Integration Of Green Energy Technologies Into Automobile Technology Education Curriculum In Tertiary Institutions In Nigeria: Challenges And Prospects

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Abstract:
The study ascertained the challenges and opportunities associated with the integration of green energy technologies into automobile technology education curricula in Nigeria at the tertiary levels. The study utilized a cross-sectional survey research design. 3 research questions guided the conduct of this study. The population for the study was 149 respondents comprising 116 lecturers, 12 curriculum developers, and 21 industrial trainers in the study area. The instrument for data collection was a structured questionnaire validated by 3 experts. Cronbach's Alpha reliability was used to ascertain the reliability coefficient of the instrument which stood at .89. The data collected were analyzed using mean and standard deviation to answer the research questions, while Analysis of Variance (ANOVA) was used to test the null hypotheses at a .05 level of significance using SPSS. Findings revealed among others that limited access to up-to-date educational materials and the skills gap among educators were challenges hindering the integration of green energy technologies into ATE curriculum in Nigeria. Also, contributing to job creation and stimulating economic growth were opportunities associated to the integration of green energy technologies into ATE curriculum in Nigeria. Equally, curriculum restructure, training educators, establishment of research and development centers were among the strategies for facilitating the integration of green energy technologies into ATE curriculum. The study recommends among others that Government should develop and implement supportive policies that promote the integration of green energy technologies.

Keywords: *Automobile Technology Education, Curriculum, Green Energy Technologies, Integration.*

INTRODUCTION

The automobile industry plays a crucial role in Nigeria's economic landscape, contributing significantly to employment [1]and industrial growth. It is a key driver of economic activities, fostering employment, revenue generation, foreign investment, infrastructure development, capacity building, and overall economic growth (National Automotive Design and Development Council NADDC, 2021). The automobile industry poses significant environmental challenges, with far-reaching consequences due to its heavy reliance on fossil fuel-powered vehicles. The combustion of fossil fuels in vehicles releases pollutants such as carbon monoxide, nitrogen oxides, and particulate matter, contributing to air pollution and

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adverse health effects world Health organization 2018. Addressing these challenges, the automotive industry worldwide is undergoing a transformative shift towards sustainability, with an increasing emphasis on green

energy technologies refer to sustainable and environmentally friendly solutions employed to power vehicles, reducing reliance on conventional fossil fuels and minimizing negative environmental impacts. These technologies aim to enhance energy efficiency, reduce emissions, and promote the use of renewable energy sources. According to the International Energy Agency (2020), green energy technologies involve environmentally friendly propulsion systems, such as electric, hybrid, and hydrogen fuel cell vehicles. In many regions, including Nigeria, there is a recognized shortage of skilled technicians and engineers specializing in green energy technologies. Chakraborty et al. (2018), attributed this shortcoming to the non-integration of green energy technologies into the automobile technology education curriculum.

As the automobile industry accounts for a significant portion of greenhouse gas emissions, it is imperative to integrate green energy technologies into the automobile technology education curriculum. This holds immense potential in equipping future professionals with the necessary knowledge and skills needed to address the energy and environmental challenges of the 21st century (Shehzad et al., 2023). According to ,(Babalola & Olawuyi, 2021; Wojuola & Alant, 2019) , integrating green energy technologies into automobile technology education is vital for staying aligned with global environmental goals. This integration not only aligns with global environmental goals but also positions Nigeria's workforce to contribute to and benefit from the shift towards sustainable transportation solutions.

However, numerous challenges hinder the successful integration of green energy technologies into automobile technology education curriculum in the country. Nwokolo et al. (2023) stated that limited awareness and understanding of green energy concepts, lack of qualified educators, and inadequate infrastructure for practical implementation are a few factors inhibiting progress. Furthermore, the absence of supportive policies and financial constraints among others pose significant barriers to the integration of green energy content in the curriculum (Majid, 2020). The disparity between the current automobile technology education curriculum and the demands of a green automotive industry also creates a pressing need for comprehensive research to identify the challenges as well as opportunities associated with the integration of green energy technology.

On the other hand, intertwined with these challenges are unique opportunities poised to reshape the trajectory of automobile technology education in Nigeria. The integration of green energy principles presents a chance to foster innovation, positioning the country at the forefront of sustainable automotive technology. According to Alwi et al. (2020), the integration fosters creativity and prepares students for evolving industry demands. Moreover, the integration of green energy technologies aligns the automobile technology education curriculum with global green standards which can enhance Nigeria's competitiveness in the international automotive market and attract investment in renewable energy research and development (Zubir et al., 2021).

These opportunities reflect the need to investigate the strategies to facilitate the integration of green energy technologies into the automobile technology education curriculum. These encompass curriculum restructuring to integrate green energy topics, training and capacity building for educators, the establishment of research and development centers, public-private partnerships, and the formulation of supportive policies and incentives . (Ahamer, 2021; Pietrapertosa et al., 2021) argued that the non-integration of green energy technologies could result in reduced competitiveness for graduates, environmental impact, missed innovation opportunities, and challenges complying with evolving regulations. Hence, to avert these

negative consequences, the study sought to empirically ascertain the challenges, opportunities as well as strategies for facilitating the integration of green energy technologies into the automobile technology education curriculum in Nigeria.

Statement of the Research Problem

The automobile technology education curriculum in Nigeria aims to prepare students for careers in the automotive industry, fostering a skilled workforce to meet the demands of the sector. The current curriculum primarily focuses on conventional internal combustion engines and lacks comprehensive coverage of emerging green energy technologies. Sadly, this has led to a skills gap that makes automobile technology education graduates ill-equipped to meet the demands of an evolving automobile industry that increasingly values sustainability and green innovation. Studies such as (Hoople et al., 2020; Igogbe, 2021; Saleet et al., 2023) among others focused on addressing the skills gap related to green energy technologies in the automotive industry. Despite these studies, automobile technology education graduates are still not adequately prepared with the requisite skills in green energy technologies in the automobile industry. The skills gap possibly contributes to reduced employability and a missed opportunity for students to contribute to and benefit from advancements in eco-friendly automotive technologies. Hence, to address negative consequences, this study aims to explore the challenges associated with the integration of green energy technologies into automobile technology education curriculum in Nigeria, identify potential opportunities for incorporating these technologies, and propose strategies to facilitate their implementation.

Aim and Objectives of the Study

The study aimed to ascertain the challenges and opportunities associated with the integration of green energy technologies into automobile technology education curriculum in Nigeria. In specific terms, the objectives of the study sought to determine the following:
1. Challenges that hinder the integration of green energy technologies into automobile technology education curriculum in Nigeria.
2. Opportunities associated with the integration of green energy technologies into automobile technology education curriculum in Nigeria.
3. Strategies for facilitating the integration of green energy technologies into automobile technology education curriculum in Nigeria.

Research Questions

The following research questions were raised and answered to achieve the objectives of the study:
1. What are the challenges that hinder the integration of green energy technologies into automobile technology education curriculum in Nigeria?
2. What are the opportunities associated with the integration of green energy technologies into the automobile technology education curriculum in Nigeria?
3. What are the strategies for facilitating the integration of green energy technologies into the automobile technology education curriculum in Nigeria?

METHODOLOGY

The study utilized a cross-sectional type of descriptive survey research design. It involves collecting data from participants at a single point in time. This design provides a snapshot of a population, capturing information at a specific moment. The study was conducted in North-Central, Nigeria. The population of the study was 149 respondents consisting of all the 116 lecturers from 3 Universities and 6 Colleges of Education offering automobile technology education, 12 curriculum developers from the National University Commission (NUC) and National Commission for Colleges of Education (NCCE), and 21 industrial trainers from Industrial Training Fund (ITF) in the study area. Due to the manageable size of the population, Total Population Sampling was utilized to select the whole population. The instrument for data

collection was a 30 items structured questionnaire with a five-point Likert's scale response options of Strongly Agree (SA)=5; Agree (A)=4; Slightly Agree (SA)=3; Disagree (D)=2; Strongly Disagree (SD)=1, designed by the researcher. The instrument was segmented into three parts, A-C and each with 10 items. Part A on the challenges that hinder the integration of green energy technologies, Part B on the opportunities associated with the integration of green energy technologies, and Part C on the strategies for facilitating the integration of green energy technologies into automobile technology education curriculum in Nigeria. The content validity of the instrument was ensured by three Technical and Vocational Education and Training (TVET) experts. The overall reliability index of the instrument was determined as .89 using Cronbach's alpha statistics. The collection of data was achieved electronically using Google Docs with 137 responses collected, indicating a response rate of 92%. The collected data were analyzed using mean and standard deviation to answer all the research questions and Analysis of Variance (ANOVA) to test the null hypotheses stated at a .05 level of significance. A decision regarding answers to the research question was based on the real limit of numbers. Items with mean values of 4.5 – 5.0 were considered strongly agree; 3.5 – 4.49 agree; 2.5 – 3.49 undecided; 1.5 – 2.49 disagree and 1.00 – 1.49 strongly disagree. Similarly, null hypotheses with P-values of 0.05 and above were considered accepted while hypotheses with P-values of less than 0.05 were considered rejected.

Results:

Research Question One: What are the challenges that hinder the integration of green energy technologies into automobile technology education curriculum in Nigeria? The result of answering research question one is presented in Table 1.

Table 1: Mean and standard deviation of the responses of the respondents on the challenges that hinder the integration of green energy technologies into automobile technology education curriculum in Nigeria

S/N	Items	$\overline{X}_A$	SD	Remark
1	Limited access to up-to-date and relevant educational materials on green energy.	3.90	.58	Agreed
2	The higher initial cost of green energy vehicles.	4.04	.48	Agreed
3	Noticeable skills gap among the existing workforce.	3.93	.56	Agreed
4	Insufficient institutional support for initiatives promoting the integration of green energy.	4.08	.44	Agreed
5	Poor government policies on the integration of green energy technologies.	3.91	.53	Agreed
6	The inflexibility of the current curriculum to adapt quickly to changes.	4.10	.46	Agreed
7	Need for additional training for educators.	3.96	.61	Agreed
8	Need for continuous updates on green energy technologies.	4.14	.49	Agreed
9	Unfulfilled accreditation requirements.	4.06	.60	Agreed
10	Resistance to change from traditional structure.	4.18	.52	Agreed
	Grand Mean	**4.03**	**.53**	**Agreed**

Table 1 shows average mean values between 3.90 and 4.14 with a grand mean value of 4.03 and average standard deviation values between .44 and .60 with a grand average value of .53. Based on the concept of real limit of numbers, these values indicated that the respondents agreed with the ten items to be the challenges that hinder the integration of green energy technologies into automobile technology education curriculum in Nigeria.

Research Question Two: What are the opportunities associated with the integration of green energy technologies into automobile technology education curriculum in Nigeria? The result for answering research question two is presented in Table 2.

Table 2: Mean and standard deviation of the responses of the respondents on the opportunities associated with the integration of green energy technologies into automobile technology education curriculum in Nigeria

S/N	Items	$\overline{X}_A$	SD	Remark
1	Contributes to job creation in the green automotive sector.	3.94	.36	Agreed
2	Stimulates economic growth by attracting investments.	3.88	.41	Agreed
3	Creates opportunities for local manufacturing of automotive technologies, reducing dependency on imports.	4.05	.44	Agreed
4	Educate students on green energy technologies.	4.00	.42	Agreed
5	Creates opportunities for technology transfer and knowledge sharing.	3.85	.45	Agreed
6	Equips students with skills relevant to sustainable practices in the automotive industry.	3.91	.42	Agreed
7	Addresses the increasing demand for eco-friendly solutions in transportation	3.89	.42	Agreed
8	Prepares students for emerging job opportunities in the green energy sector.	3.87	.51	Agreed
9	Fosters innovation, positioning the country at the forefront of sustainable automotive technology.	3.90	.52	Agreed
10	Supports the country's efforts to reduce carbon emissions.	3.95	.48	Agreed
	Grand Mean	**3.92**	**.44**	**Agreed**

The average mean values between 3.85 and 4.05 with a grand mean value of 3.92 and average standard deviation values between .36 and .51 with a grand average value of .44.are presented in Table 2. Based on the concept of real limit of numbers, these values indicated that the respondents agree with the ten items to be the opportunities associated with the integration of green energy technologies into the automobile technology education curriculum in Nigeria.

Research Question Three: What are the strategies for facilitating the integration of green energy technologies into automobile technology education curriculum in Nigeria? The result for answering research question three is presented in Table 3.

Table 3: Mean and standard deviation of the responses of the respondents on the strategies for facilitating the integration of green energy technologies into automobile technology education curriculum in Nigeria

S/N	Items	$\overline{X}_A$	SD	Remark
1	The curriculum restructuring to integrate green energy topics.	4.08	.42	Agreed
2	There should be training and capacity building for educators.	3.93	.48	Agreed
3	Establishment of research and development centers.	4.07	.46	Agreed
4	Strengthen public-private partnerships for funding the integration of green energy integration.	4.06	.48	Agreed
5	Formulation of supportive policies on green energy integration.	3.87	.54	Agreed

6	Adopting Government policies supporting green energy integration.	3.93	.52	Agreed
7	Creating awareness and positive attitudes toward green energy vehicles.	3.89	.42	Agreed
8	Encouraging a supportive institutional environment.	3.87	.51	Agreed
9	Encouraging research and development initiatives.	3.90	.52	Agreed
10	Fulfilling accreditation requirements.	3.95	.48	Agreed
	Grand Mean	**3.96**	**.48**	**Agreed**

Table 3 shows average mean values between 3.87 and 4.08 with a grand mean value of 3.96 and average standard deviation values between .42 and .54 with a grand average value of .48. Based on the concept of real limit of numbers, these values indicated that the respondents agree with the ten items to be the strategies for facilitating the integration of green energy technologies into automobile technology education curriculum in Nigeria.

FINDINGS AND DISCUSSION OF FINDINGS
Findings on the challenges that hinder the integration of green energy technologies into automobile technology education curriculum in Nigeria revealed limited access to up-to-date educational materials, higher initial cost of green energy vehicles, skills gap among educators, insufficient institutional support, poor government policies, inflexible curriculum to adapt to changes, need for additional training, unfulfilled accreditation requirements, need for continuous update and resistance to change. The finding is similar to the observations of (Asghar et al., 2023; Kneen et al., 2020; Majid, 2020; Nwokolo et al., 2023; Shehzad et al., 2023) that limited awareness, lack of qualified educators, and inadequate infrastructure pose significant challenges to curriculum integration. The findings illuminate a complex set of challenges that demand immediate attention. However, addressing these issues requires a concerted effort from educational institutions, policymakers, industry stakeholders, and accreditation bodies to create a dynamic and supportive environment that fosters the successful integration of green energy technologies into the automotive technology education curriculum.

Findings on the opportunities associated with the integration of green energy technologies into automobile technology education curriculum in Nigeria revealed contributes to job creation, stimulates economic growth, creates opportunities for local manufacturing of automotive technologies, educates students, creates opportunities for technology transfer, equips students with skills, addresses the increasing demand for eco-friendly solutions, prepares students for emerging job opportunities, fosters innovation and supports Nigeria's efforts to reduce carbon emissions. The finding is in harmony with (Alwi et al., 2020; Basri et al., 2021; Igogbe, 2021; Saleet et al., 2023; Zubir et al., 2021) on fostering creativity, and preparing students for evolving industry demands aligning with global green standards as opportunities associated with the integration of green energy technologies. The revealed opportunities present a promising outlook for the education sector and the nation's automotive industry. These opportunities not only serve to enhance the educational experience but also position Nigeria at the forefront of the global shift towards sustainable and technologically advanced automotive practices.

Findings on the strategies for facilitating the integration of green energy technologies into automobile technology education curriculum in Nigeria revealed curriculum restructuring, training and capacity building for educators, the establishment of research and development centers, strengthening public-private partnerships, formulation of supportive policies, encouraging research and development initiatives, encouraging a supportive institutional environment, creating awareness, adopting Government policies supporting green energy, and fulfilling accreditation requirements. These strategies resonate with the findings of (Ahamer,

2021; Altassan, 2023; Hoople et al., 2020; Pietrapertosa et al., 2021) which revealed training and capacity building for educators, the establishment of research and development centers, and public-private partnerships as strategies for facilitating curriculum integration. The identified strategies revealed a comprehensive roadmap for transformative change. These multifaceted strategies collectively represent a proactive approach to ensure the successful and sustainable integration of green energy technologies into the automobile technology education curriculum in Nigeria.

Conclusion

The study has identified the challenges hindering the integration of green energy technologies into automobile technology education curriculum in Nigeria, which include among others resistance to change, resource constraints, and the need for specialized training. On a positive note, the study identified promising opportunities linked to this integration, such as preparing students for emerging sustainable industries and aligning education with global trends. To bridge the gap, the study proposes strategies involving comprehensive teacher training, collaborative planning, and an adaptive administrative environment. These strategies aim to navigate challenges and leverage opportunities, ultimately fostering the seamless integration of green energy technologies into the automobile technology education curriculum in Nigeria. In essence, these proposed strategies are designed to serve as catalysts for overcoming challenges and harnessing opportunities, steering the trajectory of automobile technology education in Nigeria toward a more sustainable and forward-looking paradigm. Based on the identified challenges, opportunities and strategies, the study recommends that the Government should develop and implement supportive policies that promote the integration of green energy technologies and also allocate funding for curriculum changes, training of educators, and establishment of research and development centers. It is also recommended that Automobile technology education educators should embrace opportunities for collaboration with industry partners and advocate for policy changes that support the integration of green energy technologies. And finally, the Industrial stakeholders should actively participate in collaborative platforms, communicate industry needs to educators, and support initiatives that enhance the integration of green energy technologies into the curriculum.

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