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Exploring Practical Skills Requirements in Auto Electricity/Electronics in Motor Vehicle Mechanic Program for Maintenance of Modern Vehicles in Technical Colleges in Nigeria

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Abstract

This study investigates the practical skills required in auto-electricity/electronics for the maintenance of contemporary automobiles within the Motor Vehicle Mechanic (MVM) program in technical colleges in Nigeria. Using a qualitative research approach, data was collected through semi-structured interviews with 20 participants, including MVM administrators, teachers, master craftsmen, and automotive industry managers. Reflexive thematic analysis was performed using NVivo 14 software to identify key themes related to practical knowledge and skill areas critical for modern vehicle maintenance. The findings revealed that proficiency in areas such as practical skills advanced automobile technology, detection and diagnosis of system faults and electrical/electronic systems and components were highlighted as essential in auto-electricity/electronic in MVM program for effective maintenance of modern vehicles. The study emphasizes the need to update the auto-electricity/electronic curriculum in the MVM program to incorporate emerging technologies and partnerships with automobile industries, ensuring that graduates can meet the demands of contemporary automotive industries. This work contributes to the understanding of necessary training and skill development to enhance the employability and performance of MVM graduates, supporting the evolution of technical vocational education and training (TVET) in Nigeria.

Keywords: Auto-Electricity/Electronic, Automotive Maintenance, Contemporary Automobile Technology, Diagnostic Tools, Motor Vehicle Mechanic Program, Practical Skill, Technical College

Introduction

The rapid advancements in automotive technology have significantly transformed the skill set required to maintain and repair modern vehicles (Idris, & Abutu, 2019; Opeyemi & Benjamin, 2020). With the increased integration of complex electronic and electrical systems, the role of auto-electricity/electronics within the Motor Vehicle Mechanic (MVM) program has grown in importance (Legg-Jack & Alant, 2022; Ogbuanya & David, 2020). As contemporary automobiles evolve, maintenance practices must adapt to include new diagnostic tools, fault detection methods, and electrical/electronic components (Olaitan, 2024). However, studies have shown that the majority of graduates of the MVM program are neither employable nor entrepreneurially viable owing to a lack of practical knowledge and skill in managing cutting-edge automotive technologies, as well as the assurance that they are capable of handling their duties (Abdulkadir et al., 2020; George et al., 2022; Ibeneme & Ebubechi, 2021; Kurniawan et al., 2021; Lemo & Adeyemi, 2022; Okolo, 2023; Owo & Deebom, 2020). This has resulted in a skill gap that limits graduates' employability and effectiveness.

This study explores the practical skills required in auto-electricity/electronics within the MVM program, a critical area for maintaining and repairing modern vehicles. Using a qualitative approach, data was gathered through semi-structured interviews with MVM administrators, teachers from nine technical colleges in Delta State and master craftsmen, and automobile industry representatives in Delta State and its environs. By employing reflexive thematic analysis with the aid of NVivo 14 software, this research seeks to identify key themes that underscore the practical skills required in the program for students to excel in the maintenance of contemporary automobiles.

The findings offer valuable insights into the practical skill challenges and expectations MVM students and educators face. Themes such as practical skills in advanced automobile technology, detection and diagnosis of system faults and electrical/electronic systems and components were identified as critical for ensuring effective vehicle maintenance. This study aims to bridge the gap between traditional MVM training and the evolving demands of the automotive industry, proposing enhancements to curricula, industrial collaboration and training strategies that better equip students for success. The result of this research will inform all educators, policymakers, curriculum designers, professionals in the MVM program, and stakeholders in automobile industries about the essential practical skills and knowledge required to equip the students for employment and maintenance and repair of modern vehicles.

Methods

This study utilized a qualitative research method by employing a single case study research design and semi-structured interviews as data collection techniques. The study's participants included nine (9) MVM administrators, primarily serving as heads of MVM departments and as MVM teachers and five (5) teachers of the MVM program. They were selected from the nine (9) technical colleges in Delta State, South-South geopolitical zone of Nigeria. Moreover, all the 9 technical colleges in the state offer MVM programs. Other participants include three (3) master craftsmen from the automotive industry who represent themselves in automobile service companies and 3 managers/representatives of automobile

companies who are considered employers of labour. Therefore, a total of twenty (20) participants were selected for the study using a non-probability purposive sampling method.

Procedure

The final interview protocol was developed after expert validation and a pilot study was conducted. The interview protocol contains three sections; the demographic section; open questions and specific questions. The demographic section dealt with the background of the interviewees, the open question section focused on the general knowledge of the issue on the program, and specific questions focused on answering the research question directly. After making initial contact with the various stakeholders and setting up appointments with them, the researcher organized the interview session with the help of research assistants. All the participant were provided with a written informed consent letter which they consented by appending their signatures. Participants were interviewed face to face on a certain date time and venue agreed with them. The entire conversation was audio recorded with the consent of the participants in addition to note taking by both the research and research assistants and later re-examined for better understanding.

Data Analysis

Reflexive thematic analysis by Braun and Clarke (2006, 2021) was used to investigate recurrent concepts and perspectives, resulting in logically consistent themes. This was made possible by the use of NVivo 14, a popular program for analyzing and managing qualitative data. NVivo allowed for careful application of codes to data portions, allowing for the comparison of themes across various stakeholder groups. The analysis aimed to identify key themes that emerged from the semi-structured interviews enabling a deeper understanding of the perspectives and experiences of the participants. In keeping with Braun and Clarke (2006, 2021). This study employed a six-phase reflexive thematic analysis approach, which highlights the significance of researcher reflexivity throughout the process. NVivo helped with this by letting the researcher evaluate and improve codes repeatedly, leading to the emergence of rich and subtle themes.

The six phases of the Braun and Clarke reflexive thematic analysis include transcript familiarization, generating initial codes, generating initial themes, revision of potential themes, naming and definition of themes and reporting. The researcher initially engaged in the preliminary phase of familiarizing himself with the data. This entailed reviewing the transcripts to become acquainted with them, taking notes and creating annotations. Following familiarization with the data, the researcher generated the initial codes as the second phase in the reflexive thematic analysis. The themes developed in the third phase were reviewed in the fourth phase to arrive at the final themes that were scrutinized and defined in the fifth phase. In achieving the study's objective, the analysis of semi-structured interview transcripts obtained from the participants is presented.

Results and Discussion

Data Analysis Report

The researcher analyzed the data from the semi-structured interview to explore the practical skills in auto-electricity/electronics that are required in the MVM program for proper maintenance of contemporary automobiles. Using NVivo 14 software for qualitative data management and coding, several important themes were identified that underscore the

practical skills needed in MVM programs, particularly in auto-electricity/electronics, to effectively manage the complex nature of today's automobile systems. These themes encompass a variety of skills, including advanced automobile technology; practical skills for detecting and diagnosing system faults; and electrical/electronic systems and components. The following sections offer an examination of the identified themes, fostering a deeper comprehension of the specific practical skills necessary for the upkeep and repairs of modern vehicles. Table 1 illustrates the relationship between the study's research question (RQ) and the emerging themes.

Table 1
Major Research Question and Emerging Themes

Research Question	**Major Themes**
What Practical Skills are Required in Auto-Electricity/Electronics in the MVM Program for Maintenance of Contemporary Automobiles**?**	Advanced Automobile Technology Detection and Diagnosis of System Faults Electrical Electronic Systems and Components

Theme 1 - Advanced Automobile Technology

This theme directly addresses RQ by emphasizing the practical skills needed in the auto-electricity/electronic aspect of the MVM program, equipping students to maintain and repair modern vehicles that increasingly integrate innovative electrical/electronic systems. It encompasses the practical skills required for working with the nascent technological advancement in automobiles, specifically in the areas of security, safety, vehicle configuration, and programming.

Sub-Theme 1- Security and Safety System

This section delves into the real-life skills needed to work on the complex safety and security systems found in contemporary automobiles. These systems are essential to guarantee the safety of the driver, the passengers, and the vehicle and to safeguard against theft and unauthorized entry. After the analysis of the data, different codes were developed that contributed to the emergency of this sub-theme. These codes represent the essential practical skills within this sub-theme, which are necessary for the maintenance and repair of modern automobiles. They include the application of safety, electric vehicle maintenance and repairs, security systems and remote control, which includes the practical skills on maintenance, repair, and installation of remote controls in the vehicle and practical skills on security system installation.

Interviewee 04. *Also, skills in applying those safety precautions are also needed.* ***Interviewee 01.*** *[…] skills in security system installation, ignition system and more.* ***Interviewee 04.*** *Yes, as I said before, practical skills on how to work on electric vehicles, […].* ***Interviewee 02.*** *So, they should know the remote-control knowledge of OBD II and the skill to apply the knowledge.*

Figure 1 illustrates the sub-theme and various codes developed to contribute to its emergency. These codes represent the essential practical skills within this sub-theme, which are necessary for the maintenance and repair of modern automobiles.

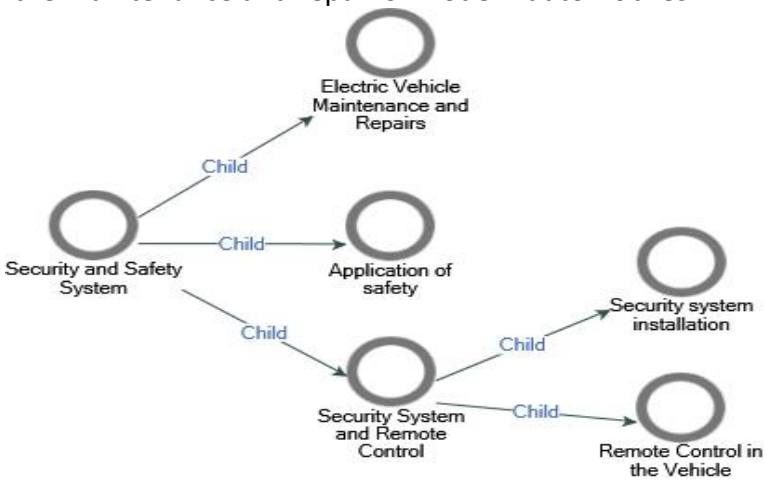

Figure 1 Practical skills on the security and safety system

Sub-Theme 2 - Vehicle Programming and Configuration

This particular sub-theme focuses on the practical skills that are required for programming, configuring, and troubleshooting the increasingly complex computer systems that are responsible for controlling the numerous activities of vehicles. This sub-theme emerged from the codes developed by the researcher after conducting the data analysis. These codes highlight the significant practical skill under the sub-theme required in the MVM program, particularly in auto-electricity/electronics, to effectively maintain and repair contemporary automobiles. These include practical skills in computers, mechatronics, practical skills in programming and configuration, and skills in diagnosing and programming vehicles.

Interviewee 01. *I would also mention skills in computer.* ***Interviewee 04.*** *Skill in the use of computer and diagnostics tools.* ***Interviewee 17.*** *Like I have mentioned earlier, it's that area of mechatronics and it's very important that it should be included in the curriculum of technical colleges as soon as possible.* ***Interviewee 17.*** *Nothing can come to mind for now but there is this area of mechatronics they talked about where the industries are actually focusing on and it has a lot of bearing with this one of electricity, auto-electrical/electronic.* ***Interviewee 01.*** *We are talking of modern cars, right? Some of them are programmed, so they should I think, have skills in programming and configuring the vehicle.* ***Interviewee 02.*** *[…] skill in computer, vehicle programming and configuration using computer devices.* ***Interviewee 10.*** *So, for me, what I do on my own is to make sure they learn, they focus on that diagnosing and programming aspect.*

Figure 2 presents the sub-theme and codes highlighting the significant practical skills required in the MVM program, particularly in auto-electricity/electronics for effective maintenance and repair of contemporary automobiles.

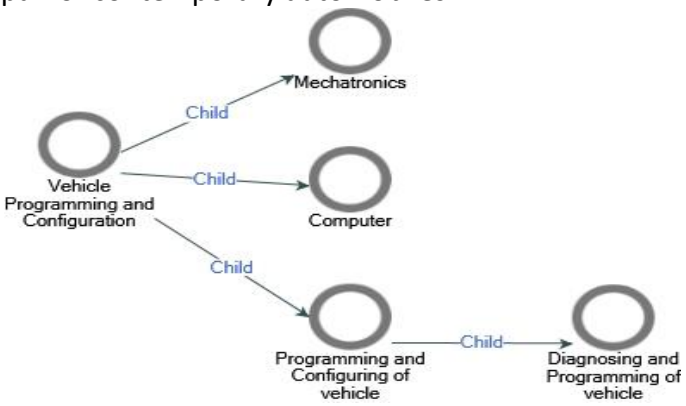

Figure 2 Practical skills in vehicle programming and configuration

Theme 2 - Detection and Diagnosis of System Faults

After conducting the data analysis, the theme titled "Detection and Diagnosis of System Faults" emerged from the sub-themes and developed codes from the semi-structured interview. It encompasses the practical skills that are required to detect, diagnose, and repair problems that occur with automobile systems. It also involves the skills to test a variety of components, examine diagnostic data, and trace faults within the circuits and systems of automobiles. Additionally, this theme encompasses two sub-themes that directly address the RQ.

Sub-Theme 1 - Diagnostics Tools and Devices

This sub-theme focuses on practical skills in using various diagnostic instruments and equipment, that are essential for testing and resolving issues in electronic/electrical systems in automobiles. It entails hands-on experience in testing a variety of electronic components, such as circuits, control units, and sensors, using the appropriate devices and equipment. The sub-theme emerged from the different codes developed by the researcher after data analysis. These codes include the specific practical skills in testing auto-electricity/electronic components; use of diagnostic tools and equipment, such as on-board diagnostics (OBD II), and the latest digital tools and equipment to trace, detect, and fix faults in contemporary vehicles.

Interviewee 12. *they need the practical skills to open and detect a particular fault and reassemble it back. Skill to test run the component and know if it is working.* ***Interviewee 02.*** *You see OBD II scan tool is very important in maintaining and diagnosing modern vehicles. I will say that first of all the practical skills on how to use or operate OBD II diagnostics tools. There are a lot of things you can do with the OBD II tools such as diagnosing engine and electrical faults, eliminating error codes, reading warning light, programming the vehicle and many things. […]. I have also mentioned skills on how to test components with digital multimeter and other testing tools apart from OBD II scan tools.* ***Interviewee 02.*** *You see, most of the implements used in electrical work are digital, computer like equipment and tools for diagnosing faults. They have problem in using them especially the OBD II machine, it is called on-board diagnostics machine.* ***Interviewee 04.*** *Very good, one, regular visit to the workshop, ehhh getting used to those modern diagnostics tools I mean having to get skill on*

how to manipulate them to make them do the work they are expected to do. Most of the tools, the students cannot operate on them or use them thereby making them redundant on the job. […]. Skills in using OBD machines are very important too. You cannot access any modern vehicle now for faults without the use of those diagnostic tools.
Interviewee 03. *The skill in using testing tools such as theodolite lamps to test fuses know where current flows and where it is not, especially when it comes to fuse,*

Figure 3 illustrates the sub-theme and the corresponding codes that contributed to its emergency providing a full analysis of how certain practical skills are classified within this sub-theme.

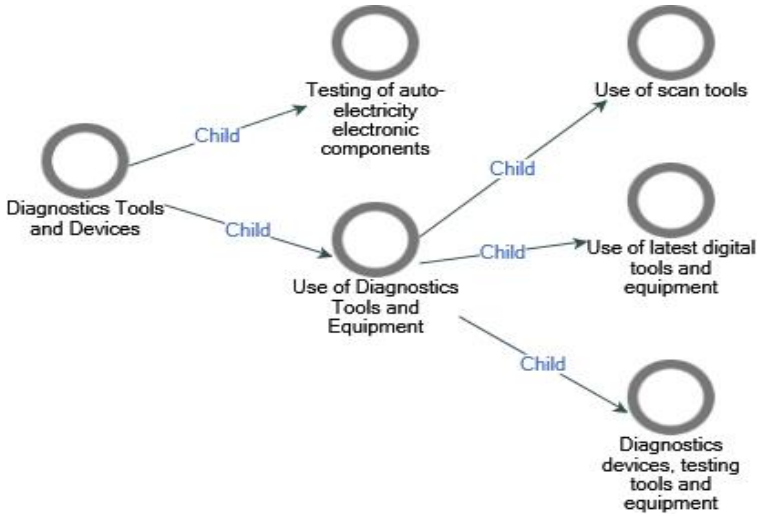

Figure 3 Practical skills in the use of diagnostics tools and devices

Sub-Theme 2 - Fault Identification and Rectification

Fault identification is the first step in diagnosing system problems, followed by the application of appropriate remedial actions to fix the issue. This sub-theme covers the practical skills needed to identify and rectify faults in modern automobiles' electrical/electronic systems. It involves the skills to accurately diagnose faults using diagnostic devices and then employ the right procedures to resolve them, ensuring that the vehicle's systems function properly. Additionally, it includes the skills to reset systems, replace broken components, or recalibrate vehicle software to address the underlying issues. Furthermore, this sub-theme is driven by code fault diagnosis and rectification, which encompasses fault tracing and diagnosis as well as identification and rectification of diagnostic trouble codes.

Interviewee 11. *The basic things to learn inside them to make sure they will be able to use them effectively on how to diagnose vehicles and diagnose the fault codes and how to fix those fault codes.* ***Interviewee 11.*** *Like in auto-electricity/electronic the practical skills they need to have been in the area of identifying the fault codes. This is the most important, if they can identify fault codes, definitely they will be able to know the right steps to follow and put it in order and fix those fault codes. When you know the fault codes, the causes of the fault code and you know the fault codes you will be able to know how to fix it. So, they should be able to know how to identify the fault code and after identifying the fault code, they should be able to know how to fix the fault codes. When they can identify fault codes, it is easier for them to fix it.* ***Interviewee 13.*** *They should have the practical skill of carrying out and*

detecting faults in auto-electricity/electronics components. They should be able to have practical skills to bring solutions to those electrical components. ***Interviewee 06****. […], skill in how to service ignition systems, replace sensors, and trace faults, especially using OBD.*

Figure 4 illustrates the sub-theme and the corresponding codes that contributed to its emergency providing a full analysis of the relationship between the sub-theme and codes.

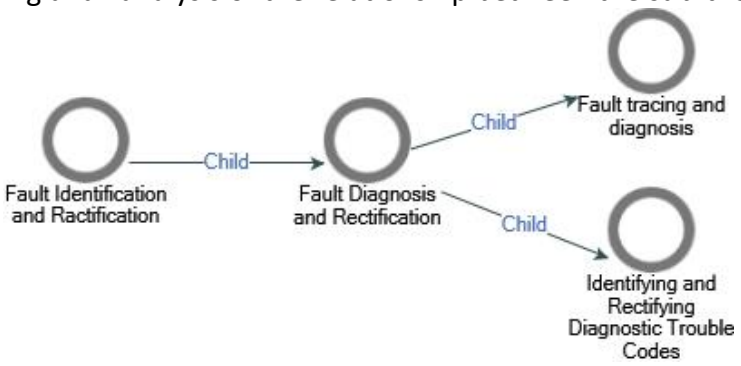

Figure 4 Practical skills in fault identification and rectification

Theme 3 - Electrical Electronic Systems and Components

This theme covers the practical skills that are necessary for maintaining, repairing, and diagnosing problems that occur within the electrical/electronic systems and components of modern vehicles. This main theme encompasses five sub-themes and associated codes that explicitly address RQ, "What practical skills are required in auto-electricity/electronics in the MVM program for maintenance of contemporary automobiles?". Additionally, it presents a detailed understanding of the practical skill areas necessary to handle modern vehicles. These sub-themes encompass auto-electrical/electronic component maintenance; the disassembly and reassembly of components; the ignition and starting system; the lighting and signaling system; as well as wiring, connections, and circuits.

Sub-Theme 1 - Auto-Electrical Electronic Component Maintenance

This sub-theme focuses on the practical skills that are required for the maintenance and repair of essential electronic/electrical components found in contemporary automobiles. It includes two practical skill areas such as the practical skill in battery maintenance and connection and practical skills in maintenance and repair of auto-electrical/electronic components. The analysis has shown that the code maintenance and repair of auto-electrical/electronic components were the most highlighted practical skill areas by the interviewees. It covers the skills in removing, servicing and replacing sensors and repairing and replacing auto-electrical/electronic components.

Interviewee 20. *So, they need to have practical skills in battery maintenance because in most of these vehicles of course the battery is the heart of the vehicle. They need to have practical experience in handling and maintaining the battery, battery charging the connection of the lead cables from the battery to various order electricity/electronic components.* ***Interviewee 01.*** *Before I forget, battery and battery connection and maintenance are very important.* ***Interviewee 11.*** *So, they should be able to know how loose and tight and couple components, mantle and fix faults, and replace whatever is wrong inside of those parts. Then, they should be able to couple the components back. So, by coupling, they will have their understanding and they have the practical aspect of it. […]. They should also have the skills to work on those*

components, identify, service them and replace them. ***Interviewee 10.*** *You must have that skill once the computer has displayed the fault is for you to go directly to the spot and replace that plug or may be the nozzle is a kind of blocked. You will know how to remove the components, service the nozzle as the case may be or replace it. […]. Have the skill on how to remove a faulty component service or replace it.* ***Interviewee 19.*** *To trace fault, they have different sensors controlling different components like the engine and other components. So, practical skills on how to fix them, remove them and fix them back when they are faulty.*

Figure 5 illustrates the sub-theme and practical skill areas that directly address the RQ.

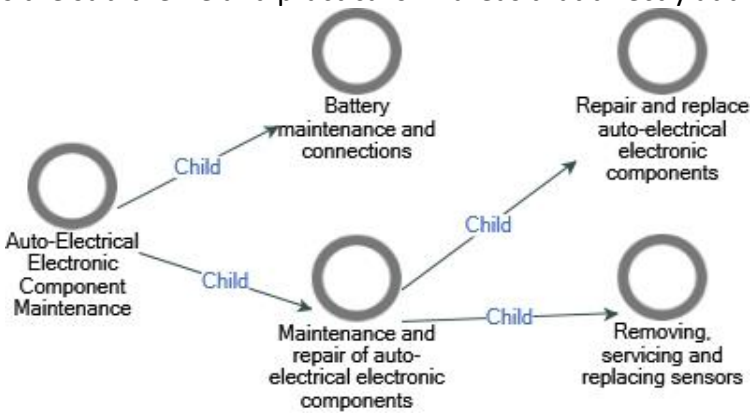

Figure 5 Practical skills in auto-electrical electronic component maintenance

Sub-Theme 2 - Disassemble and Reassemble of Components

This subtheme emphasizes the practical skills that are necessary to remove and reassemble important mechanical and electrical components found in contemporary automobiles. It encompasses several practical skill areas that contributed to its emergence. These practical skill areas include the practical skills in disassembling and reassembling auto-electrical/electronic components; practical skills in dismantling and assembling an engine; and skills in technical drawing. These skills are required to enable MVM students to disassemble electrical/electronic systems and components, access internal engine components, diagnose faults, and reassemble them correctly to ascertain their functionality.

Interviewee 11. *The skills now, they should be able to know how to loose and tight components, if they have the knowledge and they cannot loose, practically they cannot dismantle, disassemble any of these components parts, so they won't be able to know how to fix it. They should be able to have practical skill on how to loose and tight, assemble and disassemble the electricity/electronic components to fix the faults. So, they should be able to know how loose and tight and couple components, mantle and fix faults, replace whatever that is wrong inside of those parts. Then, they should be able to couple the component back. So, by coupling, they will have their own understanding and they have the practical aspect of it.* ***Interviewee 16.*** *So, of course, skills in dismantling and assembling of vehicle parts like the electrical parts of the vehicle. Such as the ignition system, the alternations, batteries and all the electrical components in the vehicles. They should be abreast with both the dismantling and assembling of these parts.* ***Interviewee 12.*** *Yes, it is expected that by the time student finishes from vocation 3, the student he or she should be able to loosen or dismantle an engine and assemble it.* ***Interviewee 13.*** *For the practical skill, they should be able to disassemble engine and assemble. Have the practical skills to overhaul an engine.* ***Interviewee 01.*** *Before you talk of vehicle design, you must think of technical drawing.*

Figure 6 presents the sub-theme and several practical skill areas that contributed to its emergence.

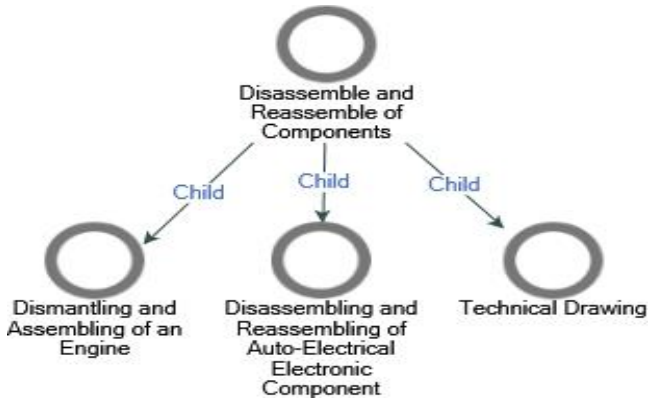

Figure 6 Practical skills in disassemble and reassemble of components

Sub-Theme 3 - Ignition and Starting System

This sub-theme covers the practical skills required to diagnose and repair problems associated with ignition and starting systems, especially in modern automobiles. Following the data analysis, the researcher identified several key practical skill areas that formed codes, significantly contributing to the development of this sub-theme. These codes include the ignition system, which focuses on the practical skill of working on the ignition system; the servicing of the ignition system, which involves the practical skill of servicing and replacing worn-out parts; the starting system, which involves the practical skill of detecting and repairing problems in the starting system of a contemporary automobile; and the fixing of faults in the starting motor, which involves the practical skill of troubleshooting, fixing, and replacing defective starting motors.

Interviewee 06. *Alright, the practical skills, like I always say, ehh like the starting system, ahh ignition system, these are parts of these electrical systems. […]. So, they need skill on starting motor, skill on how to service ignition system, […]. Now the students should be able to fix a faulty starting system like starter motor.* ***Interviewee 10.*** *First and foremost, as an auto-electrical/electronic students you must know how to repair a kick starter. Maybe, a car stopped you on the way, maybe you tried to start it and the car is not coming up. What you do as somebody that you know that has gone dipper or have been imparted with those practical skills you just have to go to the car, check kick, if the kick is still functioning, so that is one of the basic things.*

Figure 7 presents the sub-theme and several key practical skill areas that formed codes.

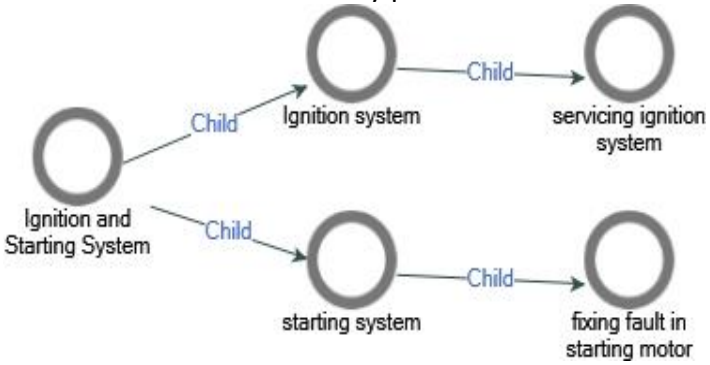

Figure 7 Practical skills in ignition and starting system

Sub-Theme 4 - Lighting and Signaling System

This sub-theme emphasizes the practical skills required for the maintenance and repair of a vehicle's lighting and signaling systems, that are crucial for road safety. Practical skills in this area based on findings include detecting and interpreting signs and signals; and lighting and bulb installation, which covers the practical skill in replacing automobile lighting such as headlights, brake lights, and interior lights. It also encompasses the practical skill of changing and installing light bulbs in various vehicle parts, repairing issues, and ensuring all lights function correctly.

Interviewee 02. *Another one is knowledge of warning lights and signs in the dashboard be skillful in interpreting them because they are very important. […]. I want to tell you the dashboard or odometer in the car is strategically most of the electrical/electronic problems in the vehicle always give sign on the dashboards or instrument board. I think they also need skills in interpreting those warning signs and lights.* ***Interviewee 03. […]*** *and skills on how to clip those bulbs to avoid field playing. […]. It is not just to put a bulb there, no, you have to clip it there and feel it very well to make sure it fits strong and very well. You know where all these bulbs are fitted are surrounded with plastics. By the time the bulb falls off from the plug, they are always very hot, so they can cause burns.* ***Interviewee 10.*** *The skills are many, you have to know how to replace a bulb in a vehicle, especially the headlamp.* ***Interviewee 20.*** *Also, the lighting system and all that with gadgets that we actually need to make these students do the connection of perhaps the rear light, the front light, the brake light and all that.*

Figure 8 presents the sub-theme and several key practical skill areas based on the analysis of data.

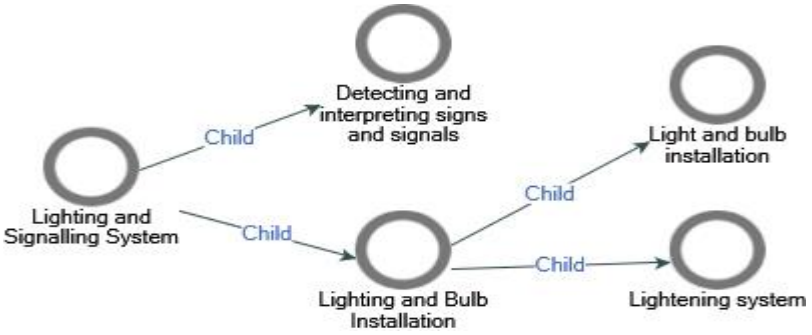

Figure 8 Practical skills in lighting and signaling systems

Sub-Theme 5 - Wiring, Connections and Circuits

This sub-theme highlights the practical skills required for the maintenance and repair of a vehicle's wiring, circuits, and electrical connections that serve as the foundation of its electrical/electronic systems. Derived from the data analysis and participant responses through the semi-structured interview were codes that contributed to the emergence of this sub-theme. These codes include fuse and relay installation and maintenance, which involves the practical skills required for changing the fuses and relays and to mount and dismantle the fuse box; Plugging-in and plugging-out of connectors, encompasses the practical skills necessary for handling electrical connectors correctly, as well as for safely disconnecting and reconnecting diagnostic connectors and electrical systems to prevent malfunctions; Finally, wiring and circuit diagnosis and repair, encompasses the practical skills required to diagnose and repair circuit faults, replace damaged wires, and correct connections. These codes form the key practical skill areas required for contemporary vehicle maintenance.

Interviewee 01. *I have mentioned before fuses, relays and basic vehicle wiring. So, if they have the knowledge, it is okay that they should have the skills too. Especially in changing the fuses and relays, skills in tracing the faults in wires and circuits.* ***Interviewee 03.*** *[…], you know every wire and connection in a vehicle report to the fuse, so they should have skills on how to mount and dismantle fuse box.* ***Interviewee 02.*** *Also, on plugging in and unplugging of the connectors to prevent faulting push the bend pin on the connector and the component.* ***Interviewee 05.*** *I am using OBD as an example. How you can plug to link your vehicle to the machine. That is the skill and knowledge of plug-in and plug-out. Different vehicle and models have their own specific positions and ways of plugging in. At least they should know that skill.* ***Interviewee 03.*** *Practical skills in wiring are also very important when the wire is cut, how to put it together and cello tape it very well. Tracing faults in the wiring system and vehicle wiring skills is very important for every auto-electrician should have skills and knowledge on. […]. Always have skills on how to trace broken wires and replace them appropriately.*

Based on the results of the data analysis, figure 21 illustrates the connections between the sub-theme and the associated practical skill areas that contributed to its emergence.

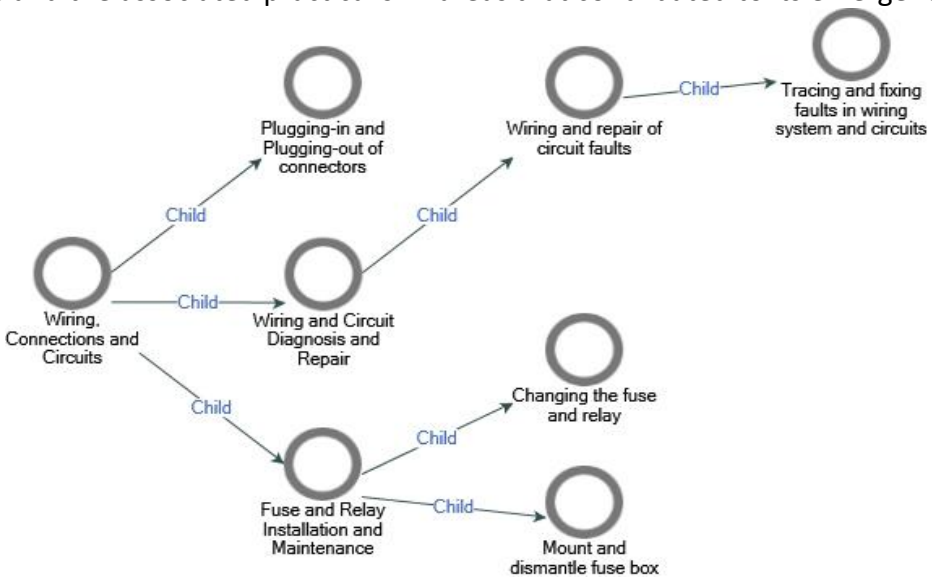

Figure 9 Practical Skills in Wiring, Connections and Circuits

Analysis of Findings

The researcher analysed the data from the semi-structured interview to explore the practical skills in auto-electricity/electronics required in the MVM program to properly maintain contemporary automobiles. Several essential themes were developed that underscore the practical skills needed in the programs. Figure 10 shows the practical skills and their references based on NVivo coding.

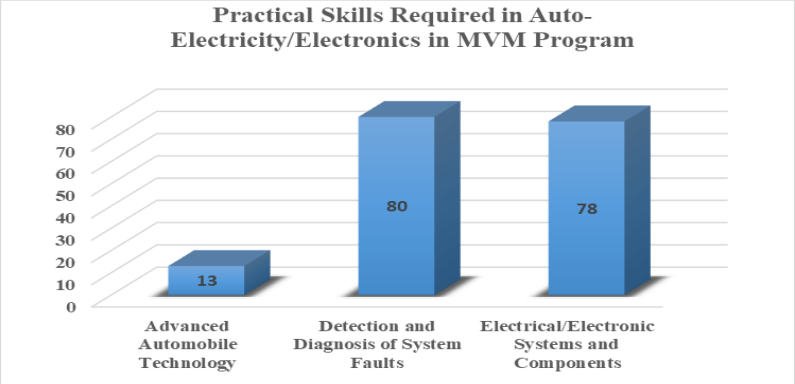

Figure 10 Practical skills required in auto-electricity/electronics in the MVM program for maintenance of contemporary automobiles

Figure 10 shows the significant practical skills required in auto-electricity/electronics, which are practical skills in advanced automobile technology (13), detection and diagnosis of system faults (80), and electrical/electronic systems and components (78). The high number of references for the detection and diagnosis of system faults and electrical/electronic systems and components (80 and 78) suggest that these are the most important practical skills areas required in auto-electricity/electronic in the MVM program to prepare students for effective maintenance of contemporary automobiles. This shows that auto-electricity/electronics in the MVM program should emphasize practical skills in the maintenance and repairs of electrical/electronic systems and components and diagnostic procedures, as well as exposing students to cutting-edge automotive technology.

Discussion

The research findings showed that practical skills in advanced automobile technology are essential in auto-electricity/electronics in the MVM program for the maintenance of contemporary vehicles. The study underlines the growing significance of practical skills in the application of safety, electric vehicle maintenance and repairs, security systems and remote control. This corroborates the study of Idris et al. (2020b), Opeyemi and Chibueze (2022), who argued that auto-electrician/electronics graduates need training in relatively all the skills in auto-electrical/electronic work. Sensor servicing and installation, problem diagnostics, pricing and valuing vehicles, fitting anti-theft security devices, and servicing and repairing electronic control units (ECUs) are all examples of cutting-edge skills in the auto industry. Generally, practical skills in operating and maintaining mechatronic components. This corroborates the findings of Kanife and Victor (2022), Okwelle and Joseph (2022), Oluwatimilehin et al. (2021), who found that students in the automobile trade need training in autotronics so that they can repair and maintain automatic transmissions and power steering systems.

To calibrate sensors, update software, and adapt vehicle functionality to user preferences or environmental circumstances, the study reveals that these systems require practical skills in vehicle programming, configuration and computer skills. This also aligns with Idris and Abutu (2019), Opeyemi and Benjamin (2020), who outlines the practical knowledge and skills needed for MVM students in contemporary automobiles. These include using computer scan tools, familiarity with computer hardware and software, understanding electronic system concepts, operating, identifying, maintaining, programming, and diagnosing semiconductor component failures in ECUs, and expertise in sensor-related jobs

like operation, maintenance, diagnosis, interpretation of data, and selecting suitable testing instruments. Understanding these technologies guarantees that technicians can meet the requirements of contemporary vehicle safety and security features as cars become more automated and linked, bridging the gap between traditional mechanical abilities and modern technological breakthroughs.

Furthermore, the study revealed that practical skills in detecting and diagnosing system faults are critical in maintaining contemporary automobiles. It describes the importance of skills in testing auto-electricity/electronic components, stressing the essential role of utilizing diagnostic tools and devices in accurately identifying and rectifying faults, testing tools and equipment, practical skills in fault diagnosis and rectification, and identification and rectifying diagnostic trouble codes. This finding is in line with the study of Amaechi and Thomas (2020), Illo (2020), Okwelle and Joseph (2022) found that students in the automobile trade need practical training in reading and interpreting diagnostic trouble codes (DTCs) and performing basic engine checks. Additionally, the research findings revealed the importance of practical skills in electrical/electronic systems and components. It focuses on the practical skills of auto-electrical/electronic component maintenance, disassembling and reassembling components, ignition and starting system, lighting and signaling system and wiring, connections and circuits. This finding corroborates the findings of Opeyemi and Chibueze (2022), who found that auto-electrician/electronics graduates need training in almost all the skills in auto-electrical/electronic work.

Conclusion

The study's findings underscore the urgent need for industrial partnership and to align the MVM program's curricula with the realities of modern automotive technology. Practical skills areas such as electrical/electronic systems, diagnostics, wiring, fault detection, and safety protocols are essential for maintaining contemporary vehicles. Additionally, skills in disassembling and reassembling components, using advanced diagnostic tools, and programming are increasingly critical as vehicles become more computerized and reliant on complex electrical systems. By incorporating these elements into technical training in auto-electricity/electronics in MVM programs can better prepare students for the challenges of modern automotive maintenance. This adaptation not only improves the employability of graduates but also meets the demands of a rapidly changing industry. To achieve this, collaboration between educational institutions, industry stakeholders, and policymakers is vital, ensuring that training programs are responsive to emerging trends and technologies. This research contributes to the broader understanding of how MVM program can evolve to empower students with the skills needed for modern vehicle maintenance, ultimately enhancing the competitiveness of the automotive workforce in Nigeria.

Contribution of the Study

This study greatly contributes to the field of TVET, most essentially in the MVM program, both theoretically and contextually. Theoretically, it contributes to the advancement and enrichment of the body of knowledge by identifying the essential practical skills needed in auto-electricity/electronic in MVM program for the maintenance of contemporary automobiles. Furthermore, it aids in understanding the necessary training and skill development required in the program to enhance the employability and performance of MVM students. Also, it provides the foundation for further study and the improvement of the

curriculum. Contextually, the findings of this study provide useful recommendations for bringing up-to-date automobile technology into MVM curricula, particularly the auto-electricity/electronics, funding the acquisition of state-of-the-art diagnostic equipment, and establishing collaborations with relevant automobile industry players to improve practical training. Similarly, the study provides educators and policymakers with practical insights to enhance the quality and relevance of training.

Conflict of Interest

The authors declare there's no conflict of interest.

Author Contribution

The authors contributed equally to the research.

References

Abdulkadir, M., Mustapha, A., Hamidu, Y. M., Alawode, O. D., & Nma, T. N. (2020). Constraints Of Motor Vehicle Mechanic Students in Entrepreneurship Development In Technical Colleges Of Niger State. *Al-Hikmah Journal of Education*, *07*(01). http://repository.futminna.edu.ng:8080/jspui/handle/123456789/14281

Amaechi, E., & Thomas, C. G. (2020). Perceived Relevance of Practical Skills in Content Development of Motor Vehicle Mechanic Works Trade in Technical Colleges in Nigeria for Global Competitiveness _. *GSJ*, *8*(12).

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, *3*(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Braun, V., & Clarke, V. (2021). To saturate or not to saturate? Questioning data saturation as a useful concept for thematic analysis and sample-size rationales. *Qualitative Research in Sport, Exercise and Health*, *13*(2), 201–216. https://doi.org/10.1080/2159676X.2019.1704846

George, W. K., Ikpe, S. A., & Udom, N. A. (2022). Assessment of Technical Education Undergraduate Students' Employability Skills in Colleges of Education in Nigeria. *Universal Scientific Bulletin (USB)*, *5*(1).

Ibeneme, O. T., & Ebubechi, U. M. (2021). Practical Skill Needs of Technical College Graduates of MVMW for Employment in Anambra and Enugu States. *African Journal of Educational Management, Teaching and Entrepreneurship Studies*, *3*(1), 150–157.

Idris, A. M., & Abutu, F. (2019). Technical Skills Requisites of Auto-Mechanics Students in the Maintenance of Modern Vehicles in Nigeria. *Journal of Association of Vocational and Technical Educators of Nigeria (JAVTEN)*, *24*(1), 32–42.

Idris, A. M., Audu, R., Abdulkadir, M., Abutu, F., & Mustapha, A. (2020b). Technical Skills Requirements for Self Reliance in Automobile Occupations in Nigeria. *Journal of Information, Education, Science and Technology (JIEST*, *6*(3).

Illo, S. (2020). Necessary Employability Skills Required Of Automotive Electrical System Technicians in Kebbi and Sokoto States, Nigeria. *World Journal of Innovative Research (WJIR)*, *Volume-9*(5), 107–112.

Kanife, C. E., & Victor, O. A. (2022). Identification of competencies required by auto-electricity/electronics graduates of technical colleges for success in automotive servicing in Nigeria. *Journal of Management and Science*, *12*(1), Article 1. https://doi.org/10.26524/jms.12.19

Kurniawan, R., Jaedun, A., Mutohhari, F., & Kusuma, W. M. (2021). The Absorption of Vocational Education Graduates in The Automotive Sector in The Industrial World. *Journal of Education Technology*, *5*(3), Article 3. https://doi.org/10.23887/jet.v5i3.35365

Legg-Jack, D. W., & Alant, B. P. (2022). Stakeholders' Perceptions on the Use of an ICT-Enabled Onboard Diagnostic System Tool for the Teaching of Motor Vehicle Mechanics at Port Harcourt Technical College, Nigeria. *Journal of Studies in Social Sciences and Humanities*, *8*(1), 84–97.

Lemo, O. O., & Adeyemi, A. B. (2022). Enterpreneurship and Skill Development in Automobile Technical Education in Nigerian University. *Centre for Entrepreneurship Dev. Studies, Gombe State University - Nigeria*, *1*(2), 81–88.

Ogbuanya, T. C., & David, U. A. (2020). Assessment of instructional facilities in implementing the contents of the motor vehicle mechanics' work curriculum in technical colleges in North Central Nigeria. *Jurnal Pendidikan Teknologi Dan Kejuruan*, *26*(2), 95–106. https://doi.org/10.21831/jptk.v26i2.30965

Okolo, N. U. (2023). *Challenges for Effective Utilization of Computerized Diagnostics Equipment by Motor Vehicle Mechanics for Troubleshooting Modern Cars in Fct, Abuja* [Thesis, Federal University of Technology Minna, Niger State]. http://repository.futminna.edu.ng:8080/jspui/handle/123456789/24120

Okwelle, P. C., & Joseph, B. S. A. (2022). Autotronic Skills for Entrepreneurship Development of Automobile Trade Students of Technical Colleges in Rivers State. *International Journal of Modern Innovation and Knowledge*, *2*(4), Article 4.

Olaitan, O. (2024). Determinants of Training Needs, Life Long Education and Learning Among Roadside Motor Vehicle Mechanics Artisans in The Informal Sector in The Maintenance and Repairs of Modern Motor Vehicle For Sustainability. *Advances in Social Sciences and Management*, *2*(2), Article 2.

Oluwatimilehin, A. S., Chimezia, U. K., & Danladi, M. (2021). Integration of Automobile Mechatronics Technology into the Curriculum of Automobile Trades Programmes at the Technical Colleges in Nigeria. *Britain International of Linguistics Arts and Education (BIoLAE) Journal*, *3*(1), Article 1. https://doi.org/10.33258/biolae.v3i1.404

Opeyemi, O. O., & Benjamin, U. O. (2020). Strategies for Enhancing Roadside Motor Vehicle Mechanics on Basic Computer Skills for Effective Manipulation of Automotive Digital Diagnostic Tools in Nsukka Urban of Enugu State. *American Journal of Mechanical and Industrial Engineering*, *5*(6), 71. https://doi.org/10.11648/j.ajmie.20200506.11

Opeyemi, O. O., & Chibueze, O. T. (2022). Assessment of the Work-skills improvement Needs of Graduate of Auto-electricity/electronics in Motor Vehicle Mechanic Work. *Frontiers*, *2*(1), 15–21. https://doi.org/10.11648/j.frontiers.20220201.12

Owo, O., & Deebom, M. T. (2020). Assessment of the Technical Skills Acquired by Students of Technology Education for Employment Generation in Rivers State, Nigeria. *International Journal of Latest Research in Humanities and Social Science*, *3*(2), 35–41.