



## Promoting Sustainable Automotive Repair Practices in Nigeria: Integrating Automobile Emission Control System into Pre-Service Automobile Teacher Training Curriculum

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### ABSTRACT

Sustainable automotive repair practice is now a significant issue in Nigeria, due to the increasing emission level from automobile sources in the country. This may be partly due to lack of knowledge and skills for the maintenance of the automobile emission control system among automobile teachers and service technicians. It was suggested that enriching the curriculum contents for automobile programmes in Nigeria can help mitigate the problem. In this paper, we focus on integrating automobile emission control systems into pre-service automobile teacher training curricula at the Colleges of Education level in Nigeria. The paper employed descriptive survey design on a population of 210 respondents. The study sampled 128 respondents, comprising 51 automobile teachers from Colleges of Education and 77 industry workshop supervisors of service industries in the North East Nigeria. Total population of the automobile teachers was used, while the purposive sampling technique was used for the workshop supervisors. Structured questionnaire validated by experts and trial tested at the Kano state was used for data collection. The reliability coefficient of the instrument was 0.87, Cronbach's Alpha. Mean, standard deviation, and t-test were used for data analysis with the help of SPSS version 23. The findings revealed 57 important contents related to automobile emission control system for integration into pre-service automobile teacher training curriculum in Nigeria. We concluded by suggesting that integrating the 57 specific contents related to automobile emission control system into the pre-service automobile teacher training curriculum is crucial for preparing future technicians and educators to address environmental challenges caused by automobile emissions in Nigeria.

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### INTRODUCTION

The need for sustainable practices in all sectors of the economy cannot be overemphasized if the earth is to remain hospital to living organisms. The world faces a lot of challenges resulting from unsustainable practices in many facets of human endeavors. The most worrisome of the current time is the air pollution which leads to many destructive consequences to

human health and the environment. Air pollution is the major environmental threat to human beings [World Health Organisation (WHO), 2021]. According to Modinah et al. (2019), the atmosphere is a dynamic natural gaseous system that must be maintained, but human activities generate toxic pollutants, that temper with the earth ecosystem, turning it hostile to living organisms. Air pollution from man-made sources

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include among others the burning of fossil fuels for mobile transportation.

Transportation sector contribute immensely to air pollution in many cities due to high number of traffic especially in urban areas. Ogola (2021) reported that transport sector contributes to greenhouse gas emissions and climate change through combustion of fossil fuels, primarily from diesel and petrol consumption for mobile transportation. The release of these chemical substances from the transportation sector remains a great threat to many developing countries especially those that are yet to fully embrace sustainable mobility means. Motor vehicles powered by internal combustion engines are the major mode of transportation in Nigeria. Most of the vehicles driving are imported used vehicles with high risk of increased emission of harmful gases. Although, the country made provision for emission testing of imported vehicles and those on the road as clearly stated in the National Environmental Control of Vehicular Emission from Petrol and Diesel Engines Regulations (2011), but the regulation seems not feasible. This is evident from the results of emission test carried out on about 25,000 vehicles in Abuja, Nigeria; where over 85% vehicles presented did not meet the emission standards set out by the country (Obayendo, 2015). In respect of these challenges Ibekwe et al. (2019), asserted that there is a great warning that the potentials for increased environmental problems caused by automobile emissions in Nigeria is on increase. This raises question on the mechanical condition and status of emission control devices in the vehicles.

The emission control devices imbedded in the motor vehicles comprise three way catalytic converter, evaporative emission control system, positive crankcase ventilation, exhaust gas recirculation system and air injection system and diesel particulate filter peculiar to diesel engines. According to Bicam (2021) when any of these components malfunctions or is missing, the result is more emission. Conversely, many automotive service technicians in Nigeria avoid problems relating to automobile emission control system at all cost. Others intentionally remove or disable the

functionality of components of the emission control system due to ignorance or fear of the system's self-reporting capability to register emission related malfunctions on the dashboard (Abubakar, 2024). Moreover, the story is the same for pre-service automobile teachers graduating from Colleges of Education (Technical) in Nigeria, because they lack skills to use OBD II scan tools, which entails diagnosing faults relating to emission malfunctions (Adamu, 2022). This problem of emission from motor vehicles in Nigeria will continue to increase, unless the vehicles are repaired and serviced by competent technicians. This has strong implication on the quality of training the automobile teacher and service technicians receive in the country.

Automobile technology education is a course of specialization offered at Colleges of Education (Technical) and some universities in Nigeria. The programme trains students on various aspect of automobile technology in addition to general education. The students are trained in areas related to maintenance, repairs and services of all vehicles systems (Adamu, 2015). Thus, adequate training is required to enable the students acquire the right competencies to face the challenges of recurrent developmental changes in vehicle designs while maintaining relevance in the teaching profession. To achieve this, the curriculum has to incorporate requisite competences for repair of all vehicle systems and sub-systems. However, automobile emission control system despite its importance in the vehicle system is still lacking in the current curriculum (reviewed in 2020) for automobile technology in Colleges of Education in Nigeria. This might be the possible reason for the reported skill deficiency with regards to maintenance of automobile emission control system in the graduate technicians. It therefore calls for urgent need to integrate automobile emission control system into the curriculum in order to upgrade the skills of graduate technicians and educators so as to take part in addressing environmental challenges caused by automobile emissions in Nigeria.

### **Statement of the Problem**

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Globally, there has been a concerted effort to mitigate the effects of automobile emissions on health and environment which forced the need for production of competent service technician and automobile educators. However, in Nigeria there is observed skill deficiency with regard to maintenance of automobile emission control system among automotive service technicians and graduate of automobile technology education, specifically those graduating from Colleges of Education in the country (Adamu, 2022). This problem may be due to lack of contents on automobile emission control system in their training curriculum. Thus, the curriculum if left without integrating automobile emission control system will continue to lead to production of graduates who cannot affect good maintenance of automobile emission control system in the country, and this will cause more harm to society and its occupants by contributing to increased emission level. Bicom (2021) emphasized that when vehicle do not have functional emission control system or is altered, the result is more emission. In view of the above, it is paramount importance that curriculum for automobile programmes in Nigeria should have automobile emission control system imbedded in them. It is against this background that this study identified relevant contents of automobile emission control system to be integrated into the Colleges of Education curriculum of automobile technology in Nigeria with a view to promoting sustainable automotive repair practices in the country.

#### **Purpose of the study**

The purpose of the study was to identify relevant contents of automobile emission control system for integration into pre-service automobile teacher training curriculum at Colleges of Education (COE) level in Nigeria.

**Research question:** What are the relevant contents of automobile emission control system to be integrated into pre-service automobile teacher training curriculum at COE level in Nigeria?

**Hypothesis:** There is no significant difference in the mean response of automobile teachers and automobile industry based workshop supervisors on the contents of automobile emission control system for integration into pre-service automobile teacher training curriculum at COE level in Nigeria?

#### **METHODOLOGY**

The study employed a descriptive survey design to describe the opinions of automobile teachers and industry based workshop supervisors on relevant contents of automobile emission control system to be integrated into pre-service automobile teacher training curriculum in Nigeria. The study was carried out in North East geo-political zone of Nigeria, where the six states which include Adamawa, Bauchi, Borno, Gombe, Taraba and Yobe were covered. A total of 46 automobile teachers from Colleges of Education and 76 workshop supervisors purposely selected from service industries all in the North east region were used in the study. The workshop supervisors were selected on the basis of their willingness to participate in the study and their expertise in modern automotive diagnosis. Dattalo (2008) said, in purposive sampling the respondents are selected based on the researcher's judgment that they will provide the desired information or access to it. Data in the study was collected using a structured questionnaire adopted from Abubakar (2024). The instrument was designed on four point scale of Highly Not Relevant (HNR), Not Relevant (NR), Relevant (R), and Highly Relevant (HR) which were assigned numerical value ranging from 1 – 4 respectively. The instrument was both face and content validated by 7 experts, were Content Validity Index of 0.95 was obtained which was considered acceptable based on recommendations of Polit and Beck (2006) and Polit et al. 2007. The instrument was further trial tested on 40 respondents at Kano state, Nigeria. A reliability coefficient of 0.87 was obtained using Crombach Alpha method which was considered good based on Hair et al. (2017) recommendation. Data collected was analysed using mean, standard deviation and t-test using SPSS version 23. The research question was answered using

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mean and standard deviation, while the Hypothesis was tested at 0.05 level of significance.

## RESULT

**Research question:** What are the relevant contents of automobile emission control system to be integrated into pre-service automobile teacher training curriculum at Colleges of Education level in Nigeria?

The results of descriptive statistics presented in Table 1 below indicated that all the items on contents of automobile emission control system for integration into pre-service automobile teacher training curriculum of Colleges of Education in Nigeria are rated by the respondents

as relevant (Mean 3.28, SD 0.403). The high means with corresponding low standard deviations across all the items suggests that all the 57 content areas of automobile emission control system are relevant for integration into the curriculum. The contents include; 8 items on automobile emissions, 14 items on components of automobile emission control system and emission reduction technologies, 20 items on diagnosis, and maintenance of automobile emission control system, 4 items on computerized exhaust gas analysis and tail pipe emission test, 5 items on OBD II system, and 6 items on vehicle emission standards and policies.

**Table 1:** Mean and Standard Deviation of Respondents on Relevant Contents of Automobile Emission Control System for Integration into Pre-service Automobile Teacher Training Curriculum in Nigeria

S/N	ITEM (n = 108)	$\bar{X}$	$\delta$	Remark
<b>Automobile Emissions</b>				
1.	Concept of automobile emission control system	3.44	0.660	Relevant
2.	Various types of automobile emissions	3.31	0.719	Relevant
3.	Sources of hydrocarbon emission in motor vehicle	3.31	0.692	Relevant
4.	Formation of carbon monoxide and nitrogen oxide emissions	3.27	0.635	Relevant
5.	Particulate Matter emission in diesel engines	3.18	0.771	Relevant
6.	Effects of automobile emissions on human health	3.31	0.757	Relevant
7.	Effects of automobile emissions on the environment	3.24	0.735	Relevant
8.	Rationale for automobile emission control system	3.27	0.721	Relevant
<b>Components of Automobile Emission Control System and Emission Reduction Technologies</b>				
9.	Purpose and function of automobile emission control system	3.37	0.620	Relevant
10.	Catalytic converter	3.36	0.703	Relevant
11.	Positive Crankcase ventilation system	3.25	0.685	Relevant
12.	Exhaust Gas Recirculation system	3.31	0.703	Relevant
13.	Evaporative Emission Control System (EVAP)	3.41	0.581	Relevant
14.	Air injection system	3.46	0.734	Relevant
15.	Engine coolant temperature sensor	3.23	0.718	Relevant
16.	Mass Air Flow (MAF) sensor/ Manifold Absolute Pressure (MAP) sensor	3.43	0.619	Relevant
17.	Oxygen sensors	3.47	0.621	Relevant
18.	Throttle position sensor	3.30	0.722	Relevant
19.	Glow plugs and intake air preheating system in diesel engines	3.27	0.683	Relevant
20.	Diesel particulate filter	3.26	0.721	Relevant
21.	Selective Catalytic Reduction (SCR) technology	3.25	0.632	Relevant
22.	Engine management system	3.31	0.791	Relevant
<b>Diagnosis, Repair and Maintenance of AECS</b>				
23.	Visual checks for AECS and components	3.46	0.633	Relevant

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24.	Removal, replacement and refitting of catalytic converter	3.35	0.616	Relevant
25.	Catalytic converter tap test	3.31	0.621	Relevant
26.	Catalytic converter efficiency test	3.25	0.699	Relevant
27.	Testing back pressure of catalytic converter	3.37	0.620	Relevant
28.	Oxygen sensors diagnosis and replacement	3.43	0.674	Relevant
29.	Oxygen sensor response test using scan tool and/or digital storage oscilloscope	3.26	0.715	Relevant
30.	Secondary Air Injection System diagnosis	3.30	0.701	Relevant
31.	Diagnosis and repair of low fuel pressure in fuel injection system	3.39	0.721	Relevant
32.	Service and replacement of fuel injectors	3.44	0.645	Relevant
33.	Mass air Flow sensor removal, cleaning and installation	3.51	0.634	Relevant
34.	Diagnosis, cleaning and replacement of mechanical EGR valve	3.31	0.719	Relevant
35.	Diagnosis, and replacement of electrically controlled EGR valve	3.39	0.721	Relevant
36.	Checks for and repair of vacuum leaks in the intake manifold including cleaning EGR valve	3.56	0.569	Relevant
37.	Removal, inspection and replacement of air filter	3.45	0.617	Relevant
38.	Engine compression test	3.37	0.705	Relevant
39.	Removal and service of spark plugs to include inspection, cleaning, re-gapping and installation	3.35	0.674	Relevant
40.	Engine coolant temperature check using scan tool	3.34	0.699	Relevant
41.	Checking coolant temperature sensor resistance using ohmmeter	3.12	0.872	Relevant
42.	Replacement of stuck open and stuck close thermostat	3.12	0.794	Relevant
<b>Computerized Exhaust Gas Analysis and Tail Pipe Emission Test</b>				
43.	Five exhaust gas analysis test using exhaust gas analyzer	3.10	0.710	Relevant
44.	Testing for Oxides of Nitrogen using portable exhaust analyzer	2.84	0.787	Relevant
45.	Loaded mode test using engine dynamometer	2.99	0.848	Relevant
46.	Remote sensing emission test	3.03	0.716	Relevant
<b>On-Board Diagnostics II in AECS</b>				
47.	Purpose of OBD II in automobile emission control system	3.19	0.716	Relevant
48.	OBD-II Diagnostic Trouble Code (DTC) numbering designation	3.25	0.699	Relevant
49.	Retrieval of OBD II codes using global (generic) scan tools	3.19	0.648	Relevant
50.	OBD II Freeze Frame Data	3.30	0.701	Relevant
51.	Resetting the PCM and erasing emission related codes using OBD II scan tools	3.16	0.726	Relevant
<b>Vehicle Emission Standards at Global and Local Levels</b>				
52.	Clean Air Act Amendments (CAAA) of 1990 (Tier 1 and Tier 2 Federal emission standards)	3.21	0.727	Relevant
53.	Smog Emission Information	3.10	0.735	Relevant
54.	California Air Resources Board (CARB) standards	3.09	0.756	Relevant
55.	European Standards (Euro I -V)	3.07	0.758	Relevant
56.	The National Environmental (Control of Vehicular Emissions) Regulations, 2011 in Nigeria	3.11	0.824	Relevant
57.	Inspection and Maintenance (I/M) programme	3.12	0.736	Relevant

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<b>Grand</b>	<b>3.28</b>	<b>0.403</b>	<b>Relevant</b>
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Note:  $n$  = Number of Respondents,  $\bar{X}$  = Mean,  $\delta$  = Standard Deviation

**Hypothesis:** There is no significant difference in the mean response of automobile teachers and automobile industry based workshop supervisors on the contents of automobile emission control system for integration into pre-service automobile teacher training curriculum in Nigeria?

The statistical evidence of independent sample t-test presented in Table 2 below indicated that there was no significant difference in the mean responses of automobile teachers ( $M = 3.28$ ,  $SD = 0.400$ ) and automobile industry based

workshop supervisors ( $M = 3.28$ ,  $SD = 0.408$ ),  $t(106) = 0.042$ ,  $p = 0.966$ , hence the null hypothesis was retained. The findings suggest that automobile teachers in Colleges of Education and industry based workshop supervisors of service industries in North east Nigeria agreed with all the 57 content areas of automobile emission control system as relevant for integration into pre-service automobile teacher training curriculum in Nigeria.

**Table 2:** Independent sample *t*-test of respondents on relevant contents of automobile emission control system for integration into Pre-service Automobile Teacher Training Curriculum at COE level in Nigeria

Levene's Test for Equality of Variances									
Variable	Groups	N	F	Sig.	t-value	Mean	SD	P-value	Decision
CAECS	Automobile Teachers	46	.197	.658	.042	3.28	.400	.966	Retained
	Industry Based Workshop Supervisors	62							

Note: CAECS=Contents of automobile Emission Control System; N=Number of Respondents; SD standard Deviation

## DISCUSSION

The finding of the study revealed 57 relevant contents area of automobile emission control system as relevant for inclusion into pre-service automobile teacher training curriculum in Nigeria. The finding is supported by test of the null hypothesis which indicated that there is no statistically significant difference in the responses of the respondents with regards to the 57 contents areas of the automobile emission control system for integration into the curriculum. The contents include; 8 items on automobile emissions, 14 items on components of automobile emission control system and emission reduction technologies, 20 items on diagnosis, repair and maintenance of automobile emission control system, 4 items on computerized exhaust gas analysis and tail pipe emission test, 5 items on

OBD II, and 6 on vehicle emission standards at global and local levels.

The findings agreed with the findings of Olayinka and Oyenuga (2010) who revealed 40 theoretical contents and 14 practical contents for integration into Nigeria technical college motor vehicle mechanic curriculum. The contents include; automobile emissions and emission control system, electronic ignition system, electronic fuel injection and gasoline direct injection, while the practical skills include; perform on-board computer diagnosis on electronic control unit, conduct engine performance test using engine analyzer, inspect, repair or replace electronic ignition components, diagnose electronic injection system faults and diagnose emission control system. This is in line with the opinion of Anastassova and Burkhardt (2009) that

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rapid technological changes in motor vehicle design influences the contents of their training programme curriculum. The implication of this is that curriculum of automobile programmes at all levels have to be updated in line with the demands of the state of art technology and the need of the society.

Similarly, the findings corroborate the result of a study conducted by Adamu (2015) who discovered that automobile technology lecturers in Colleges of Education in North-East Nigeria need capacity building on electronically controlled fuel injection systems, emission control systems, Exhaust Gas Recirculation (EGR), interpretation of On-board detection and diagnostic system, use of OBD II scan tools and exhaust gas analyzers. This further strengthens the finding of the current study that automobile teachers rated contents related to automobile emission control system as relevant for inclusion into pre-service automobile teacher training curriculum. Moreover, the finding also aligns with global effort to mitigate the environmental impact of vehicular emissions which according to World Health Organization (WHO, 2018) contributes to many health issues. Hence, integrating automobile emission control system into pre-service automobile teacher training curriculum will help automobile students to grasp the meaning and functions of the components of automobile emission control systems and how these components are serviced.

## CONCLUSION

Integrating the 57 specific contents related to automobile emission control system into the pre-service automobile teacher training curriculum at Colleges of Education level in Nigeria is crucial for equipping educator and future technicians with relevant skills for maintenance of automobile emission control system. This will improve the status of the graduates and as well contribute toward addressing environmental challenges caused by automobile emission in the country.

## RECOMMENDATIONS

The paper recommends that Nigeria Commission for Colleges of Education (NCCE)

should consider integrating the 57 content areas related to automobile emission control system into pre-service automobile teacher training curriculum at Colleges of Education level in Nigeria.

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