RELEVANCE OF ELECTRICAL AND ELECTRONICS TECHNOLOGY EDUCATION FOR SUSTAINABLE WORKFORCE DEVELOPMENT IN NIGERIA

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Abstract

In the contemporary landscape of education and in promoting technological literacy for sustainable national development, electrical and electronics is very crucial especially in the area of technopreneurial skills and work force development. The use of zooms for conferences, workshops, meetings and online learning through ICT and innovation in the areas of alternative power generation for the mitigation of climate change are just few to mention which has proven the relevance of electrical and electronics technology for sustainable workforce development. In addition, reduction in security risk, creating more jobs for our teaming youth and easy communication through GSM handset also enhance good business startup and relationships. However, this paper believed that the advancement in electrical and electronics technology is seriously threatened by poor leadership, poor funding and use of unqualified personnel in the position of authority. To ameliorate these problems, it is recommended among others that the public and government alike must pay attention to the areas of deficiency and provide the necessary facilities for the advancement of electrical and electronic technology education.

Keywords: Relevance, Electrical and Electronics Technology, Sustainable Workforce Development.

Introduction

Electrical and electronics technology education stands as the pillar of innovation, ingenuity and transformation in the ever-evolving technological advancement and sustainable workforce development. It encompasses the study, design, and application of electrical systems and devices, including circuits, components, and systems used in various industries such as telecommunications, power generation, transportation, and consumer electronics. It involves understanding principles of electricity, electronics, and electromagnetism to develop, troubleshoot, and maintain systems for various purposes. According to Ogbuanya and Oziegbunam (2012), Electrical and electronics technology is the application of scientific knowledge in the design, selection of materials, construction, operation and maintenance of electrical and electronics equipment. Electrical and electronics technology education is designed to produce electrical and electronics personnel for power generation, transmission, distribution and utilization.

Electrical and Electronics technology education as a component of Technical and Vocational Education and Training (TVET) is a specialized type of education that is focused on the acquisition of skills needed in the workplace with a special focus on technology education. It can also be referred to as a type of education or training, which is aimed at providing technological skills for a person related to a profession, in order for that person to get a job and provide a livelihood. The purpose of TVET is to prepare people for self-employment and to serve as a medium of evolution for people in the world of work; by enabling individuals to develop a sense of belonging in their communities. National Board for Technical Education (NBTE, 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. The trainees on completing the programmes have the options to; secure employment in the industries, set up their own business, to become self-employed and able to employ others; pursue further education in advanced craft/technical programme and in post-secondary (tertiary) technical institutions such as Polytechnics, Colleges of Education (Technical) and Universities (FRN, 2014). This means that, Technical, Vocational Education and Training (TVET) especially electrical/electronics technology programme will enable persons to obtain the skills they need in order to be gainful-employed either on paid employment or as self- employed, thereby reducing the level of unemployment and sustaining the workforce in the country

On the other hand, Sustainable workforce development could be said to be the process of ensuring that the workforce is equipped with the skills, knowledge, and opportunities necessary to meet current and future economic, social, and environmental needs without compromising the ability of future generations to meet their own needs. It also involves creating long-term strategies and practices to support the ongoing growth, adaptability, and well-being of employees while also considering the broader environmental and societal impacts of workforce activities. It encompasses initiatives such as skills training, career advancement opportunities, diversity and inclusion efforts, and promoting work-life balance to ensure a resilient and thriving workforce for the future. It involves fostering a workforce that can adapt to changing technologies, market demands, and environmental challenges while promoting inclusive growth, social equity, and environmental stewardship. Kossek (2013) described a sustainable workforce as one where the work environment is caring and supports employee well-being; where employees are not seen as primarily resources that can be deployed (and depleted) to serve employers' economic ends. Where their skills, talent, and energies are not overused or overly depleted. Where they are not faced with excessive workload nor with relentless pace of work for weeks or years on end. During times of crisis (e.g., natural disasters, sickness), employees are given time to recover or seek the extra resources they need to be able to perform in the future. Where burnout is avoided and workers are given time for renewal. Workforce development, through a well-planned and orchestrated education and training initiative, will contribute significantly to promoting the interests of individuals, employers, enterprises, the economy and society within such country. A well-structured Technical Vocational Education and Training (TVET) system with special attention to Electrical and Electronics technology will enable productivity, enhance competitiveness and promote entrepreneurial activity.

Electrical and Electronics Technology Education as an Aspect of Technical Vocational Education and Training (TVET).

Electrical/Electronics technology education is an aspect of Technical Vocational Education and Technology (TVET) offered in technical colleges in order to produce electrical and electronic craftsmen and technicians. TVET stands for Technical and Vocational Education and Training which refers to education and training that focuses on providing individuals with the skills and knowledge necessary for specific trades, occupations, or professions. Its programs typically combine theoretical learning with practical hands-on experience, preparing students for careers in various industries such as manufacturing, construction, healthcare, automotive, hospitality, and information technology.

TVET programs are designed to meet the needs of the labor market by equipping students with practical skills that are in demand by employers. These programs can range from short-term vocational courses to more comprehensive technical education programs offered at vocational schools, community colleges, and specialized training centers. According to UNESCO and ILO

(2001) in Ayonmike, C. S.(2015), TVET is a comprehensive term referring to those aspects of the educational processes involving, in addition to general education, the study of technology and related sciences and the acquisition of practical skills, attitudes, understanding and knowledge relating to occupation in various sectors of economic and social life. Ugwuja (2010) defined TVET as an aspect of education designed to prepare students for industry, agriculture, commerce, home economics which is usually provided at the secondary or lower tertiary level.

The National Policy on Education (FRN, 2014) described TVET as the aspect of education that leads to the acquisition of practical and applied skills as well as basic scientific knowledge and can be explained in terms of

- Training designed to advance an individual's proficiency in relation to his or her present or future occupation.
- Training or retraining which is given in schools or classes under public supervision and control.
- Provision of systematic training experiences which are designed to fit individuals in recognized occupation.

The main goal of electrical/electronics technology programme as outlined by National Board for Technical Education (NBTE, 2010) 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. The trainees on completing the programmes have the options to; secure employment in the industries; set up their own business, to become self-employed and able to employ others; pursue further education in advanced craft/technical programme and in post-secondary (tertiary) technical institutions such as Polytechnics, Colleges of Education (Technical) and Universities (FGN, 2014). This implies that effective programmes of Technical, Vocational Education and Training (TVET) especially electrical/electronics will enable persons to obtain the skills they need in order to be gainful-employed either on paid employment or as self- employed, thereby reducing the level of unemployment in the country.

The relevance of Electrical and Electronics Technology education for sustainable workforce development cannot be over-emphasized due to the crucial role it plays. Electrical/electronics technology is like the pivot for other technological development. Other technological sector depends on electrical and electronics technology for their growth and development as evident in the energy sector, industry, telecommunication, renewable energy, innovation and entrepreneurship. They all depend on electrical and electronics technology for their development.

Relevance of Electrical and Electronics Technology for Sustainable Workforce Development.

Electrical and electronics technology is relevant to sustainable workforce development because of indispensable role it plays in shaping the modern world: from the generation and distribution of electricity to industrial processes to the development of artificial intelligence-driven solutions. It permeates virtually every aspect of the economic and social life. For the sake of this paper the relevance of electrical and electronics technology for sustainable workforce development is identified as follows:

1. Renewable Energy Integration: Electrical and Electronics Technology plays vital role in the area of renewable energy integration. Renewable energy is a form of energy that uses energy sources that are continually replenished by nature. They are such energy as solar, wind, hydro and geothermal power which are essential to reducing greenhouse gas emissions and combating

climate change. Blaabjerg, Yang, Ma, and Wang, (2015) opined that the demands of reliable and environmental-friendly electricity generation from Renewable Energy Systems (RESs) have been the main driving force for the RES development. Consequently, great efforts have been made by many countries (e.g., Germany, Spain, and Denmark) to alter their energy paradigms with more installations of renewable energy sources such as wind power, PhotoVoltaic (PV) power, hydropower, and biomass power. The author stated that among various renewable power systems, Wind Turbine System (WTS) and PV system technologies are still the most promising technologies, accounting for a large portion of renewable energy generation, and will expand more. By transitioning from fossil fuel to renewable energy, we can significantly reduce our carbon footprint and mitigate the impact of climate change on our planet. With the increasing focus on renewable energy sources, electrical and electronics technology is essential for integrating these sources into the power grid efficiently, thereby reducing reliance on fossil fuels and promoting energy sustainability and reliability.

2. Energy Efficiency: Electrical and electronics technology plays a crucial role in improving energy efficiency across various sectors. Through innovations such as smart grids, energy-efficient appliances, and renewable energy systems, it enables better monitoring, control, and optimization of energy usage, leading to reduced waste and environmental impact. This technology also drives advancements in energy storage solutions, electric vehicles, and smart buildings, all contributing to a more sustainable future. According to Kabeyi and Olanrewaju (2022), technological advances that support electric vehicles include battery technologies like nickel-metal hydride (Ni-MH) and lithium-ion (Li-Ion), intelligent energy management systems, and vehicle-to-grid (V2G) technology that stores the energy to sustain the electric cars and other battery energy dependent devices. Electrical and electronics technology enables the development of energy-efficient devices and systems, such as smart grids, energy-efficient lighting, and appliances. This efficiency reduces energy consumption, lowers costs, and minimizes environmental impact. The process of achieving these technological advancement creates a workforce that is sustainable and required in the industry.

3. Transportation: Electrical and electronics technology plays a crucial role in modern transportation systems, contributing to efficiency, safety, and sustainability. According to Oladunni (2022) Road and rail transport is the principle mode of transport for people and cargo most of which are driven by fossil fuel powered internal combustion engineers. The use of electric vehicles can reduce greenhouse gas emissions, reduce dependency on fossil fuel sources, promote deployment of renewable energy sources, the dependency on fossil fuel and mitigate the release of ozone depleting substances. The relevance of electrical and electronic technology has led to the innovations in the transportation industry such as:

- Electric Vehicles (EVs) which relies heavily on electrical and electronics technology for propulsion systems, battery management, charging infrastructure, and onboard electronics for control and monitoring.
- Advanced Safety Systems are electronics technology that are integral to modern vehicle safety features such as anti-lock braking systems (ABS), electronic stability control (ESC), collision avoidance systems, and adaptive cruise control, enhancing road safety.
- Telematics and Connectivity are Electrical systems which enable vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communication, facilitating traffic management, navigation, and remote diagnostics.
- Autonomous Vehicles (AVs) are heavily depending on electrical and electronics technology for sensors, actuators, processing units, and communication systems, enabling them to perceive and navigate the environment autonomously.

- Public Transportation Systems: Electrical technology powers various forms of public transportation, including trains, trams, and buses, enhancing efficiency, reducing emissions, and improving passenger comfort.
- Aviation and Maritime: Electrical and electronics systems are essential for avionics in aircraft, navigation systems, communication, and control systems. In maritime transportation, they are crucial for navigation, communication, propulsion, and safety systems.
- Infrastructure Development: Electrical and electronics technology is vital for developing smart transportation infrastructure, including intelligent traffic management systems, tolling systems, and electric vehicle charging stations.

Electrical and electronics technology continues to drive innovation and transformation across the transportation sector, making it more efficient, safer, and environmentally friendly. These innovation and transformation has created a workforce that is sustainable and needed for economic development and sustainability.

4. Smart Infrastructure: Electrical and electronics technology facilitates the creation of smart infrastructure, including smart buildings and cities, which optimize resource usage, enhance sustainability, and improve quality of life. Electrical and electronics technology plays a crucial role in developing smart infrastructure for sustainable workforce development by enabling efficient energy management, automation, and connectivity. It facilitates the implementation of smart grids, renewable energy systems, and IoT devices, which optimize resource usage and reduce environmental impact. Additionally, it supports the integration of advanced communication systems, data analytics, and artificial intelligence, enhancing productivity and creating opportunities for skill development in emerging technologies. Overall, electrical and electronics technology is essential for building resilient, eco-friendly infrastructure that fosters sustainable workforce growth and innovation.

5. Telecommunication: Electrical and electronics technology is fundamental to telecommunications. It can be said that it is the backbone of transmitting, receiving, and processing information in various forms such as voice, data, and multimedia. From the circuits in smartphones to the massive infrastructure of communication networks, electrical and electronics technology enables the efficient transfer of information over long distances, shaping the modern world of telecommunications. From use of mobile phones for easy communication, zooms for conferences, workshops, meetings and online learning through ICT to social media activities. Every point of the telecommunication activities require skilled personnel who constitute a workforce required in the industry and as important as telecommunication is, these workforce is sustained as the need for their skills increases in the industry.

6. Education and Training: Electrical and electronics technology is incredibly relevant in the education and training sector. It forms the backbone of many technical courses, providing students with essential skills for various industries like engineering, telecommunications, and IT. Understanding these technologies equips learners with the knowledge needed to innovate, troubleshoot, and adapt to evolving tech landscapes. Additionally, hands-on training with electrical and electronics equipment prepares students for real-world applications and careers in fields like robotics, automation, and renewable energy. Training programs in electrical and electronics technology prepare individuals for careers in sustainable industries, such as renewable energy, energy management, and green technology, thus contributing to workforce development in these critical areas. Even in classroom instruction, electrical and electronics technology has found a wide spread use. These includes audio materials (Radio and Cassette Recorder) visual materials (computer and audio visual materials like television, video and modern computer games and programs). Speaking on the use of these items, Onyejemezi (2011)

as cited by Saidu, Umar and Bichi. (2022) said Radio and Television are products of the technological age designed among other things to improve communication and maintained that today, these items are widely used to develop and improve education as well as expansion of instructional techniques. The computer has been generally used in education in what is generally referred to as Computer Assisted Instruction (CAI). Ametefe (2015) explained that CAI shows the computer as a chain that includes a leaner, a computer, a programme and the output. Ametefe added that CIA model of teaching presents the computer as a teaching machine. Instructional materials are presented to students and the computer is able to interpret their responses. Electrical and Electronic technology education acquired through the use of the computer has found a very wide application in sustainable national development thereby creating a workforce that is sustainable.

7. Job Creation: According to Torruam and Abur, (2014), one of the greatest challenges that Nigeria is confronted with and which on the average has continued to witness a rising trend over the years is unemployment. The authors further stated that the scourge of unemployment is known to be responsible for a high level of poverty, inequality, increasing rate of criminality, and general low level of living in the country. The electrical and electronics industry is a significant source of job opportunities as it presents opportunity for people to acquire skills that constitute a workforce needed in the industries. By investing in this sector, Nigeria can create employment for its growing population, especially for young people who are entering the workforce. This can help reduce unemployment rates and contribute to economic growth thereby creating a sustainable workforce to drive the Nation's economy.

Problems Facing Electrical and Electronics Technology Education in Nigeria

Sustainable workforce development can only be achieved where there is enabling environment. Consequently, electrical and electronic technology education is still faced with some problems. The following are some of the problems facing electrical and electronic technology education in Nigeria.

1. Lack of effective education and training. The lack of effective education and training in electrical and electronics technology in Nigeria can hinder technological advancements, limit innovation, and lead to a shortage of skilled professionals in the field. This could result in poor quality of electrical installations, increased safety hazards, and reduced competitiveness in the global market. Additionally, without proper training, there may be a lack of understanding and utilization of emerging technologies, slowing down progress in the industry.

2. Lack of skill development initiative: Without proper training and skill enhancement programs, graduates may lack the practical skills needed to excel in the field, leading to a workforce that may struggle to meet industry demands and innovations. Koledoye, Ogunrewo, Phillips and Jumah (2016) stressed that inadequate skills possession necessary for most cutting-edge technology needed by the industry is also a problem facing technology education. This could ultimately slow down the technological advancement and competitiveness of the country's electrical and electronics industry.

3. Non partnership and collaboration with relevant stakeholders: Non-partnership and collaboration with relevant stakeholders in the electrical and electronics technology education sector in Nigeria can result in several negative outcomes. These may include, outdated curriculum,
lack of practical experience, limited access to resources, missed opportunities for research and innovation, mismatch between supply and demand. Koledoye, Ogunrewo, Phillips and Jumah (2016) identified stakeholders in technology education to include government, industries and

academic institutions and opined that lack of collaborative forums where the challenges facing technology education are collectively addressed is one of the problems facing technology education in Nigeria. Non-partnership and collaboration with relevant stakeholders can hinder the effectiveness and relevance of electrical and electronics technology education in Nigeria, ultimately limiting the country's ability to develop a skilled workforce and compete in the global economy.

4. Lack of promotion of lifelong learning: The lack of promotion of lifelong learning in electrical and electronics technology education in Nigeria can have several negative impacts such as skills obsolescence where professionals may find their skills obsolete in a rapidly evolving field like electrical and electronics technology. Professional may also lack innovation and limit their career advancement. This can lead to situations where professionals are unable to address emerging challenges and reduce competitiveness at the global level and impede the country's ability to address current and future challenges in the field.

5. Lack of focus on sustainability and Green technologies: This can result in several negative consequences including environmental impact where graduates may lack awareness of the environmental consequences of their work and continue to engage in to practices that harm the environment, such as inefficient energy use, improper disposal of electronic waste, and the use of hazardous materials. Green technologies represent a growing market with significant opportunities for innovation and economic growth. Wilfred, Chigozir, Muyideen, and Ikotoni (2022) stated that green energy exists in multiple forms and has greater diversity when compared to fossil fuel resources. He further stated that green energy provides the foundation for energy independence. When green energy resources are properly harnessed, independence with a diversified energy portfolio to access is achievable. Without education and training in this area, graduates may miss out on opportunities to develop and implement sustainable solutions, limiting their competitiveness in the global market and lack the skills and knowledge needed to develop resilient infrastructure to reduce vulnerability to climate change.

Obviously, the lack of focus on sustainability and green technologies in electrical and electronics technology education in Nigeria can hinder environmental protection, limit economic opportunities, and increase vulnerability to climate change. Integrating these topics into the curriculum is essential for ensuring that graduates are prepared to address the challenges of the future responsibly and effectively.

6. Lack of Innovation and Research Funding: Lack of innovation and research funding in electrical and electronics technology education in Nigeria can hinder progress, limit collaboration and industry partnerships, and reduce the country's competitiveness in the field. It can cause stagnation in knowledge and technology, brain drain, limited infrastructure and resources which could result in reduced competitiveness at the global market. Moses, Manabete and Michika, (2024), stressed that government, the community and all stake holders in education must rise up to the challenge of providing adequate funding to undertake functional and durable electrical/electronic technology education for sustainable development.

7. Lack of diversity and inclusion: This can limit the range of perspectives and ideas, hindering innovation and problem-solving processes. It can also perpetuate inequalities, excluding talented individuals from marginalized groups and depriving the field of their contributions. Additionally, a lack of diversity can create an environment that is unwelcoming or even hostile to certain groups, further exacerbating the issues and prevent a more robust learning environments and better outcomes for everyone involved.

Strategies for Enhancing Electrical Electronic Technology Education in Nigeria

Enhancing electrical and electronics technology education in Nigeria could involve initiatives like expanding vocational training programs, promoting (Science, Technology, Engineering and Mathematics) STEM education, fostering collaboration between industry and academia, and investing in infrastructure for research and development. These efforts can help create a skilled workforce capable of driving innovation and sustainable development in the electrical and electronics technology education sector. The following strategies can be applied to enhance electrical and electronics technology education towards sustainable workforce development:

1. Education and Training Programs: Electrical and electronic technology can be enhanced by developing a comprehensive education and training programs that cover foundational principles as well as emerging technologies in electrical and electronics technology. These programs should emphasize hands-on experience, problem-solving skills, and interdisciplinary collaboration.
2. Skill Development Initiatives: Implement skill development initiatives focused on areas such as renewable energy systems, smart grid technology, energy efficiency, and sustainable design practices. Offer workshops, seminars, and online courses to up skill and reskill the workforce.
3. Partnerships and Collaboration: Foster collaboration between industry, academia, and government agencies to align curriculum with industry needs, provide access to state-of-the-art facilities and equipment, and offer internship and apprenticeship opportunities for hands-on learning.
4. Promotion of Lifelong Learning: Encourage a culture of lifelong learning by providing resources and incentives for professionals to continuously update their skills and stay abreast of technological advancements. Offer flexible learning options such as online courses, webinars, and professional development programs.
5. Focus on Sustainability and Green Technologies: Integrate sustainability principles and green technologies into electrical and electronics engineering curricula. Emphasize the importance of energy efficiency, renewable energy sources, and environmentally friendly practices in design and implementation.
6. Innovation and Research Funding: According to Koledoye, Ogunrewo, Phillips and Jumah (2016), government should encourage research and development in academic institutions through adequate funding. The government and other stakeholders should invest in research and development initiatives that drive innovation in electrical and electronics technology for sustainable workforce development and provide funding support for projects focused on developing new technologies, improving existing systems, and addressing environmental challenges.
7. Diversity and Inclusion: Promote diversity and inclusion in the electrical and electronics workforce to ensure a broad range of perspectives and ideas. Encourage participation from underrepresented groups and create inclusive environments where all individuals can thrive and contribute in a more robust learning environment.

By implementing these strategies by the stakeholders, it can enhance electrical and electronics technology towards sustainable workforce development, fostering innovation, addressing societal challenges, and creating opportunities for sustainable economic growth.

Conclusion

Electrical and electronic technology education is the pivot through which other technological advancement stand on. Acquisition of useful skills that abound in electrical and electronic technology if well harnessed will be relevant to a sustainable workforce development. This paper discussed the relevance of electrical and electronic technology education for sustainable workforce development. The paper identified areas where skills acquired by this training are

relevant, such as renewable energy, energy efficiency, transportation, smart infrastructure, telecommunication, education and job creation. It is observed that the products of electrical and electronic technology education find employment in various industries, some are involved in self-employment while some are employers of labour, thereby making way for a sustainable workforce development.

However, electrical and electronic technology education is faced with several problems which include lack of effective education and training, lack of skill development, lack of focus on sustainable and green technology, poor funding for research and innovation among other things. As a way paper outlined the strategies that could be applied for enhancing electrical and electronics technology education which include education and training, skills development initiative, partnership and collaboration, promoting lifelong learning, focus on sustainable and green technologies, etc., and call on the relevant stakeholder to look at the strategies with a view to applying them for enhancement of electrical and electronics education for sustainable workforce development.

Recommendations

The following recommendations are made to ameliorate the problems facing electrical and electronics technology education in Nigeria.

1. The Government and non-governmental organization (NGO) should pay attention to the areas of deficiency and provide the necessary facilities especially in the education sector.
2. The government of Nigeria should retrain the trainers for optimum productivity.
3. The qualified personnel should be placed where necessary with strict supervision of projects and infrastructures.

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