneurship Educators (n_2=10)		
S/N	**Green Technologies**	$\bar{x}_1$	**SD1**	**Decision**	$\bar{x}_2$	**SD**	**Decision**
9	Solar photovoltaic PV system	3.92	1.50	Agree	3.90	1.60	Agree
10	Solar inverter & battery storage systems	3.83	1.66	Agree	3.80	1.14	Agree
11	Smart energy meters	3.88	1.30	Agree	3.50	1.58	Agree
12	LED & smart lighting system	3.67	1.05	Agree	3.30	1.43	Agree
13	Energy management system	3.75	1.07	Agree	3.20	1.93	Agree
14	Electric vehicle EV charging station	3.96	1.12	Agree	3.80	1.14	Agree
15	Microgrid and smart grid technology	3.75	.99	Agree	3.60	1.43	Agree
16	Wind energy system	3.88	1.08	Agree	3.90	1.37	Agree
17	Biomass/Biogas power system	3.96	.86	Agree	3.70	1.25	Agree
	Total	**3.84**	**1.18**		**3.66**	**1.43**	

Source: Field Survey, 2026

Result in Table 2 shows that both electrical/electronic educators and entrepreneurship educators agreed that green technologies highlighted are emerging technologies for 21st Century Electrical/Electronic Technical Education students' skills development in colleges of education in Rivers State, Nigeria. This is evidence in the grand mean scores of 3.84 for electrical/electronic educators and 3.66 for entrepreneurship educators, which are both greater than the acceptable mean value of 3.00. Also, the closeness in the Standard Deviation for both groups which is 1.18 and 1.43 shows homogeneity in the responses of both groups. This is in consonance with Sadiku et al (2025) that found emerging technologies to include artificial intelligence (AI), blockchain, Internet of Things (IoT), big data, quantum computing, 3D printing, and biotechnology

Conclusions

The study deduced that AI based fault detection and diagnosis trainers, predictive maintenance training system, AI powered IoT home automation training kit, AI powered circuit design and simulation tools, AI Chatbot for technical support, AI in smart grid management simulators, AI driven robotics in electronic assembly training and AI + AR/VR for virtual electrical labs are AI emerging technologies for 21st Century Electrical/Electronic Technical Education students' skills development in colleges of education in Rivers State, Nigeria. Also, the study deduced that Solar photovoltaic PV system, Solar inverter & battery storage systems, smart energy meters, LED & smart lighting system, energy management system, electric vehicle EV charging station, Microgrid and smart grid technology, wind energy system and Biomas/Biogas power system are green emerging technologies for 21st Century Electrical/Electronic Technical Education students' skills development in colleges of education in Rivers State, Nigeria.

Recommendations

The following recommendations are made;

1. Electrical/electronic technology educators should be trained on emerging technologies for instruction delivery so as to advance teaching and learning process in electrical/electronic technology education programme and to bridge the technology gap in electrical/electronic technology education programme.
2. Colleges of education should be equipped with emerging technologies that will help bridge technology gap created by unavailability of emerging technologies in colleges of education in Nigeria.

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