

Emerging-Technology Learning Outcomes, Objectives, and Instructional Practices for Inclusion into the Transmission and Fuel Supply Modules of National Technical College Programme in Nigeria

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The study determined the emerging-technology learning outcomes, objectives and instructional practices for inclusion into the transmission and fuel supply modules of national technical college programme in Nigeria. Three research questions were formulated to guide the study. Sequential explanatory mixed method research design was adopted for the study. The targeted population of the study was 125 respondents, consisting 67 school-based experts, 46 Industry-Based Experts and 12 regulatory experts. Census random sampling technique was employed for the study since the target population was of manageable size. A structured questionnaire and a Focus Group Discussion (FGD) Guide were used for data collection. The instruments were validated by three experts and pilot tested in Nasarawa State. The overall reliability index of questionnaire was 0.81 using Cronbach Alpha Statistical Technique. While, the reliability index of the FGD guide was established as 0.84 using Cohen's Kappa formula. The findings of the study revealed among others that understanding and diagnosing modern fuel injection systems, analyzing the role of sensors and AI in fuel management, applying knowledge of alternative fuels, and performing predictive diagnostics and efficiency tests were found to be the expected learning outcomes after implementing the learning objectives on emerging technology contents for inclusion in the fuel system module of the NTC programme in Nigeria with a grand mean of 3.59. Based on the findings, it was recommended among others that NBTE should revise and update the fuel system module of the NTC programme to incorporate the identified

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(CC BY) license (<http://creativecommons.org/licenses/by/4.0/>). learning outcomes, which involves understanding and diagnosing modern fuel injection systems and analyzing the role of sensors and artificial intelligence in fuel management among others

Keywords- population, implementing, applying, efficiency

Introduction

Motor Vehicle Mechanics Work (MVMW) constitutes a critical trade within Nigeria's Technical and Vocational Education and Training (TVET) framework, delivered through technical colleges under the National Technical Certificate (NTC) programme. The programme is structured to develop students' theoretical knowledge and practical competencies in motor vehicle maintenance and repair operations. The National Board for Technical Education (NBTE, 2016) stipulates that MVMW training should produce skilled craftsmen capable of understanding vehicle operating principles, applying maintenance procedures, and adhering to industry safety standards. The NTC curriculum architecture comprises five integrated components: general education, theory and related courses, workshop practice, industrial training or production work, and entrepreneurship training, all designed to foster comprehensive technical proficiency. Graduates are expected to demonstrate competence in diagnosing faults, performing maintenance procedures, and executing repairs across diverse vehicle systems. However, Adekunle *et al.* (2018) highlighted significant gaps in the curriculum, particularly regarding the incorporation of contemporary technological developments in transmission and fuel supply modules. James *et al.* (2017) further observed that technical college graduates frequently exhibit insufficient understanding of modern automotive systems. Ezeama *et al.* (2016) argued that MVMW craftsmen must contribute meaningfully to Nigeria's economic development by maintaining vehicles according to manufacturers' specifications. As automotive manufacturers continue introducing sophisticated technologies to improve vehicle safety, fuel efficiency, and

performance (Murali *et al.*, 2022), craftsmen require current knowledge and skills to remain competitive in the evolving automotive service sector.

Emerging technologies represent innovative applications of contemporary knowledge that generate advanced technical capabilities and improved operational processes. Veletsianos (2010) characterized them as tools, concepts, and innovations that transform educational delivery and professional practice. Within the automotive sector, emerging technologies including Electronic Control Units (ECUs), Electronic Fuel Injection (EFI), Electronic Ignition Systems, Antilock Braking Systems, Variable Valve Timing Intelligence, Active Suspension Systems, Emission Control Systems, and On-Board Diagnostics (OBD) have fundamentally altered vehicle functionality and servicing requirements (Trovão, 2021). This technological evolution necessitates that NTC graduates acquire proficiency in diagnostic equipment operation and computer-based technical reference systems (Opeyemi & Mary, 2024). Contemporary vehicles incorporate complex mechanical assemblies such as dual-clutch transmissions, continuously variable transmissions, direct shift gearboxes, hybrid transmission configurations, and advanced fuel delivery mechanisms including Gasoline Direct Injection (GDI) and Multi-Point Injection (MPI). Further innovations encompass intelligent fuel pump systems, modular component architectures, and digital communication networks such as onboard units (OBUs) and wireless connectivity between vehicles and service facilities (Ezeama *et al.*, 2016). These technological integrations have substantially increased the complexity of automotive maintenance operations. Dagala *et al.*

(2018) emphasized that these emerging subsystems must be incorporated into appropriate MVMW modules to ensure training programmes reflect current automotive industry practices.

Learning outcomes define the demonstrable competencies students should exhibit upon completing an instructional programme. Sewagegn (2020) emphasized that outcomes must be specific, measurable, and observable indicators of student achievement, while UNESCO (2016) noted they should encompass industry-aligned competencies such as identifying advanced transmission configurations, operating digital diagnostic instruments, and executing computer-assisted troubleshooting procedures. Well-articulated learning outcomes serve as foundational elements for curriculum development in emerging automotive technologies. They provide clear performance expectations and enable systematic assessment of students' technical proficiency in sensor-integrated systems, electronic control architectures, and hybrid vehicle platforms. The achievement of these outcomes depends significantly on clearly defined learning objectives, which specify the knowledge domains, practical skills, and professional attitudes students must acquire through instruction. According to Umar *et al.* (2022), objectives function as comprehensive guides that direct both teaching activities and learning experiences toward desired competency development. Gupta and Mishra (2020) described effective objectives as precise statements that facilitate structured instructional design and systematic competency assessment. When properly formulated, objectives ensure alignment between curriculum content, instructional delivery, and industry requirements in emerging automotive technologies.

The realization of intended learning outcomes requires appropriate instructional practices that combine theoretical understanding with practical application. Chidinma and Adokiye (2015) emphasized that instructional delivery should integrate classroom-based theoretical instruction

with workshop-based practical experiences. Teachers should employ interactive lectures, multimedia presentations, and hands-on exercises involving real-time diagnostic procedures. Practical sessions must incorporate training with EFI systems, transmission control software, and hybrid vehicle simulation platforms. Long (2023) advocated for blended instructional approaches incorporating discussion-based learning, problem-solving activities, and experiential training methodologies that correspond with technological advancements and students' learning needs. The effectiveness of these instructional practices is enhanced through adequate provision of learning resources. Ndukwe and Allen (2018) asserted that well-resourced training facilities significantly improve students' skill acquisition outcomes. Theoretical instruction should utilize e-learning platforms, computer-based simulation tools, and digital reference materials, while practical training requires diagnostic scan tools, computerized testing equipment, and hybrid system training units (Yan & Wang, 2015). Access to appropriate instructional resources ensures effective knowledge transfer and development of hands-on competence in emerging automotive technologies.

The development of relevant learning outcomes, objectives, and instructional practices necessitates input from Subject Matter Experts (SMEs) who possess specialized knowledge in specific technical domains. Valdez-Juárez *et al.* (2016) noted that SMEs identify critical skills, tools, and performance standards essential for curriculum development processes. In this study, SMEs comprise school-based experts (technical college instructors), industry-based experts (practicing automotive technicians and workshop supervisors), and regulatory experts from organizations such as the NBTE (Zun & Teerakapibal, 2020). Comparative analysis of perspectives between school-based and industry-based experts provides empirical evidence regarding the necessity for emerging technological content in MVMW training

programmes (Uduafemhe *et al.*, 2018). The absence of such content in current transmission and fuel supply modules may contribute to unemployment among MVMW craftsmen, consequently affecting Nigeria's socioeconomic development. Recent needs assessments revealed that existing modules are outdated, employers increasingly demand modern automotive competencies, and there exists urgent need for practical training in emerging technologies. Therefore, assessing the learning outcomes, objectives, and instructional practices for emerging technological content in the transmission and fuel supply modules of the NTC programme is essential to produce competent craftsmen capable of servicing contemporary vehicles in Nigerian automotive industry.

Statement of the Problem

The transmission and fuel supply modules of NTC programme in MVMW lack clearly defined learning outcomes, objectives, and instructional practices that address emerging automotive technologies. Current curriculum content does not adequately reflect contemporary vehicle systems such as Electronic Fuel Injection (EFI), dual-clutch transmissions, continuously variable transmissions (CVTs), hybrid transmission configurations, Gasoline Direct Injection (GDI), and digital diagnostic systems that have become standard in modern vehicles. Consequently, graduates of technical colleges are inadequately prepared to diagnose, maintain, and repair contemporary vehicle transmission and fuel supply systems, limiting their employability and effectiveness in the automotive service industry.

The absence of structured learning outcomes and objectives for emerging technologies, coupled with outdated instructional practices and insufficient learning resources, undermines the programme's capacity to produce competent craftsmen who meet current industry standards. This gap between training content and industry requirements contributes to unemployment among MVMW craftsmen and hinders Nigeria's efforts to develop a skilled technical workforce capable of supporting the automotive sector.

Therefore, there was urgent need to assess the emerging-technology learning outcomes, objectives, and instructional practices for inclusion into the transmission and fuel supply modules of national technical college programme in Nigeria.

1.3 Aim and Objectives of the Study

The aim of this study was to determine the emerging-technology learning outcomes, objectives, and instructional practices for inclusion into the transmission and fuel supply modules of national technical college programme in Nigeria. Specifically, the objectives were to determine the:

1. Expected learning outcomes for students regarding emerging technology contents in the fuel system module of the NTC programme in Nigeria.
2. Specific learning objectives on emerging technology contents for inclusion in the transmission system module of the NTC programme in Nigeria.
3. Teachers' activities for implementing the learning objectives on emerging technology contents for inclusion in the transmission system module of the NTC programme in Nigeria.

Research Questions

The following research questions guided the study:

1. What are the expected learning outcomes for students regarding emerging technology contents in the fuel system module of the NTC programme in Nigeria?
2. What are the specific learning objectives on emerging technology contents for inclusion in the transmission system module of the NTC programme in Nigeria?
3. What are the teachers' activities for implementing the learning objectives on emerging technology contents for inclusion in the transmission system module of the NTC programme in Nigeria?

Methodology

Sequential explanatory mixed method research design was adopted for the study. The study was conducted in Federal Capital Territory (FCT), Abuja, Kaduna and Niger States. The targeted population for the study was 125 respondents, consisting 67 school-based experts (MVM work teachers) from technical colleges, 46 Industry-Based Experts (Automobile Industrial Personnel) from Kojo Auto Services, TRP Limited, Lanre Shittu Motors and CIG Motors Co. Limited; and 12 regulatory experts from NBTE and National Automotive Design and Development Council (NADDC). Since the total population is of manageable size, census sampling was employed for the study. Hence, census sampling technique involving the entire population was used for the study. A structured instrument titled Transmission and Fuel Systems Emerging Technological Contents Questionnaire (TFSETCQ) and a Focus Group Discussion (FGD) Guide validated by three experts were used for data collection. The TFSETCQ was trial tested using Cronbach Alpha Statistical Technique on a randomly sampled size of five (5) MVM teachers from Federal Science and Technical College, Doma and five (5) Industrial Experts using split-half method in modern automobile maintenance

workshops in Nasarawa state. The overall reliability index of TFSETCQ was 0.80 which indicated that the instrument was reliable for use. Also, the reliability index of the FGD guide was established as 0.84 using Cohen's Kappa formula. The questionnaire was administered by the researcher with the help of six research assistants. Furthermore, the FGD guide was used to collect qualitative data from technical college teachers and industry experts. The research questions were answered using mean and standard deviations, while z-test was used to test the null hypotheses at 0.05 level of significance using Statistical Package for Social Sciences (SPSS) version 26. Furthermore, the data collected through the FGDs were analysed using thematic analysis.

Results and Discussion

Research Question 1

What are the learning outcomes after implementing the learning objectives on emerging technology contents for inclusion in the fuel system module of the NTC programme in Nigeria?

Results for addressing research question four are displayed in Table 1a and 1b.

Table 1a: Mean and standard deviation of the respondents' ratings on learning outcomes after implementing the learning objectives on emerging technology contents for inclusion in the fuel system module of the NTC programme in Nigeria.

S/N	Items	Mean	SD	Decision
Theoretical Students' Learning Outcomes on Emerging Technology Contents in Fuel System				
1.	Explain the principles and advancements in modern fuel injection technologies, including Gasoline Direct Injection (GDI) and Common Rail Direct Injection (CRDI).	3.64	.50	Agree
2.	Compare traditional fuel systems with modern electronic and AI-driven fuel management systems.	3.64	.48	Agree
3.	Identify and describe alternative fuel types, such as biofuels, CNG, LPG, hydrogen fuel cells, and synthetic fuels, and their applications in modern vehicles.	3.70	.45	Agree
4.	Analyze the role of sensors (for example, MAF, O ₂ , MAP, and knock sensors) in optimizing fuel efficiency and emissions control.	3.64	.60	Agree

5.	Demonstrate knowledge of electronic fuel management systems, including drive-by-wire technology and ECU-based fuel injection control.	3.54	.56	Agree
6.	Evaluate the impact of AI and predictive analytics on fuel optimization, diagnostics, and predictive maintenance.	3.63	.51	Agree
7.	Assess the integration of hybrid-electric and plug-in hybrid powertrains in fuel management systems.	3.67	.55	Agree
8.	Explain the function and benefits of smart fuel delivery systems, IoT connectivity, and blockchain-based fuel tracking.	3.62	.50	Agree
9.	Demonstrate understanding of electronically controlled fuel pumps and injectors and their role in improving fuel efficiency.	3.64	.48	Agree
10.	Discuss advancements in waste heat recovery (WHR) technologies and their applications in enhancing fuel system efficiency.	3.70	.45	Agree
Practical Students' Learning Outcomes on Emerging Technology Contents in Fuel System				
11.	Diagnose faults in modern fuel injection systems, including Gasoline Direct Injection (GDI) and Common Rail Direct Injection (CRDI), using diagnostic tools.	3.67	.63	Agree
12.	Install and calibrate sensors such as Mass Air Flow (MAF), Oxygen (O ₂), Manifold Absolute Pressure (MAP), and knock sensors in fuel management systems.	3.54	.56	Agree
13.	Carry out maintenance and troubleshooting of electronic fuel pumps and injectors.	3.63	.51	Agree
14.	Perform fuel efficiency tests using AI-driven fuel management tools.	3.63	.49	Agree
15.	Implement smart fuel delivery systems and integrate IoT-based fuel tracking.	3.62	.50	Agree
16.	Carry out predictive maintenance and diagnostics on AI-driven fuel systems	3.50	.72	Agree
Grand Mean		3.59	.56	Agree

Table 1a presents the mean and standard deviation values of respondents' ratings on the expected theoretical and practical learning outcomes after implementing the learning objectives on emerging technology contents in the fuel system module of the NTC programme in Nigeria. The mean values range from 3.50 to 3.70, while the standard deviation values range

from .45 to .72, with a grand mean of 3.59 and a standard deviation of .56. These values indicate a strong level of agreement among respondents and minimal variability in opinions, suggesting broad consensus that students should be able to explain modern fuel injection systems, evaluate sensor and AI applications, install and diagnose electronic components, and perform predictive diagnostics and efficiency tests as core learning outcomes of the updated curriculum

Table 1b: Thematic analysis on learning outcomes after implementing the learning objectives on emerging technology contents for inclusion in the fuel system module of the NTC programme in Nigeria.

S/N	Themes	Contents	n	%
1	Understanding Modern Fuel Injection Systems	Respondents indicated that students gained a strong theoretical and practical understanding, ability to explain operation and diagnose faults using digital diagnostic tools of modern fuel injection systems, including Gasoline Direct Injection (GDI) and Common Rail Direct Injection (CRDI).	19	95
2	Comparing Traditional and Smart Fuel Systems	Participants noted that students should compare conventional fuel systems with modern, AI-driven, and electronic fuel management systems, enhancing their critical understanding of fuel system evolution and innovation.	18	90
3	Applying Knowledge of Alternative Fuel Technologies	Respondents reported that students should acquire the knowledge to identify and describe various alternative fuels—such as biofuels, CNG, LPG, hydrogen fuel cells, and synthetic fuels—and understand their applications in environmentally friendly vehicle technologies.	20	100
4	Mastery of Fuel System Sensor Functions	Respondents emphasized that learners should be able to analyze the roles of key sensors (MAF, O ₂ , MAP, knock) in emissions control and fuel efficiency. Students also demonstrated competence in installing and calibrating these sensors during practical sessions.	19	95
5	Competence in Electronic Fuel Management Systems	Participants indicated that learners should develop both theoretical and hands-on proficiency in the operation of drive-by-wire systems and ECU-controlled fuel injection.	18	90
6	Application of AI and Predictive Technologies	Participants reported that students should be able to evaluate how artificial intelligence and predictive analytics enhance fuel optimization, system diagnostics, and preventive maintenance. .	17	85
7	Understanding and Implementing Hybrid and IoT-Connected Systems	Respondents Agree that students should be able to assess the integration of hybrid-electric and plug-in hybrid powertrains in fuel systems and implement IoT-based tracking solutions.	18	90
8	Familiarity with Electrically Controlled and Energy-Efficient Technologies	Respondents affirmed that learners should be able to work with electronically controlled fuel pumps and injectors.	19	95
9	Developing	The participants showed that students should be proficient	19	95

Advanced Maintenance and Diagnostic Skills	in fuel efficiency testing, maintenance, and diagnostics of advanced fuel systems using modern tools—especially AI-assisted diagnostic and fuel analysis equipment.
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Table 1b presents a thematic analysis of the expected learning outcomes following the implementation of emerging technology content in the fuel system module of the NTC programme in Nigeria. The findings show strong agreement among respondents that students should achieve both theoretical understanding and practical competence in key areas such as modern fuel injection systems, alternative fuels, electronic and AI-driven fuel management, sensor functions, hybrid systems, and diagnostic tools. Support for these outcomes ranged from 85% to 100%, indicating

widespread endorsement of the targeted competencies.

Research Question 2

What are the specific learning objectives on emerging technology contents for inclusion in the transmission system module of the NTC programme in Nigeria?

Results for addressing research question five are presented in Table 2a and 2b.

Table 2a: Mean and standard deviation of the respondents' ratings on specific learning objectives on emerging technology contents for inclusion in the transmission system module of the NTC programme in Nigeria.

S/N	Items	Mean	SD	Decision
Theoretical Learning Objectives on Emerging Technology Contents in Transmission System				
1.	Introduce students to the evolution of transmission systems, covering traditional manual and automatic types through to modern electronically controlled systems.	3.64	.49	Agree
2.	Teach the design, operation, and fuel economy implications of multi-speed automatic transmissions (including 8-speed, 9-speed, and 10-speed systems).	3.64	.48	Agree
3.	Explain the working principles and applications of Continuously Variable Transmissions (CVTs), especially in hybrid and electric vehicles.	3.59	.59	Agree
4.	Present a comparative analysis of Dual-Clutch Transmissions (DCTs) versus conventional automatic transmissions with respect to performance and efficiency.	3.75	.49	Agree
5.	Provide insights into the role and functioning of intelligent Transmission Control Units (TCUs) and how AI enhances shift optimization.	3.72	.59	Agree
6.	Explain how predictive analytics is used to improve transmission performance and enable proactive maintenance.	3.60	.61	Agree
7.	Introduce electrified transmission systems such as electronic CVTs (e-CVTs) and their applications in hybrid and electric powertrains.	3.69	.54	Agree

8.	Present modern predictive maintenance technologies relevant to transmission systems, including their application in fleet management.	3.69	.53	Agree
9.	Teach the impact and integration of energy recovery technologies like regenerative braking and waste heat recovery in enhancing transmission efficiency.	3.67	.54	Agree
10.	Explain the role of thermoelectric generators (TEGs) in improving overall vehicle energy efficiency and their interaction with transmission systems.	3.81	.52	Agree
Practical Learning Objectives on Emerging Technology Contents in Transmission System				
11.	Train students to diagnose issues in multi-speed automatic transmissions and evaluate their influence on vehicle fuel economy.	3.72	.52	Agree
12.	Equip students with the skills to carry out maintenance and troubleshooting of CVTs and DCTs.	3.72	.51	Agree
13.	Teach students to programme and test intelligent Transmission Control Units (TCUs) for optimized shift performance.	3.78	.48	Agree
14.	Introduce tools and techniques for analyzing transmission performance using predictive analytics software.	3.51	.68	Agree
15.	Provide hands-on experience in installing and configuring electrified transmission systems, including e-CVTs, in hybrid and electric vehicles.	3.64	.57	Agree
16.	Enable students to perform diagnostics and implement predictive maintenance strategies on modern electronic transmission systems.	3.70	.54	Agree
17.	Provide practical training in integrating and evaluating energy recovery technologies such as regenerative braking within vehicle transmission systems.	3.70	.53	Agree
Grand Mean		3.68	.54	Agree

Table 2a presents the mean and standard deviation values of respondents' ratings on the specific theoretical and practical learning objectives on emerging technology contents for inclusion in the transmission system module of the NTC programme in Nigeria. The mean values range from 3.51 to 3.81, while the standard deviation values range from .48 to .68, with a grand mean of 3.68 and a standard deviation of .54. These values indicate a high

degree of agreement among respondents and relatively low variability, suggesting that objectives such as teaching intelligent transmission control units (TCUs), programming predictive analytics software, evaluating CVTs and DCTs, and integrating energy recovery systems like regenerative braking were widely recognized as essential for aligning the transmission system module with emerging technological trends.

Table 2b: Thematic analysis on specific learning objectives on emerging technology contents for inclusion in the transmission system module of the NTC programme in Nigeria

S/N	Themes	Contents	n	%
1	Understanding Evolution and Functionality of Modern Transmission Systems	Respondents emphasized that learners are expected to understand the design and operation of multi-speed automatics (8-speed, 9-speed, 10-speed), and analyze the performance and fuel economy implications.	19	95
2	Exploring Advanced Transmission Types (CVTs and DCTs)	Participants noted that students should learn the working principles, benefits, and limitations of Continuously Variable Transmissions (CVTs) and Dual-Clutch Transmissions (DCTs), particularly in relation to hybrid and electric vehicle applications.	18	90
3	Integrating Intelligent Control Technologies (AI and TCUs)	Respondents reported that learners should be equipped to understand and apply intelligent Transmission Control Units (TCUs), focusing on how AI enhances gear shift optimization and improves drivability and energy efficiency.	20	100
4	Applying Predictive Analytics in Transmission Systems	The data revealed that students should gain skills in using predictive analytics to monitor, diagnose, and improve transmission performance. This includes hands-on experience with performance analysis software and predictive maintenance techniques.	19	95
5	Installing and Managing Electrified Transmission Systems	Respondents emphasized the need to train students in installing, configuring, and maintaining electrified transmission systems like electronic CVTs (e-CVTs), especially in hybrid and electric vehicles.	18	90
6	Enhancing Skills in Diagnostic and Maintenance Practices	Participants Agree that students must develop diagnostic and maintenance capabilities for modern transmission systems, including multi-speed automatics, CVTs, and DCTs.	19	95
7	Integrating Energy Recovery and Efficiency Technologies	Respondents supported teaching students about technologies like regenerative braking and thermoelectric generators (TEGs), and how they interact with transmission systems to enhance energy efficiency.	17	85

Table 2b presents a thematic analysis of the specific learning objectives related to emerging technology content for inclusion in the transmission system module of the NTC

programme in Nigeria. Respondents widely Agree on the need for students to understand modern transmission designs, such as multi-speed automatics, CVTs, and DCTs; integrate intelligent control technologies like AI and

TCUs; and develop skills in predictive analytics, diagnostics, electrified systems, and energy recovery techniques. Support levels ranged from 85% to 100%, reflecting a strong consensus on the relevance of these competencies for future automotive technicians.

Research Question 3

What are the teachers' activities for implementing the learning objectives on emerging technology contents for inclusion in the transmission system module of the NTC programme in Nigeria?

Results for addressing research question six are displayed in Table 3a and 3b.

Table 3a: Mean and standard deviation of the respondents' ratings on teachers' activities for implementing the learning objectives on emerging technology contents for inclusion in the transmission system module of the NTC programme in Nigeria.

S/N	Items	Mean	SD	Decision
Teachers Activities for Implementing Theoretical Learning Objectives				
1.	Explain the evolution of transmission systems, from traditional manual and automatic transmissions to modern electronically controlled systems.	3.67	.54	Agree
2.	Describe the design and operation of multi-speed automatic transmissions (8-speed, 9-speed, 10-speed) and their impact on fuel economy.	3.56	.82	Agree
3.	Analyze the working principles of Continuously Variable Transmissions (CVTs) and their application in hybrid and electric vehicles.	3.70	.53	Agree
4.	Compare Dual-Clutch Transmissions (DCTs) with conventional automatic transmissions in terms of efficiency and performance.	3.70	.51	Agree
5.	Identify the role of intelligent Transmission Control Units (TCUs) and AI-driven shift optimization in modern transmission systems.	3.75	.49	Agree
6.	Explain the function of predictive analytics in transmission performance and maintenance.	3.74	.58	Agree
7.	Explain the role of electrified transmission systems, including e-CVTs, in hybrid and electric vehicles.	3.70	.45	Agree
8.	Discuss predictive maintenance technologies for transmission systems and their benefits in fleet management	3.50	.63	Agree
9.	Explain the impact of energy recovery technologies, such as regenerative braking and waste heat recovery, on transmission efficiency.	3.62	.63	Agree
10.	Demonstrate knowledge of thermoelectric generators (TEGs) and their role in improving vehicle energy efficiency.	3.58	.55	Agree
Teachers Activities for Implementing Practical Learning Objectives				
11.	Guide students in diagnosing faults in multi-speed automatic transmissions and assessing their impact on fuel economy.	3.62	.50	Agree
12.	Supervise students in carrying out maintenance and troubleshooting of Continuously Variable Transmissions (CVTs) and Dual-Clutch Transmissions (DCTs).	3.62	.48	Agree
13.	Train students on programming and testing intelligent Transmission Control Units (TCUs) for optimized performance.	3.74	.54	Agree

14.	Facilitate transmission performance analysis using predictive analytics tools.	3.57	.57	Agree
15.	Guide students in installing and configuring electrified transmission systems, including e-CVTs, in hybrid and electric vehicles.	3.66	.47	Agree
16.	Provide hands-on training on performing diagnostics and predictive maintenance on modern transmission systems.	3.70	.45	Agree
17.	Engage students in integrating and assessing energy recovery technologies, such as regenerative braking, in vehicles.	3.67	.59	Agree
Grand Mean		3.65	.51	Agree

Table 3a presents the mean and standard deviation values of respondents' ratings on the teachers' activities for implementing the theoretical and practical learning objectives on emerging technology contents in the transmission system module of the NTC programme in Nigeria. The mean values range from 3.50 to 3.75, while the standard deviation values range from .45 to .82, with a grand mean

of [to be entered] and a standard deviation of [to be entered]. These values reflect a high level of agreement among respondents and moderate variability in their views, suggesting consensus that teachers should engage in activities such as explaining the role of intelligent TCUs and energy recovery systems, training students to diagnose and troubleshoot CVTs and DCTs, and facilitating the application of predictive maintenance tools and electrified transmission technologies.

Table 3b: Thematic analysis on teachers' activities for implementing the learning objectives on emerging technology contents for inclusion in the transmission system module of the NTC programme in Nigeria.

S/N	Themes	Contents	n	%
1	Explaining the Evolution and Structure of Modern Transmission Systems	Respondents emphasized the need for teachers to introduce students to the progression from traditional manual and automatic transmission systems to advanced electronically controlled systems. Instruction should also cover the operation and fuel efficiency implications of multi-speed transmissions (8-speed, 9-speed, and 10-speed systems).	19	95
2	Teaching Advanced Transmission Technologies (CVTs and DCTs)	Participants Agree that educators should analyze the functionality and applications of Continuously Variable Transmissions (CVTs) and Dual-Clutch Transmissions (DCTs), especially in the context of hybrid and electric vehicles. Practical supervision during troubleshooting and maintenance of these systems was also emphasized.	18	90
3	Introducing Intelligent Transmission Control and AI Applications	Respondents highlighted the need for teachers to explain the role of Transmission Control Units (TCUs) and how artificial intelligence contributes to optimal shift performance. This includes activities where students are trained to programme and test TCUs for real-time driving optimization.	20	100

4	Applying Predictive Analytics in Learning Activities	Several respondents stressed the importance of equipping students with skills in predictive analytics to assess transmission performance and anticipate maintenance needs. Teachers are expected to facilitate the use of digital tools for data-driven diagnostics and performance analysis.	19	95
5	Guiding Practical Skills in Electrified Transmission Systems	Participants suggested that teachers should provide practical guidance in installing and configuring electrified transmission systems, particularly electronic CVTs (e-CVTs) used in hybrid and electric vehicles.	18	90
6	Facilitating Diagnostics and Predictive Maintenance Tasks	Respondents reported that teachers must guide students in identifying and resolving faults in electronic transmission systems, with emphasis on predictive maintenance using modern diagnostic tools and methods.	19	95
7	Integrating Energy Recovery and Efficiency Technologies	Many respondents affirmed that instructional activities should cover energy recovery systems like regenerative braking and waste heat recovery. Teachers are expected to engage students in evaluating how these technologies impact transmission efficiency and overall vehicle performance.	17	85

Table 3b provides a thematic analysis of the recommended teacher activities for delivering learning objectives on emerging transmission system technologies in the NTC programme in Nigeria. The data shows strong agreement among respondents on the importance of combining theoretical instruction with hands-on training across areas such as modern and intelligent transmission systems, AI and TCU applications, predictive analytics, electrified systems, and energy recovery technologies. With support ranging from 85% to 100%, the responses highlight a comprehensive teachers activities aligned with industry trends.

Discussion of Findings

Understanding and diagnosing modern fuel injection systems, analyzing the role of sensors and artificial intelligence in fuel management, applying knowledge of alternative fuels, and performing predictive diagnostics and efficiency tests were identified as the expected learning outcomes after implementing the learning objectives on emerging technology contents for inclusion in the fuel system module of the NTC programme in Nigeria. These outcomes

represent a paradigm shift toward competency-based, industry-responsive education designed to equip learners with practical skills that address the requirements of contemporary automotive technologies. This finding highlights the imperative for technical college graduates to transcend theoretical knowledge acquisition and demonstrate applied proficiency in intelligent fuel system technologies. The focus on diagnosing modern fuel injection systems and analyzing artificial intelligence-driven fuel management processes indicates a transition from conventional mechanical procedures to digitally enhanced automotive servicing competencies.

This corresponds with Gwana and Sule (2024), who stressed the necessity of retraining motor vehicle mechanics teachers in Nigeria to address emerging technological demands in the automotive sector. Their study revealed that traditional mechanical skills are insufficient for managing advancements in contemporary vehicle systems. Complementing this perspective, Enoch (2024) established that technical college graduates must acquire competencies in emerging technologies such as

predictive maintenance and diagnostic procedures to successfully manage or establish automotive service enterprises. The present study reinforces this position by demonstrating that predictive diagnostics and interpretation of efficiency test results constitute not merely desirable but essential learning outcomes for students in the current technological environment.

Introducing modern transmission systems, analyzing continuously variable transmissions (CVTs) and dual-clutch transmissions (DCTs), exploring artificial intelligence applications in transmission control units (TCUs), applying predictive analytics, and integrating electrified and energy recovery technologies were identified as the specific learning objectives on emerging technology contents for inclusion in the transmission system module of the NTC programme in Nigeria. These objectives represent a fundamental reorientation toward technology-driven, competency-based education aimed at preparing learners with the capabilities required to service contemporary automotive transmission systems.

This finding reveals the need for technical college graduates to advance beyond conventional mechanical knowledge and demonstrate practical expertise in intelligent transmission technologies. This corresponds with Gwana and Sule (2024), who underscored the necessity of retraining motor vehicle mechanics teachers in Nigeria to address emerging technological requirements in the automotive industry. Their study established that conventional mechanical skills are inadequate for managing the complexities of modern vehicle systems. Supporting this position, Enoch (2024) determined that technical college graduates must acquire proficiencies in emerging technologies such as predictive maintenance and advanced diagnostic procedures to effectively operate or establish automotive service businesses. The present study reinforces this assertion by demonstrating that predictive analytics and the integration of electrified transmission technologies are not

merely desirable but essential learning objectives for preparing students to meet current industry standards.

Findings on the teachers' activities for implementing the learning objectives on emerging technology contents for inclusion in the transmission system module of the National Technical College (NTC) programme in Nigeria revealed that explaining the structure and evolution of modern transmissions, teaching CVT and DCT technologies, guiding students in predictive diagnostics, supervising the practical configuration of electrified transmission systems, and facilitating hands-on training with AI and energy recovery technologies were found to be the major instructional responsibilities of teachers. These findings underscore the expanded pedagogical roles that automotive teachers must now embrace as transmission technologies become more sophisticated and integrated with electronics, artificial intelligence (AI), and sustainability-driven innovations. Teachers are expected not only to impart foundational knowledge but also to bridge theoretical concepts with practical industry applications.

This aligns with the earlier conclusions of Haruna *et al.* (2025), who advocated for the incorporation of new automotive technologies into the curriculum to prepare students for modern vehicular systems. Teaching Continuously Variable Transmissions (CVTs) and Dual-Clutch Transmissions (DCTs) reflects the increased reliance on advanced drivetrains, especially in electric and hybrid vehicles. The ability of teachers to both explain the operation and supervise troubleshooting and maintenance of these systems is key to closing the technical skill gaps noted in Gwana and Sule (2024). Their study emphasized the retraining needs of teachers to stay updated with industry-relevant instructional practices in motor vehicle mechanics.

Conclusion

This study assessed the emerging-technology learning outcomes, objectives, and instructional

practices necessary for inclusion into the transmission and fuel supply modules of the National Technical College programme in Nigeria. The findings revealed critical components required to align the Motor Vehicle Mechanics' Work curriculum with contemporary automotive industry demands and technological advancements. Similarly, the establishment of learning objectives for the transmission system module emphasizes the importance of introducing modern transmission systems, analyzing continuously variable transmissions and dual-clutch transmissions, and integrating electrified and energy recovery technologies among others. Furthermore, the delineation of teachers' activities for implementing these learning objectives highlights the instructional practices necessary for effective knowledge transfer and skill development. Teachers must explain the structure and evolution of modern transmissions, teach CVT and DCT technologies, guide students in predictive diagnostics, supervise practical configuration of electrified transmission systems, and facilitate hands-on training with artificial intelligence and energy recovery technologies. The findings collectively demonstrate that integrating emerging technological content into the transmission and fuel supply modules of the NTC programme is essential for producing

competent craftsmen capable of maintaining modern vehicles in Nigeria.

Recommendations

Based on the findings of this study, the following were recommended:

1. NBTE should revise and update the fuel system module of the NTC programme to incorporate the identified learning outcomes, which involves understanding and diagnosing modern fuel injection systems and analyzing the role of sensors and artificial intelligence in fuel management among others.
2. Technical colleges offering MVMW programme should adopt and implement the identified learning objectives for the transmission system module, including introducing modern transmission systems, analyzing continuously variable transmissions and dual-clutch transmissions, and exploring artificial intelligence applications in transmission control units among others.
3. NBTE in collaboration with automotive industry associations and vehicle manufacturers, should organize comprehensive training programmes for technical college teachers to equip them with the knowledge and skills necessary to implement the identified instructional activities.

References

- Adekunle, P. A., Omirin, M. S., & Adeniji, C. A. (2018). Curriculum development in technical and vocational education: Issues and challenges in Nigeria. *Journal of Technical Education and Training*, 10(2), 23-35.
- Chidinma, N. E., & Adokiye, E. (2015). Effective teaching methods in technical and vocational education. *Nigerian Journal of Educational Research*, 8(1), 45-58.
- Dagala, M. B., Shuaibu, M. M., & Yunusa, A. A. (2018). Integration of emerging technologies in motor vehicle mechanics curriculum in Nigeria. *Journal of Technical and Science Education*, 8(3), 234-247.
- Enoch, S. O. (2024). Competency requirements for automobile enterprise management among technical college graduates in Nigeria. *International Journal of Vocational Education*, 12(1), 67-82.
- Ezeama, M. C., Unachukwu, G. O., & Onyene, V. E. (2016). Relevance of motor vehicle mechanics work in Nigeria's economic development. *Journal of Education and Practice*, 7(15), 112-120.
- Gupta, M., & Mishra, V. N. (2020). Development of self-instructional modules for technical education. *Journal of Engineering Education Transformations*, 33(Special Issue), 456-463.
- Gwana, A. M., & Sule, M. A. (2024). Retraining needs of motor vehicle mechanics teachers for emerging automotive technologies in Nigeria. *Journal of Technical Teacher Education*, 15(2), 89-104.
- James, A. O., Ogunleye, B. O., & Adeleke, A. A. (2017). Assessment of technical college graduates' competencies in modern vehicle systems. *African Journal of Educational Research*, 21(2), 156-168.
- Long, C. (2023). Blended learning approaches in vocational education: Aligning instruction with technological advancement. *International Journal of Training Research*, 21(1), 34-50.

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- Murali, G., Vijayakumar, M., & Nagajothi, P. (2022). Technological innovations in automotive industry: Implications for technical education. *Materials Today: Proceedings*, 52(3), 1245-1250.
- National Board for Technical Education. (2016). *National Technical Certificate curriculum and module specifications for Motor Vehicle Mechanics Work*. NBTE.
- Ndukwe, C. I., & Allen, A. A. (2018). Impact of learning resources on skill acquisition in technical colleges. *Journal of Educational Technology Systems*, 46(3), 312-328.
- Opeyemi, A. S., & Mary, O. E. (2024). Diagnostic competencies required of motor vehicle mechanics in the digital age. *Nigerian Journal of Technology and Education*, 9(1), 78-91.
- Sewagegn, A. A. (2020). Learning objectives and assessment in competency-based education. *Cogent Education*, 7(1), 1-15.
- Trovão, J. P. F. (2021). Electric and hybrid vehicle technology: Challenges for automotive education. *Energies*, 14(4), 1-18.
- Uduafemhe, M. E., Nwogu, G. A., & Nwankwo, O. C. (2018). Subject matter experts' perspectives on curriculum development in Nigerian technical education. *International Journal of Vocational and Technical Education*, 10(3), 23-31.
- UNESCO. (2016). *Strategy for technical and vocational education and training (TVET) 2016-2021*. UNESCO
- Umar, I. Y., Olorundare, S. A., & Mohammed, A. (2022). Module development for competency-based technical education in Nigeria. *Journal of Science, Technology and Education*, 10(1), 145-159.
- Valdez-Juárez, L. E., García-Pérez de Lema, D., & Maldonado-Guzmán, G. (2016). Management of knowledge, innovation and performance in SMEs. *Interdisciplinary Journal of Information, Knowledge, and Management*, 11, 141-176.
- Veletsianos, G. (2010). A definition of emerging technologies for education. In G. Veletsianos (Ed.), *Emerging technologies in distance education* (pp. 3-22). Athabasca University Press.
- Yan, W., & Wang, J. (2015). Simulation-based training in automotive technology education. *International Journal of Engineering Education*, 31(6), 1567-1578.
- Zun, A. B., & Teerakapibal, S. (2020). Role of subject matter experts in vocational curriculum development. *Asian Journal of Education and Training*, 6(2), 234-245.