SKILLS REQUIRED BY ROADSIDE AUTOMOBILE MECHANICS IN THE MAINTENANCE OF ANTI-LOCK BRAKING SYSTEM IN THE FEDERAL CAPITAL TERRITORY, ABUJA

BY

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A RESEARCH PROJECT SUBMITTED TO THE DEPARTMENT OF INDUSTRIAL AND TECHNOLOGY EDUCATION, FEDERAL UNIVERSITY OF TECHNOLOGY MINNA, IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF BACHELOR OF TECHNOLOGY DEGREE (B. TECH) IN INDUSTRIAL AND TECHNOLOGY EDUCATION

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DECLARATION

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CERTIFICATION

This project has been read and approved as meeting the requirement for the award of B. Tech degree in Industrial and Technology Education, School of Science and Technology Education, Federal University of Technology, Minna.

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DEDICATION

This project is dedicated to God for his sufficient Grace, mercy and unlimited love, favour and supply, to my parents for their love, care and support, to the family of Abah and all my loved ones for their relentless support during this program.

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ABSTRACT

The study determined the Skills Required by Roadside Automobile Mechanics in the Maintenance of Anti-lock Braking System in the Federal Capital Territory, Abuja. The study possesses three specific objectives to guide the study which are to identify the skills required by roadside automobile technician for servicing anti-lock braking system, identify the skills required by roadside automobile technician for repairing anti-lock braking system and identify the safety measures required by roadside automobile technician when maintaining anti-lock braking system. Three (3) corresponding research questions and null hypotheses were raised. The research design is a descriptive survey, the population of the study comprises of sixty three (63) automobile supervisor and thirty seven (37) automobile teachers. There was no sampling techniques for the study. The data was analyzed by computing the mean and t-test statistics. Mean was used to answer the research questions while Independent t-test was used to test the hypotheses at 0.05 level of significance. The findings of the study revealed identifying the needed tools for servicing of Anti-lock braking system, removing the wheels in order to clean the brakes and manually clean the brakes on the car and replacing the brake fluid as The study concluded that the need for high premium skills are required to be placed on the training and re-training of automobile supervisor and automobile teachers in order to fast track getting them well-groomed and acquainted with principles and methods of imparting the knowledge and skills to automobile students and satisfying the customers needs in terms of servicing, repairing and safety measures. The study recommended that automobile instructors should possess the required skills in identifyingtheneededtoolsforservicingof Anti-lock braking system and automobile instructors should possess the required skills in identifyingtheneededtoolsforrepairingof Anti-lock braking system.

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CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the Study

Technical colleges are post-basic education schools, where students acquire skills in various occupations. According to the National Board of Technical Education (NBTE, 2014), the aim of technical colleges is to give training and impart the necessary skills leading to the production of craftsmen, technicians and other skilled personnel who will be enterprising and self-reliant. Usman (2016) stated that standard of equipment useful in modern mechanical workshops of technical colleges for sustainable national development include oscilloscope multimeter, on-board diagnostic scan tool among others. Olaitan and Ikeh (2015) stated that modern machines expected in the technical college should meet with international standards to enhance competency, expertness and efficiency in term of acquiring practical knowledge needful and requires in place of work. Kama (2018) stated that the major goals of technical colleges are to produce efficient and relevant craftsmen that will promote industrial development in the areas of maintenance, production of goods and general services. According to the Beako (2018) technical colleges offer various trades which include Bricklaying, Block-laying and concreting, carpentry and joinery, metal fabrication and welding, woodwork trade, electrical installation and automobile technology.

Technical collegesaresecondary institutionswhereindividualsaretrainedtoacquireskills knowledgeandattitudesrequiredforeitherselfor paidemployment.Technicalcollegesoffer varietiesof technicalandvocationaltradestoinclude Motor Vehicle Mechanic Work(MVMW). Olayinka(2013), explained that MVMW is designed to produce competent automobile craftsmen for Nigeria technologicalandindustrialdevelopment.Theaimof motor vehicle mechanicworkaccording toNationalBoardforTechnicalEducation(NBTE)(2014)istogive trainingandimpartthenecessary skillsleadingtotheproductionofcraftsmen,technicians,

technologist and engineerswhowillbeenterprisingandself-reliant.ThegraduatesofMVMWare called automobile craftsmen and are expected to acquire necessary skills to test, diagnose, service and completely repairanyfaultonthemotorvehicletothemanufacturers'specification.

The automobile industry is considered one of the most important for a country's economy and trade because it shapes the industry, the cities, communal and individual life (Thomas, 2013). The automobile industry incorporate most of the skilled personnel who are the artisan, craftsmen, technicians, technologist and engineers. The artisans are those skilled personnel who passes through informal education i.e apprenticeship, these personnel make use of their hands to create unique, functional and/or decorative items using traditional techniques. The technicians are those skilled personnel that acquire their skills through formal education and understand basic knowledge of technology. A technologist is an individual who completely understands automobile technology and how it can be applied effectively (Thomas, 2013).

According to Wilcon (2013) digitization will drive more innovation in the automobile industry in the next 20 years than there has been in the past 100 years. The digital transformation of the automobile industry is in effect, the innovative reassembly of customer and company resources, and of products and services, in order to grow value, revenue and efficiency via digital technologies. A similar story could be told with respect to the spread of digital technology for monitoring every aspect of engine performance. The pace of technological improvements, influenced by regulatory pressure, continues to grow. Technology to reduce the environmental footprint of motor vehicles will be even more vital in the future (Okwelle, 2019). Fadairo (2015), stated that the components of automobile technology are arranged in modules for easy assimilation by learners. These components include engine maintenance ,suspension ,auto electricity

andtransmissionreconditioningwork,majorengine repairworks,servicestation mechanic, steeringand brakingsystem.

A brake is a mechanical device which inhibits motion, slowing or stopping a moving object or preventing its motion. A vehicle brake therefore is a device used to slow down a vehicle by converting its kinetic energy into heat energy. Various types of vehicle brakes include disc brakes, drum brakes, emergency brakes, air brakes, vacuum brake and anti-lock braking system is the most recent one found in modern vehicles. Heibing, (2015) defined anti-lock braking system (ABS) as an automobile safety system that allows the wheels on a motor vehicle to maintain tractive contact with the road surface according to driver inputs while braking, preventing the wheels from locking up (ceasing rotation) and avoiding uncontrolled skidding. Reynold, (2014) stated that ABS is an automated system that uses the principles of threshold braking and cadence braking which were practiced by skillful drivers with previous generation braking systems. Anti-lock braking system does this at a much faster rate and with better control than a driver could manage.

Typically ABS includes a central electronic control unit (ECU), four wheel speed sensors, and at least two hydraulic valves within the brake hydraulics (Gerald, 2014). The ECU constantly monitors the rotational speed of each wheel; if it detects a wheel rotating significantly slower than the others, a condition indicative of impending wheel lock, it actuates the valves to reduce hydraulic pressure to the brake at the affected wheel, thus reducing the braking force on that wheel; the wheel then turns faster. Kicy (2013) explained that anti-lock braking systems use different schemes depending on the type of brakes in use. They can be differentiated by the number of channels: that is, how many valves that are individually controlled and the number of speed sensors. The schemes according to Heibing (2015) include four-channel, four-sensor ABS; three-channel, four-sensor ABS; three-channel, three-sensor ABS; two-channel, four sensor ABS and one-channel, one-sensor ABS. Anti-lock

braking system in cars and most multi-purpose vehicles (MPV's) and pick-up trucks works on all four wheels. This promotes directional stability and allows steering while maximizing braking. ABS uses wheel speed sensors to determine if one or more wheels are trying to lock up during braking (Omkar, 2014). If a wheel tries to lock up, a series of hydraulic valves limit or reduce the braking on that wheel. This prevents skidding and allows driver to maintain steering control.

There are four main components of ABS: speed sensors, valves, a pump, and a controller (Sam, 2013). A speed sensor is used to determine the acceleration or deceleration of the wheel. These sensors use a magnet and a coil of wire to generate a signal. There is a valve also in the brake line of each brake controlled by the ABS. On some systems, the valve has three positions: In position one, the valve is open; pressure from the master cylinder is passed right through to the brake. In position two, the valve blocks the line, isolating that brake from the master cylinder.

This prevents the pressure from rising further should the driver push the brake pedal harder. In position three, the valve releases some of the pressure from the brake. Club (2013) explained that the majority of problems with the valve system occur due to clogged valves. The pump in the ABS according to Geek (2013) is used to restore the pressure to the hydraulic brakes after the valves have released it. The controller is an ECU type unit in the car which receives information from each individual wheel speed sensor, in turn if a wheel loses traction the signal is sent to the controller, the controller will then limit the brake force (EBD) and activate the ABS modulator which actuates the braking valves on and off. Computer-controlled anti-lock braking system (ABS) is an important safety feature which is equipped on most new vehicles (Sam, 2018). When brakes are applied suddenly, ABS prevents the wheels from locking up and the tires from skidding. The system monitors the speed of each wheel and automatically pulses the brake pressure on and off rapidly on any wheels where skidding

is detected (Club, 2013). This is beneficial for driving on wet and slippery roads. ABS works with the service brakes to decrease stopping distance and increase control and stability of the vehicle during hard braking but still create some maintenance problems for the owners of cars in Abuja where modern cars are mostly used (Reynold, 2014). The ABS is a complex and sophisticated unit of motor vehicle and this makes it so difficult for road side mechanic to maintain. The modern car owners hardly locate efficient automobile craftsmen who can service and repair mal-functional ABS. The qualified automobile maintenance industries who can handle anti-lock braking systems are few in number compare to number of vehicles in Abuja. The maintenance of ABS in these maintenance industries is very expensive and most of the car owners could not afford it. The road side automobile technologists who claim to be skilled in ABS maintenance mostly cause more damage to ABS in modern cars contracted to them. In order to provide solution to these problems and to expand the chance of employment of the graduates of automobile technology, therefore there is need to investigate the skill acquisition needs for roadside automobile technicians in the maintenance of anti-lock braking system in Abuja in Federal Capital Territory (FCT) Abuja.

1.2 Statement of the Problem

Based on the sizeable vehicular population in Abuja, it is evident that the maintenance of modern automobiles is still lacking thereby increasing the prospects of automobile technologists for effective practice of automobile trade and a successful auto-mechanic career. This situation could be attributed to the deficiency of automobile curriculum and module specification as well as insufficient training on modern automobile technology skills which has equally restricted automobile graduates of technology schools in skillfulness, efficiency, proficiency and productivity.

However, Okolocha and Baba (2016) observed that automobile technology graduates lack requisite skills to used modern equipment and operate modern machines to optimal practical

performance and maintenance work to the expectations and satisfaction of their employers. Beako (2018) attributed the trend to the few available sub-standard and outdated equipment, tools and machines used in training which are not performing the requisite tasks optimally in automobile technology in a dilapidated workshops in technical college in some State, hence demand scaling up in automobile technology.

Oneof themostimportantreasons whysuddenbraking causesthecar'simbalanceand accidentsisthatthe wheelslosetheirmaneuverability bylocking.ABShasbeen developedtopreventthebrakesfrom beinglocked, (Hassan, 2017). When brakes are applied suddenly, ABS prevents the wheels from locking up and the tires from skidding. The system monitors the speed of each wheel and automatically pulses the brake pressure on and off rapidly on any wheels where skidding is detected (Club, 2013). ABS still create some maintenance problems for the owners of cars in Abuja where modern cars are mostly used (Reynold, 2014). The ABS is a complex and sophisticated unit of motor vehicle and this makes it so difficult for road side mechanic to maintain. The modern car owners hardly locate efficient automobile craftsmen who can service and repair mal-functional ABS. The qualified automobile maintenance industries who can handle anti-lock braking systems are few in number compare to number of vehicles in Abuja. However, most roadside automobile technician lack the skills to work not only with special tools and diagnostic equipment, but also with sophisticated electronics and computer systems (Funk, 2013). Therefore, the study is undertaken to find out the Skills Required by Roadside Automobile Mechanics in the Maintenance of Anti-lock Braking System in the Federal Capital Territory, Abuja.

1.3 Purpose of the Study

The purpose of the study is to determine the Skills Required by Roadside Automobile Mechanics in the Maintenance of Anti-lock Braking System in the Federal Capital Territory, Abuja. Specifically the study sought to achieve the following:

1. Identify the skills required by roadside automobile technician for servicing anti-lock braking system
2. Identify the skills required by roadside automobile technician for repairing anti-lock braking system.
3. Identify the safety measures required by roadside automobile technician when maintaining anti-lock braking system.

1.4 Significance of the Study

The findings of this study would be of immense benefit to roadside automobile technicians, students of automobile technology and graduate of automobile technology, Automobile lecturers, National Board for Technical Education, Automobile companies, Government and educational researchers.

Roadside automobile technicians who are products of the informal automobile sector or apprenticeship programme will benefit from the findings of this study by becoming more enlightened on the automobile technologies and strive towards updating their knowledge and skills in line with the required technology skills. This will enable them to keep pace with technological improvements for performing optimally and remain relevant in the modern automobile industry.

The automobile technology skills identified in this study when integrated into the curriculum could help the technical college students of automobile technology to acquire new set of skills required for servicing and maintenance of modern vehicles. Students will also be exposed to new body of knowledge/content on modern cars so as to enhance their understanding of their working principles and how to handle complex fault in anti-lock braking system.

The acquisition of anti-lock braking system technology skills identified in this study will enable automobile technology graduates to become self-reliant, self-employed and employers

of labour. The findings of the study will also enable automobile graduates to acquire new competencies for servicing and repair of modern vehicles in order to remain relevant in the automobile industry.

Automobile lecturers will benefit from the findings of this study by identifying areas of automobile technology where students are deficient and on which they may need to update their technical competence for the production of enterprising graduates who will be productive in paid or self-employment. Lecturers through the findings of this study will also identify out-dated technologies in curriculum content that should be given less emphasis while the emerging technologies will be given adequate recognition in the training of automobile technology students. Automobile lecturers will equally use the findings of the study to master these new technology skills as a means of enhancement towards productivity and adaptability. Hence, updating their skills will remain paramount with constant advancement in frequent changes in automobile technology. This will be attainable when automobile lecturers attend planned retraining and improvement programmes that takes practical and new skills in automobile technology into cognizance.

The National Board for Technical Education which is solely responsible for planning and reviewing the technical college curriculum will through the findings of this study will become aware of anti-lock braking skills required by automobile graduates in the maintenance of modern vehicles. National Board for Technical Education could use these identified skills to update the pedagogy and components of the curriculum for Automobile technology in tertiary institutions technical colleges. This could make the curriculum more activity centered thereby stimulating the interest and motivation of students towards the automobile trade.

Automobile companies will equally find the result of this study very beneficial when incorporated into the curriculum content of automobile technology in technical colleges and

tertiary institutions as it will produce a pool of highly skilled automobile graduates, craftsmen, technician, technologist and engineers who will be versatile and adaptable to the dynamic nature of modern vehicles, thereby enhancing the performance and productivity of the automobile industry towards the sustenance of Nigeria's economic and industrial growth.

The findings of this study will sensitize the government on the performance gap between technical skills acquired by roadside automobile technicians and graduates in technical colleges and the requirements of modern automobile industries. Hence, the government will be encouraged to organize retraining programmes and skill improvement workshops for instructors of automobile technology whose responsibility it is to impart technical skills on students for gainful employment upon graduation.

1.5 Scope of the Study

The study will be conducted among automobile companies and roadside automobile technicians in federal capital territory Abuja, Nigeria. The study will utilize six (6) municipal councils where automobile companies and roadside automobile technicians operate in the federal capital territory namely: Abaji municipal council, Abuja municipal council, Bwari municipal council, Garki municipal council, Gwagwalada municipal council and Kuje municipal council respectively in the federal capital territory (FCT) Abuja. On the time scope, the study will be carried out in four (4) weeks. The study will specifically focuses on Antilock braking system in automobile cars.

1.6 Research Questions

The following research questions was raise to guide the study:

1. What are the skills required by roadside automobile technician for servicing anti-lock braking system?

2. What are the skills required by roadside automobile technician for repairing anti-lock braking system?
3. What are the safety measures required by roadside automobile technician when maintaining anti-lock braking system?

1.7 Research Hypotheses

The following null hypotheses were tested at 0.05 level of significance:

H_{01}: There is no significant difference in the mean responses of automobile supervisor and automobile teachers on the skills required by roadside automobile technician for servicing anti-lock braking system

H_{02}: There is no significant difference in the mean responses of automobile supervisor and automobile teachers on the skills required by automobile technician for repairing anti-lock braking system

H03: There is no significant difference in the mean responses of automobile supervisor and automobile teachers on the safety measures required by automobile technicians for servicing anti-lock braking system**.**

CHAPTER TWO

2.0 LITERATURE REVIEW

The following sub-headings are explained under this chapter which extensively examines literature that are associated and significant to the subject of this study, which are as follows;

2.1 Theoretical Framework

2.2 Technical and Vocational Education and training (TVET) programme in Nigeria

2.3 Apprenticeship system of skills acquisition among Nigeria Automobile mechanics

2.4 Skills and Relevance of Automobile Mechanics Skills to Trainees in Nigeria

2.5 Anti-Lock Braking System

2.6 Automobile Skills Needed in Servicing Anti-lock Braking System (ABS)

2.7 Automobile Maintenance skills needed for repairing Anti-lock Braking System (ABS)

2.8 Safety measures required by automobile mechanics for the maintenance of Anti-lock Braking System (ABS)

2.9 Related Empirical Studies

2.10 Summary of Related Literature

2.1 Theoretical Framework

Theories are postulates requiring further explanations in order to make meaning. According to Jamabo &Kinanee (2014), theories can be described as a set of concepts, principles, propositions and generalizations that are logically interconnected which present a systematic view of phenomena that enable the user to describe, explain, predict or advance knowledge. Theories are thus the foundation of any research (Olaitan, 2015). In other words, theories are principles on which a subject of study is based. When a theory is applied in teaching and learning, it provides the principles, which directly governs it (Nwachukwu, 2011). Continuing, Nwachukwu stated that for a theory to be useful, it should play two important roles such as:

- It should serve as a process of systematizing information in an area of knowledge thereby leading to the discovery of unknown facts
- It should summarize information in such a manner that is easily used to explain a given concept.

Therefore, the theoretical foundations upon which this study is based are Dreyfus model of skill acquisition and Dynamic skill theory

2.1.1 Dreyfus Model of Skill Acquisition

Stuart and Hubert Dreyfus (1980) propounded the "Dreyfus model of skill acquisition" which states that formal system of education is a gradual process that involves being embodied in different ways and developing skills that would make it possible for people to deal with the world. The main idea behind the Dreyfus's model of skill acquisition is the distinction they make between "knowing that" and "knowing how". The two concepts are considered as one concept, which is acquired through a formal system of education. According to Stuart and Hubert Dreyfus (1980), learners acquire skills through instruction and experiences, they do not appear to leap suddenly from rule-guided "knowing that" to experienced based knowing-how. The Dreyfus model of skill acquisition is a model of how students acquire skills through formal instruction and practicing. They believe that there is a gradual process involved for a learner to go through in order to reach the stage of expertise or knowing-how.

The original model proposes that a student passes through five distinct stages: novice, competence, proficiency, expertise, and mastery. However, these stages of skillacquisition relates to this study in the following ways:

Novice Stage: At this first stage, a person follows rules as given, without context, with no sense of responsibility beyond following the rules exactly. In the process of learning the rules, students upon graduation are already exposed to the basic knowledge and principles of skill

acquisition in order to prepare him for technology required skills for the maintenance of modern vehicles.

Advanced Beginner: The learner at this stage recognizes new situations in which the rules may be applied. Student's performance improves to a relatively acceptable level only after the novice has had enough experience in copying the real situation, the students start to show unique performance through personal experience.

Competency Stage: Competence develops when the individual develops organizing principles to quickly access the particular rules that are relevant to the specific task at hand; hence, competence is characterized by active decision making in choosing a course of action. Student's at this stage begins to get involved personally with the task. They start seeing more than one option from which they have to choose the best one for optimal performance.

Proficiency Stage: Proficiency is shown by individuals who develop intuition to guide their decisions and devise their own rules to formulate plans. The progression is thus from rigid adherence to rules to an intuitive mode of reasoning based on tacit knowledge. This is the stage where the student while intuitively understanding his task, still thinks analytically about his actions. The student must have acquired basic skills that will enable him think creatively towards becoming self-employed after graduation. Hence, analyzing ways of raising capital, location of business and other business strategies becomes his priority.

Mastery Stage: Experts in general know what to do base on mature understanding of the task. An expert has had so much experience with the task that the skill of carrying out the task is part of him. He acts upon correct intuitions without analytically thinking about his every move. They also emphasize on the fact that practice is required for the agent to maintain the knowing-how. Without practice, the agent will gradually lose his expertise and s most likely to regress as far as the competence stage. This is the level to which the ability to create jobs which will in turn make an automobile graduate self-employed becomes necessary.

2.1.2 Dynamic Skill Theory

Kurt Fisher (1980) propounded the theory "the dynamic skill theory", which states that skill within domains may promote or suppress other skills as they first develop resulting in spurts of growth in one skill concurrently with regression in another. The dynamic skill theory is related to the present study in that when it is applied to skills in automobile emerging technology. As such, it will enhance skill development and improvement in the utilization of new technologies (diagnostic/scan tools and equipment).

2.2 Technical and Vocational Education and training (TVET) Programme in Nigeria

Technical Vocational Education and Training (TVET) is widely recognized as the most effective means of empowering the citizenry to stimulate sustainable national development, enhance employment, improve the quality of life, reduce poverty, limit the incidence of social vices due to joblessness and promote a culture of peace, freedom and democracy. UNESCO (2015) identified the two main objectives of TVET as; the need to train the workforce for self-employment as well as to raise the productivity of the informal sector of the economy. According to Olaitan (2012) vocational education, an aspect of TVET is a designed field of study for the development of work skill attitudes, appreciations, and creativity in the individuals as well as the creation of awareness of occupational entry and progression demands. Emphasis in vocational training is on skill acquisition.

Technical and Vocational Education and training (TVET) Programme in Nigeria evolved in response to technological and industrial needs of the people. Technical and vocational education is a type of training that borders on the acquisition of knowledge and skills in occupational trades such as woodwork, metalwork, electrical/electronics, welding and fabrication, building, auto-mechanics, etc, including workshop organization and management. According to Miller (2011), there are five technical institutions in Nigeria outside the universities namely- pre-vocational and vocational schools at post primary level (Technical

Colleges), Polytechnics and Colleges of Education (Technical) at the post-secondary level established to provide a base for technological take off in the country.

Technical Colleges have continued to train graduates for the acquisition of requisite skills or competence or mastery of skills in various occupational trades. The Federal Government of Nigeria (2010) reported that technical and vocational education is that form of education which is obtainable at the technical colleges and tertiary institutions. Aikema (2012) also stated that now in Nigeria, the need for the development of vocational education that takes place in technical colleges, tertiary institutions and skill acquisition centres has become imperative, taking cognizance of their relevance to the socio- economic manpower development of the nation. Tertiary institutions is a post senior secondary school (SSS) institution designed to provide individuals with vocational-technical instruction and skills in a particular trade or occupation. It is equivalent to Advanced senior secondary education but designed to prepare individuals to acquire practical skills, basic scientific knowledge and attitudes required as craftsmen and technicians at sub-professional level. According to Federal Government of Nigeria, (2010), Technical Colleges are saddled with the task of providing, imparting or teaching practical skills, attitudes, understanding and knowledge relating to occupations in various sectors of economy and social life. As such, it should provide training on the acquisition of relevant and needed skills to meet the demand of modern commerce, technologies, related sciences and industries. In the opinion of Adegbile (2013), Technical Colleges are institutions where scientific knowledge and practical skills required for specific trade; employment or professionals, craftsmen, technician, technologist, scientist or similar levels of manpower are imparted or taught. The Federal Government of Nigeria (FGN) in her National Policy on Education (FRN, 2010) stated that the curricula activity for Technical Colleges is structured in foundation and trade modules, with the trade modules consisting of five components. These five components or elements include:

1. General Education
2. Theory and Related Courses
3. Workshop Practice
4. Industrial Training/Production Work
5. Small Business Management
6. Entrepreneurial Training

General Education

The general education programme is designed to create an environment which makes provision for trainee (student) development of knowledge, manipulative skills, attitude and values to realistic work settings, including the responsibility of maintaining strong ties with a variety of agriculture, business and industry-related areas.

Theory and Related Courses

This component is centred on the knowledge about any aspect of the occupation student/trainee will enter into and the performance expected in the occupation.

Workshop Practice

This aspect of the curriculum is focused on practical training of participants or students to the required levels of competencies.

Industrial Training/Production Work

This will enable Technical College graduates to be well equipped to perform inter-related functions in and outside the industry effectively in various trades or occupation setting.

Small Business Management and Entrepreneurial Training

This programme is designed to equip graduates with skills for wealth creation, employment generation, self- sufficiency etc. The craft level is one of the trade modules (FGN, 2010). Continuing, FGN (2010) stated that for effective participation of students in practical work, the teacher-student ratio shall be kept at 1:20. Trainees completing tertiary institution programmes shall have three options. These include:

1. Secure employment either at the end of the whole trade modules, (that is craft level trade module, advanced trade module and technical level trade module) or after completing one or more trade modules of employable skill
2. Set-up self- owned business or become self-employed and then be able to employ others
3. Pursue further education in advanced and technical levels for higher skill acquisition capabilities in chosen trade. The range of courses in the technical colleges according to FGN (2010) shall be as wide as possible and include but not limited to: Mechanical Trades; Computer Craft Practice; Electrical Engineering Trades; Building Trades; Wood Trades; Hospitality; Textile Trades; Printing Trades; Beauty Culture Trades; Business Trades and others.

2.3 Apprenticeship System of Skills Acquisition Among Nigeria Automobile Mechanics

Non-formal education has been with man as old as his existence in this world and has said to be a concrete means of educating youth through apprenticeship by passing it from one generation to the younger generation, (do Amaral, 2019). Modernization has however influenced some positive innovations in non-formal education sector where by apprenticeship programs are provided in many fields of occupations that include tailoring, hair dressing and iron bending, carpentry, brick laying, auto-mechanics, auto-body repairing, air conditioner maintenance, tyrevulcanising, electrical installation, furniture making, welding/ fabrication, sheet metal work, machining (turning), fitting and foundry work, amongst others.

The non-formal education in Northern Nigeria is a popular program whose important component involves a contract agreement entered into between the master craftsman and the apprentice. Such contractual agreement incorporates the fee payable by the apprentice, the

period of training and also spells out the penalty to be meted out when either party breaks the contract, (Matenda, 2017).

The organisational set-up for the auto mechanics training workshop is normally made up of the master craftsman (trainer), who owns the facility exercises full control, owns the tools for the exercise and possesses the skills to provide the needed training to the apprentice, who happens to be the learner, (Ziblim *et al.*, 2018). Furthermore, Hyland, (2014), in his contributions, asserted that the system is planned such that it provides a wide ranging trainings and technical competencies suitable to satisfy the needs of the society and the economy, and, through articulated measures, enhance the economic well-being of the nation. However, (Ziblim*et al.*, 2018), observed that the often illiterate or semi-illiterate master models, develop training programs that are predominantly practical and lacking in basic theoretical concepts. They further posited that, despite the fact that road side mechanics function successfully in the labour market, they remain in the final analysis, in the lower cadre of manpower personnel and their practical expertise gradually taken over by modern mechanical manipulation. Be it as it may, however, the fact remains that the roadside auto mechanics apprentice program is a major contributor, in its own way, to the Nigerian economy. It has continued to create training and employment opportunities for many Nigerians who would have become social miscreants to the public and is indisputably, an indispensable part and parcel of the formal education with a lot of demands coming its way. In view of the enormous contributions of the roadside apprenticeship to the national economy and its attendant challenges, therefore, leaving the master craftsman to absolutely determine the training situation of the system is amounting to placing too much responsibility on that person.

Having acknowledged the contributions of road side apprenticeship, and with the view to enhancing its operations, the Federal Government of Nigeria introduces a policy for the

accreditation of the program and it states that “the question of accreditation for roadside mechanics and others who complete training programs through non-formal education will be undertaken by the National Board for Technical Education (NBTE)”, (World Bank, 2015). Unfortunately, however, more than three decades after the promulgation of this policy, not a single roadside mechanic has been accredited, and there is no concrete evidence of the intention to implementing the policy.

2.4 Skills and Relevance of Automobile Mechanics Skills to Trainees in Nigeria

Skill acquisition can be defined as the form of training by individuals or group of individuals that can lead to acquisition of knowledge for self-sustenance; it involves the training of people in different fields of trade under a legal agreement between the trainers and the trainees for certain duration and under certain conditions (Idoko, 2014). Skills acquisition has been described by scholars as the recipe for eradicating extreme poverty and hunger by creating avenues for employment, thereby introducing an avenue for jobs and wealth creation while instilling self-sufficiency and reliance (Isaac, 2011).

Motor Vehicle Mechanic (MVM) trade is one of the vocational training skill programmes operated basically through the informal setting with apprenticeship mode of instruction. It is designed to produce competent motor vehicle artisans for the technological and industrial development of the society. In Nigeria, Motor Vehicle Mechanic Works trade as a vocational training programme is offered in Technical Colleges, companies and designated skills acquisition centers of Motor Vehicle Workshops across the Nigeria. It is expected that those who acquired MVM skills will be gainfully employed or self-employed after their training.

A workshop, according to Jubril (2011) is a place, area, room or building where machines, equipment, hand tools, workbenches and materials are used in manufacturing or repairing of things. Hence, Motor Vehicle Mechanic workshop is a designated place, room or hall where

workbenches, mechanical toolbox, other basic vehicle maintenance and repair equipment are used for vehicle maintenance by motor vehicle mechanic. With proper ventilation and layout plan in place, include modern machines and tools available for work. A Motor Vehicle Mechanic is a skilled personal, trained in auto mechanics which include: Auto body repair and spraying painting, auto electrical work, auto body mechanic work, auto body building (panel beating) and auto parts merchandise (Penn,2011). According to Hiller & Coombes (2014) Motor Vehicle Mechanic is skilled personnel who specialized in motor vehicle maintenance, repairs and sometimes modification of motor vehicles. Motor Vehicle Mechanic Apprentice is a trainee who acquired technical skills through the informal setting at a designated motor vehicle mechanic workshop within a specify time duration.

Motor Vehicle is a self-propelled land vehicle usually having four wheels and an internal combustion engine, used for personal and public transportation. It is of assorted brand with respect to its styles, number of doors and purpose of uses (Abwage, 2010). Motor Vehicle consists of different systems available for efficient functioning of an engine which includes fuel supply system, lubrication system, ignition system, cooling system and governor. Understanding of the principle of operations of the various motor vehicle systems by a skilled apprentice is vital to efficient and effective repairs and maintenance of motor vehicles.

According to Cranmer (2014) skills is an ability and capacity acquired through deliberate, systematic and sustained effort to smoothly and adaptively carryout complex activities or job functions involving ideas (cognitive skill) things (technical skills) and/or people (interpersonal skills). Medina (2011) stated that technical skills are hard skills associated with the use of tools, equipment related to work properly and efficiently, as well as all technical matters. In the view of Abinu (cited in Agada, 2014) technical skills are the knowledge and skills specific to a particular occupation or group of occupations. In this study, mechanical technical skills refer to the ability to repair, service and maintain engine components expertly

and well in accordance to set standard or manufacturer instructions. Giri (2015) stated that mechanical technical skills expected in maintaining and servicing of carburetor include: cleaning and fixing to ensure float chamber allows fuel through the jet into an enlarged carburetor passages, replace the defective pump, clean properly the fuel lines and connecting unit and a new gasket should be used while installing the pump at its place. Udogu (2015) stated that the mechanical technical skills that are needed in maintaining and servicing modern motor vehicle ignition system includes, perform magnetic sensor testing, use plug wire or adapter to check for spark, test run the ignition system using the multimeter, check the crank sensor using diagnostic tool, check the battery to make sure there is ample voltage to start the engine, test and diagnose defective regulator sensor. Furthermore, Abwage (2011) stated that the fuel supply system of spark ignition engine consists of fuel tank, fuel lift pump, fuel pipes, sediment bowl and carburetor. further stated that the functions of the carburetor include: to mix the air and fuel thoroughly, atomize the fuel, regulate the air-fuel ratio at different speeds and loads on the engine and supply correct amount of mixture at different speeds and loads. These roles are paramount in the operations of an engine as from the carburetor the fuel goes to the engine cylinder through inlet manifold of the engine.

The National Business and Technical Examinations Board (2007) stated that motor vehicle mechanic needed technical mechanical skills in maintaining, balancing and alignment of wheels and tyres in order to set up a befitting standard motor vehicle mechanic enterprise. These set of skills are required by Motor Vehicle Mechanic artisans for the maintenances and services of modern motor vehicles.

Maintenance is described as an action taken on anything to keep it working or to restore it to a good working condition. This ensures that a piece of equipment or item remains functional and serves us better (Abwage, 2010). Maintenance is a repair activity carried out on equipment, vehicles or other machineries to keep them unaltered, and if altered, to restore

them to their original state. For effective maintenance on motor vehicle, expert opinion of mechanical technical skills obtained through organized vocational skill at the Mechanical Workshops and other skill acquisition centers that will improve entrepreneurship in the economy is essential and demanding.

2.5 Anti-Lock Braking System

ABS (Anti-lock Braking System) is a braking system that ensures full control of the steering wheel by preventing the vehicle from locking the wheels in sudden braking situations in all road conditions and at all speeds. ABS system is developed to prevent the locking of the wheels on motor land vehicles. In the case of ABS braking, the change in the number of revolutions of each wheel is controlled by an electronic control unit which is called Brake Control Module (BCM). While driving, it may need to urgently press the brake pedal because of the various obstacles that appear in front of the car. In such cases, both the clutch and the brake or only brake pedal must be pressed at the same time very strongly in order to stop the car. Otherwise, the car might hit the object, or it could lead to an accident that will cause a huge damage (Toyota, 2013).

When the brake pedal is suddenly pressed, the wheels of vehicles that do not have an ABS system lose their connection with the steering wheel and are locked. Therefore, in this case the wheels cannot sense the commands from the steering wheel. These locked wheels reduce the vehicle's maneuverability to zero. However, vehicles with an ABS system do not lock the wheels in sudden braking situations. The driver can easily get rid of the car in a simple maneuver by turning the steering wheel light slightly while the car is skidding (Toyota, 2013).

ABS is a system that does not lose the connection of the wheels with the steering wheel when the brake pedal is pressed. It stops the wheels by sending a command to the wheels with very

short intervals, and after a very short time it sends the command again to deactivate squeezed brake calipers. This sequence state is repeated twenty times in a second. The aim is; when a car at high speed it cannot suddenly stops, it cannot stay where it is due to moment of inertia. So, it continues to slide forward suddenly. At this time, passengers inside the vehicle can even jump out of the windshield. However, ABS slows the wheels and stops the car in a controlled way (Shinhua, 2013).

In ABS, the system runs under the control of computers. The driver only operates the brake pedal and, if necessary, maneuvers the car by steering wheel. Any inexperienced driver with an ABS vehicle; compared with the experienced drivers- who use the vehicle without ABS, it stops the car in a much safer and more comfortable way and gets rid of it by accident. In the working system of ABS; When the sensors detect that the wheels are starting to slip, it sends a command to the brake to immediately cut the stopping power. As shown in Figure 2.1, here it is understood that the working formula of the ABS is based on the pressure limitation (Shinhua, 2013).

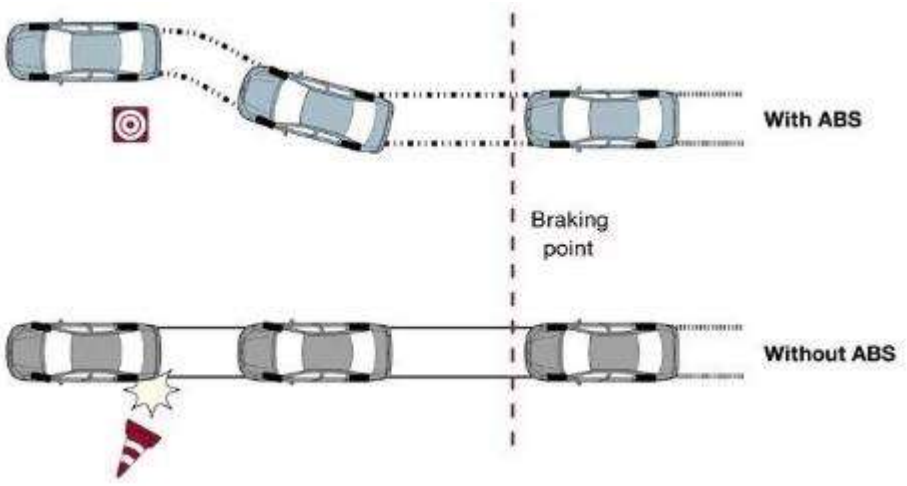

Figure 2.1: With ABS, the car gets better stability and control while braking
Source:www.toyota.lk (2013)

Vehicles with ABS stop at a shorter distance than other vehicles, more stable and safe. Especially there is a vital importance of ABS when sudden entry into curved roads and emergency braking is required. The vehicle with ABS can safely brake and maneuver because of its maneuverability, but in the same situation the vehicle without ABS is at risk of being thrown out of the road. Because the vehicle with ABS continues to be under the control of the driver in curved roads (Shinhua, 2013).

2.5.1 MainComponents of ABS

According to Toyota (2013) there are six main component of ABS which are stated below

2.5.1.1 Hydraulic ControlUnit

Thehydraulicunitadjuststhebrakecylinderpressureof eachwheelwith commandscomingfrom theenginecontrolunit(ECU).Duringthisadjustment,solenoid valves areused.Wherethecar'sengineislocated,themainbrake ispositionedbetween themaster cylinderandthewheel brake cylinders.Thus, theconnectionsto thebrake centercylindersandthe linksto the wheelbrakecylinders arekept short.Thehydraulic unitshaveinletandoutletsolenoid valvesforcontrollingeachwheelpressure.The ECU playsan importantrole inthispart andfulfills allelectronic andelectricaltaskswith the controlfunctionsofthesystem.Figure2.2showslocationofHydraulicControlUnite in the car engine (Toyota, 2013).

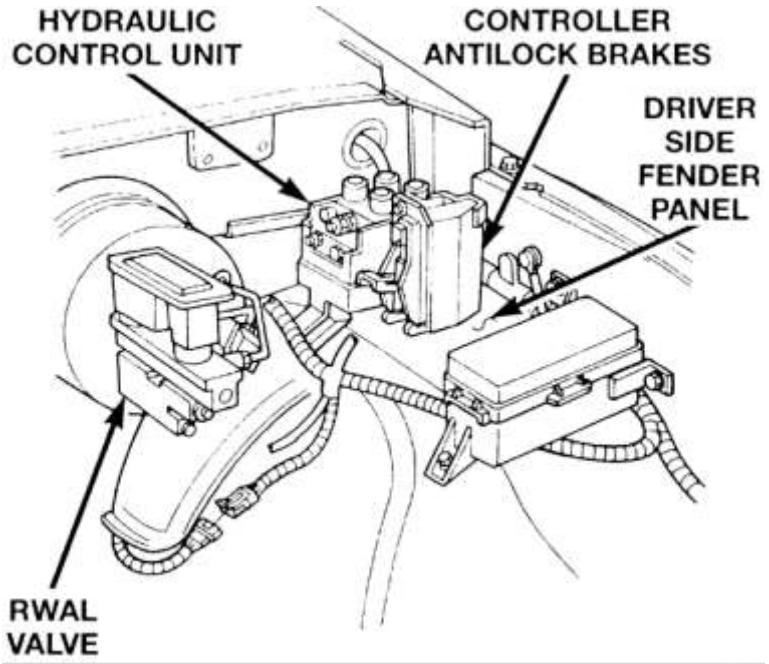

Figure2.2: Locationof Hydraulic Control Unitincarengine.
Source:www.toyota.lk (2013)

2.5.1.2 Wheel Speed Sensor

TheECU,orenginecontrolunit,usesthesignalsfrom thewheelspeedsensorsto calculate the speedof thecar'swheels.Thereare twoprinciplesinthisregard,active and passivewheelspeeds. Whetheractiveor inactive,bothspeedsmeasurethespeedof the wheelswith themagneticfield,withouttouching thewheels.Todaymoreactivesensors areused.Activesensorvariantscancontrolboththedirectionofrotationofthewheels andthe speed of the wheels. Figure 2.3 shows location ofwheel speed sensors in car.

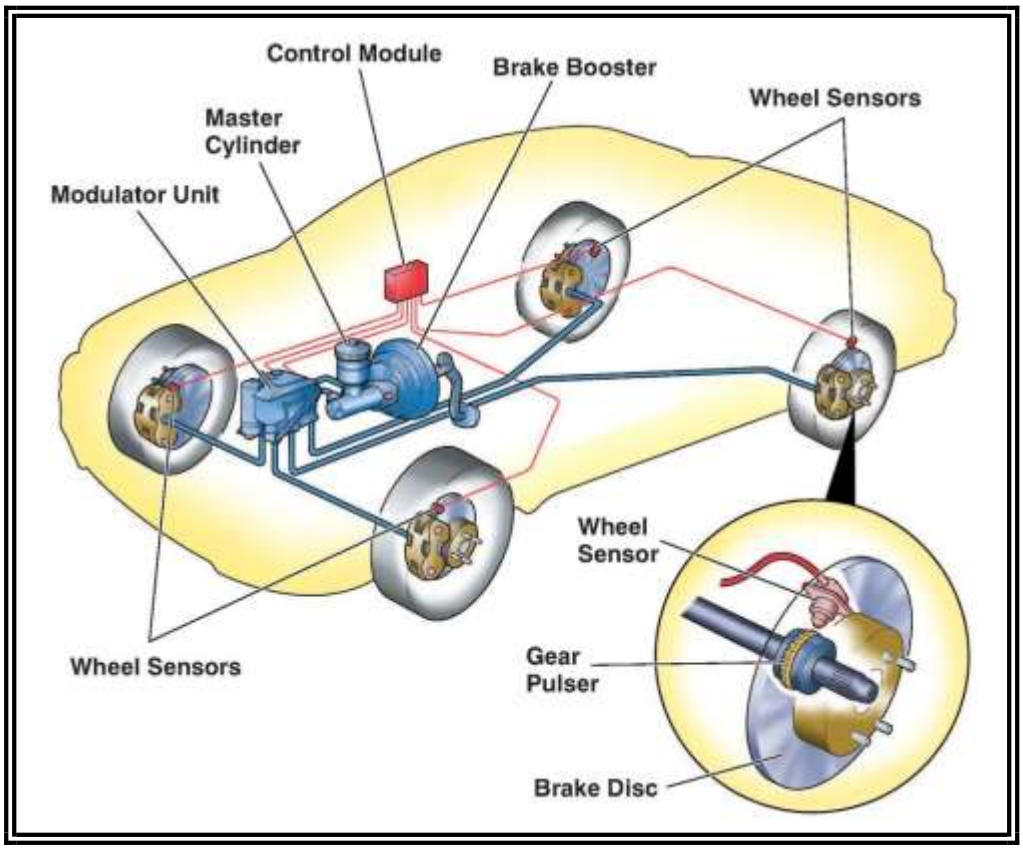

Figure2.3: Locationof wheelspeedsensors, MasterCylinder, Controlmodule in car.
Source:www.toyota.lk (2013)

2.5.1.3 Deceleration Sensor

Duringbrakingonfour-wheel-drivevehicles,it detectsthevehicle'sdeceleration rateandsendsthesesignalstotheECU.TheECUusesthesesignalstodetermine preciselytheroadsurfaceconditions andmaketherequired controlmeasurements.The deceleration speedsensoris locatedin theluggagecompartmentinpassengercarsandin theenginecompartmentinothervehicles.Decelerationsensorcontainstwopairsof LEDs (light emitting diode) and one channel with photo transistor plateand a signal conversion circuit.

Whenthevehicle'sdecelerationratechanges,thechannelplateisrockedalong the longitudinaldirection of the vehicle in accordance with the deceleration rate. Channelson thechannelplate open andclose thephototransistorbycuttingoff thelight comingfrom thephoto-transistorfrom theLEDs.Therateatwhichthesetransistorsturn on and offis divided intofour levels, which are signaled tothe ECU.

2.5.1.4 Valves

TheHydraulicControlUnitcontrolsthesevalveswhicharecontinuouslyactiveinthe system. The main tasks of valves are inthefirstposition,valveopen,thepistonsinthecaliperarebrakedbygivingfullpower to them. Inthesecondposition cutsthevalve line;itcuts off thehydraulicflow onthelineleading to the pistonand nopower istransmitted even when the pedalis pressed. Inthethird position,halfopen;inthismodeacertainamountofhydraulicisallowedto passandpressure isappliedto thepistonswhile thebrakeforceiskeptundercontrol so that the lineis notcompletely opened.

2.5.1.5 Hydraulic Pump

Whentheflow ofthevalveline isstopped,thehydraulicpressureisreleasedfrom thepumptoregainthelostpressure.Thisprocessisrepeatedeverytime whenthe hydraulicpressuredecreasedduetoopeningofvalves.Itislocatedonthehydraulic unit. In the faultcondition,the ABS is deactivated andthe ABS warning lamp lights up.

2.5.1.6 ABS Control Module

ABSControlModule isamicroprocessorthatevaluatestheinformation transmitted by thewheelspeedsensors andwiththisinformationitcontrols the ABS system by givingthenecessarycommandstotheactuators.Generally,itislocatedunder thehydraulic unit.Insomevehicles thehydraulicunitmayhavebeenmountedata differentlocation. In the eventof afault,theABS andtheconnectedsystemsare disabled,somefailures maycauseproblemswithothersystems,andtheABSwarning lamp isturnon.

2.5.2 Types ofABS

According to Toyota (2013) there are five types of ABS which are stated below

2.5.2.1 Four-wheel ABS andRear-wheelABS

Theaim ofthefour-wheelABSistoprovidemaximumstability in thecar's stoppingconditionsandmaneuverabilityof thedriver.OnvehicleswithABSonallfour wheels,the brakingsystems of thecarspreventthewheelsfrom lockingonallfour wheels.Thedrivercancontrolthevehiclebetter anditiseasiertokeepthevehicleunder control.At thistime,thebraking pressure requiredforbrakingisset.Ifonlythereartwo wheelshave ABS;thissituationisusuallyfoundintrucks,minibusesandsports cars.The caris prevented fromlocking only onthe rear wheels. IfonlythereartwO-wheelABSsystem isavailable;Ifthedriverispressonthe

brakepedalandlocksthewheels,thedrivermustknowthat thebraking system isnotas effectiveasthefour-wheelABS. In thiscase, the drivermust manually adjustthe pressureonthebrakepedal.Thus,thedrivercanconvenientlyorientthecarinthe desireddirectionandprovidesafedriving.Figure2.4showsdifferencesbetweenFour- channel, Three-channel and One-channel ABS.

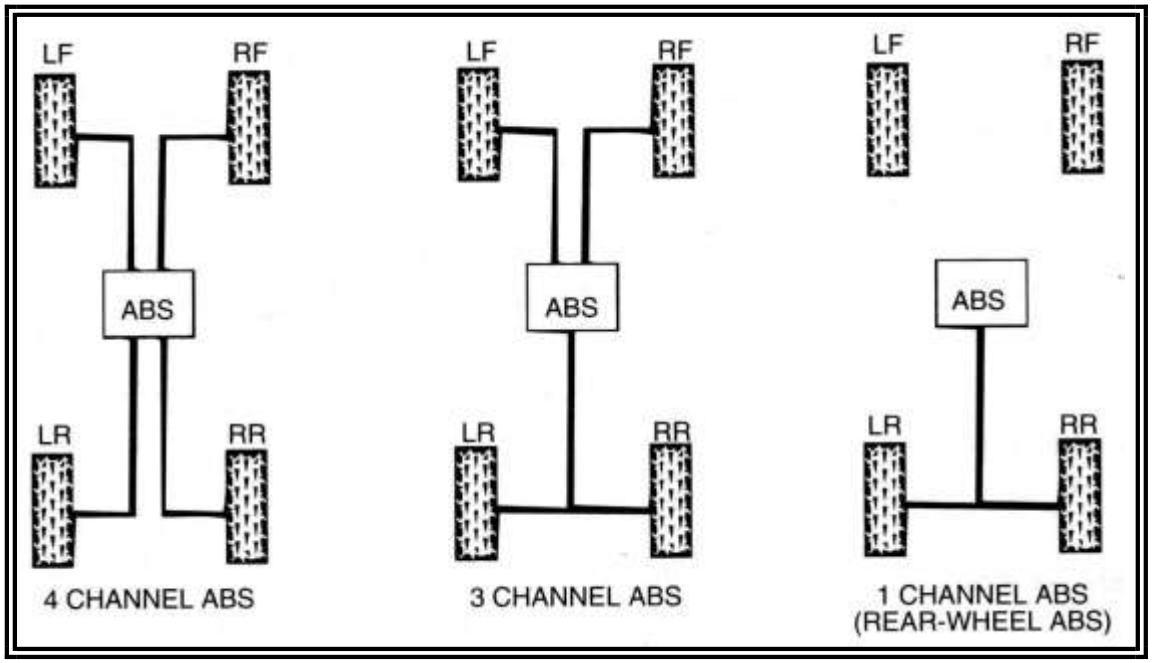

Figure2.4: Four-channel, Three-channeland One-channelABS.

2.5.2.2 Four-channel Four-sensor ABS

Thistypehasfour-wheel sensorsandfourhydrauliccontrolchannels.Eachwheel iscontrolled independently.Steeringsafetyandstoppingdistanceonallroadconditions areprotected.Infront-wheeldrive vehicles,mostoftheweightisonthefrontwheelsdue toengineandtransmissionsystem locatedinfrontofthevehicle.Frontwheelscontrol almost70% of thebrake force.The

remaining30%of the brakingforce provided onthe rearwheelsisveryimportantfortheprotectionof thestabilityof thevehicle.Theyawing momentthatcausesthespeeddifferenceonthewheelsontherearaxleondifferentroad surfacescancausethevehicletobe outofbalance.Forthisreason,vehicleswithfour-channelABShavealow-logicchoiceontherearwheelsto maintainthebalanceof the vehicle in the majority.

2.5.2.3 Three-channel Three-sensorABS

Thethreespeedsensors measurethe numberof revolutionsof boththewheeland differentialsungear.Thebraking forceonthefrontwheelisadjustedseparatelyby solenoidvalves.Thebrakingforce oftherear wheelsisregulatedbyasinglesolenoid valve.Thistype hydraulic unitsareused in parallel brake circuits.

2.5.2.4 Two-channel ABS

Thistypeofhydraulicunitisusedonheavyvehiclesoronvehiclessuchas trucks. Only the rear twowheels arecontrolled.

2.5.2.5 One-channel One-sensor ABS

Thistypeofanti-locksystem isusuallyfoundinSUVsinVANsandpickups. Thereisonlyonevalve andonesensor,which controlstherearwheels.Itissimilarto the three-channelABSsystem forthewayofoperation.Thedistinctivefeatureof the system is that there is no independent speedsensor for each wheel.

2.6 Automobile Skills Needed in Servicing Anti-lock Braking System (ABS)

Ifthewarninglightof theABSbrakesystemdoesnotextinguishwithinthree secondsofapplyingthevoltage,orifthelamplightsupduringdriving,thereisafault and thesystemis switched off.Figure 6.1 shows ABS and Brake systemwarning lights.

Figure2.5: ABS andBrakesystemwarning lights**.**

Thevehicle mustbecheckedtomaketheABS brakesystem functionalagain.In themeantime,thenormaloperationofthebrakesremainsunaffected.Theinvestigation ofthefaultsisextremelyeasywiththediagnosticfacility.Faultsaredetectedaccording tothefault codeappropriatetothefaulttype.Determination of thefaultlocationin the faulty line can also be done by conventional methods.

If the ABS warning light is on

Inorder toprovideseparatetestingof thepartsinthesystem,thisdiagnosticmethodis dividedintostages.Inanykindoffaultdiagnosis,thetestshouldbestartedfrom thefirst stage untilthe fault is corrected.

- The voltageof the electronic module should be checked,
- whetherreservoirwarningandpressurewarningswitchesareoperatingshouldbe checked
- The resistance of the sensor should be checked
- Main valve operation should be checked
- The inlet and outlet valves should be checked forresistance

- Electronic modulesmust bereplaced.

If the ABSwarninglightison aftertheengine hasstarted,sensor cablesand isolationsshouldbechecked.Allsensorcablinginthesystem andtheirinsulationshould be checkedone by one.

If the ABSwarning light comes onafter the vehicle has been inmotion; If the fault stillcannot berectified asaresultofinspectionsofthesensorcablesandtheirinsulation made afterindividual control of the partsin thesystem,thefollowing checksare possible:

- Sensor resistance control
- Wheelsensor operation and sensor track control.

The ABS and brake warning lamps are on, or the pump is running long;

Itispossibletoinvestigatethefaultin thissituationatvariousstages.First,the system'smembersshould betested onebyone,thencomplaintsshouldbefollowedupto the developer. The following checkare;

- Outside leakage control,
- Pumpmotorcontrol,
- Pressureincreasetime control,
- Operation ofthe pressuresphere,
- Pressure warning function control
- Internalleakcheck of the hydraulic center unit.

If the ABS warning lamp lights up intermittently;

Itisalsopossibletoinvestigatethefaultinthiscaseagainatvariousstages.First,the systemelementsmust betested one by one, then these operations should be followed:

- Improper connectioncheck in theinstallation plugs,
- Hydraulic reservoir cover operation and pressurewarning operation control,
- Sensor resistance check.

If only thebrake warning lightis on;

Once the systemcomponentshave been checked individually,the following test sequence should be followed:

- Check the parking brakelamp operation,
- Check brakehydraulic level warninglamp operation,
- Check for external leaks,
- Check the operation of reservoir andpressure warning lights.

Parking brake lamp operation check;

Theignitionisswitchedoff,thebrakepedalispumpedatleast20timesandtheignition isswitchedon,waitinguntiltheenginehasstopped.Thehandbrakeisreleased;ifthe lightremainson, the hand brake setting is checked.

Hydraulic levelwarning lamp operation check;

Theignitionisswitchedoff,thepedalispumpedatleast20times.Theignitionis switchedon andthehydrauliclevelischeckedimmediatelywhentheenginehasstopped running;Itshould be between 'max' and 'min'lines.

Outside leakage control;

- The brakehydraulic pipes arechecked,
- Check central pump lowand high pressure hydraulic pipes,
- Near thereservoir, leaksare checkedat felts andjoints,

- Leakunderthecarpetattheentrancetothecentralpumpofthepushrodwith brake pedalcontrol is done,
- The necessary actions are taken, and the fault is corrected.

If the ABS warning light is notlit at all;

Alltherecommendedoperationsareperformedsothatallpartsinthesystemcanbe testedonebyone.IftheABSwarninglightisnotlitatall,fuses,light bulbsandwiring should be checked.

If the brakepedal goestoo deep (While ABS warning light is off);

Afterallthepartsinthesystem havebeenchecked,externalleaksarechecked,andairis takenfrom thesystem.Centralpumpinternalhydraulicleaksarealsochecked, and necessary actions andchanges are performed.

If the brakepedal travel increases when the ABSsystem is running;

Ifthepedal travelincreaseswhentheABSsystemisswitchedon,allpartsarefirsttested inthesystem,thenthe systemischeckedforleaksandairis takenfrom thebrakesystem. This operation is followed by electricalcontrol of the main valve.

If the operation of ABS is weak;

Afterallelementsarecheckedinthesystem,diodeoperationcontrol is performed.Then anexternal leak check is carried outand airinthe system isremoved.After that, resistancecontrolof theinletand outletvalvesisperformed,andthehydraulicduty controlsof theinletandoutletvalvesareperformed.Asaresultof thechecks made, necessary actions are taken.

2.7 Automobile Maintenance Skills Needed for Repairing Anti-lock Braking System (ABS)

The brake system converts the momentum of the vehicle into heat by slowing and stopping the vehicle wheels. This is done by causing friction at the wheels. The application of the friction units is controlled by a hydraulic system (Erjavec, 2010). The brake system produces friction to slow or stop the vehicle. When the driver presses the brake pedal, fluid pressure actuates a brake mechanism at each wheel. These mechanisms force friction material (brake pads or shoes) against metal discs or drums to slow wheel rotation. When the brake pedal is pressed, pressure is placed on a confined fluid. The fluid pressure transfers through the system to operate the brakes. An emergency brake is a mechanical system that applies the rear wheel brake. To obtain the most effective braking and allow the driver to retain control of the vehicle, the wheels should not lock up under braking. In order to overcome wheel lock, antilock braking system (ABS) is introduced.

Antilock braking system (ABS) technology has been used in the automotive industry since the 1980's and is implemented in most modern cars today (Li, 2010). In the opinion of Bosch (2004), 76 percent of all new vehicles were equipped with ABS in 2007 and it has become standard equipment for passenger cars in the European Union (EU), United States of America (USA) and Japan. Modern antilock brake systems can be thought of as electronic/hydraulic pumping of the brakes for straight-line stopping under panic conditions (Erjavec, 2010). A typical antilock braking system consists of a conventional hydraulic brake system (the base system) plus a number of antilock components. The base brake system consists of a vacuum power booster, master cylinder, front disc brakes, rear drum or disc brakes, interconnecting hydraulic tubing and hoses, a low fluid sensor, and a red brake system warning light. Antilock components are added to this base system to provide antilock braking ability. When the driver quickly and firmly applies the brakes and holds the pedal down, the brakes of a vehicle not equipped with ABS will almost immediately lock the

wheels. The vehicle slides rather than rolls to a stop. During this time, the driver also has a very difficult time keeping the vehicle straight and the vehicle will skid out of control. The skidding and lack of control was caused by the locking of the wheels. If the driver was able to release the brake pedal just before the wheels locked up then reapply the brakes, the skidding could be avoided. This release and application of the brake pedal is exactly what an antilock system does.

When the brake pedal is pumped or pulsed, pressure is quickly applied and released at the wheels. This is called pressure modulation (Erjavec, 2010). Pressure modulation works to prevent wheel locking. Antilock brake systems can modulate the pressure to the brakes as often as fifteen times per second. By modulating the pressure to the brakes, friction between the tires and the road is maintained and the vehicle is able to come to a controllable stop. ABS works primarily to ensure that the driver maintains steering control of the vehicle under heavy braking. This is achieved by preventing the tyres from locking during heavy braking (Lambourn *et al.,* 2007). There are two reasons for installing an ABS system in a car. The first objective is to avoid wheel lock-up and preserve the tyre ability or produce a lateral force, and thus vehicle maneuverability. Furthermore, the wheel slip is kept in a neighborhood of the point that maximizes the tyre force in order to minimize the vehicle's braking distance (Li, 2010). During ABS operation the brake fluid returns to the master cylinder and the driver will feel pulsations at the brake pedal which help to indicate that ABS is in operation. When ABS operation stops the modulator pump continues to run for approximately 1 second(s) in order to ensure that the hydraulic accumulators are empty (Bonnick, 2001).

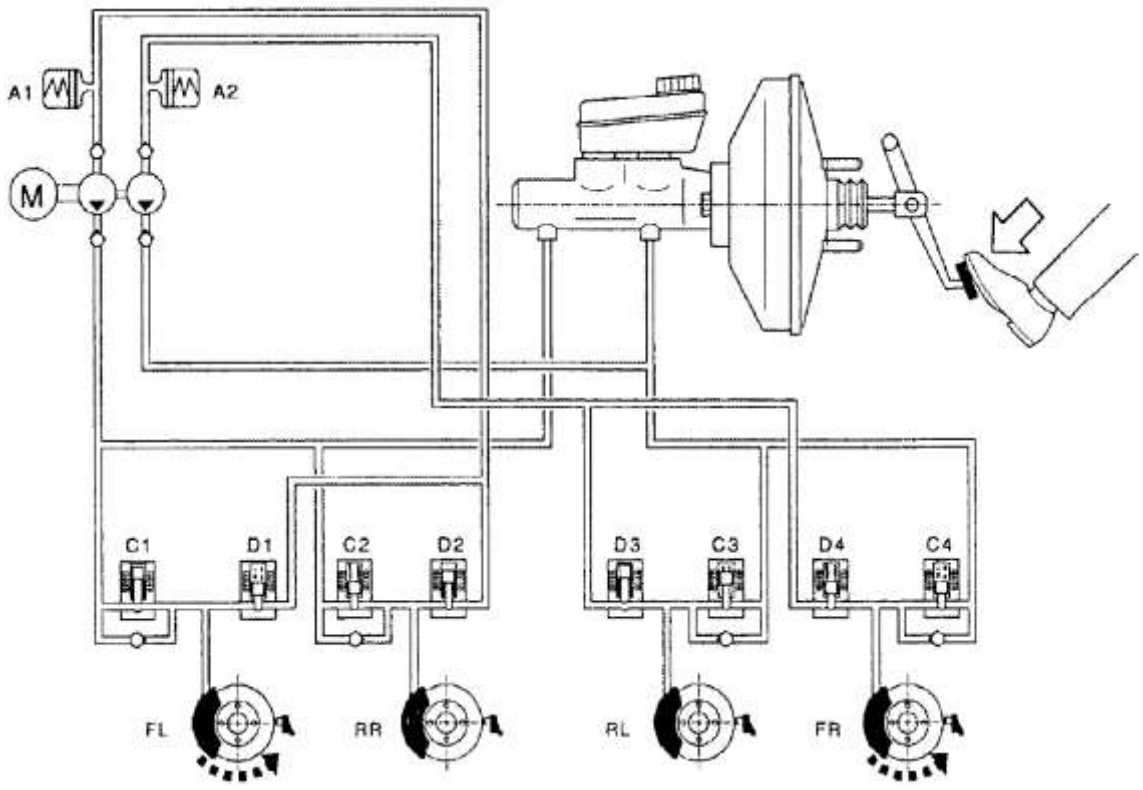

Figure 2.6: Principle Operation of the ABS adopted from Bonnick

At the bottom of the diagram are the four-wheel brakes and above these are the inlet and outlet valves (labelled C and D, respectfully) which, under computer control, determine how braking is applied when the ABS system is in operation. When ABS is not operating, the inlet valves rest in the open position (to permit normal braking) and the outlet valves rest in the closed position. At each inlet valve there is a pressure sensitive return valve that permits rapid release of pressure when the brake pedal is released and this prevents any dragging of the brakes (Bonnick, 2001).

According to Bonnick (2001), depressing the brake pedal operates the brakes in the normal way. For example, should the wheel sensors indicate to the computer that the front right wheel is about to lock, the computer will start up the modulator pump and close the inlet valve C4. This prevents

any further pressure from reaching the right front brake. This is known as the ‘pressure retention phase’. If the wheel locks up, the computer will register the fact and send a signal that will open the outlet valve D4 so that pressure is released. This will result in some rotation of the right front wheel. This is known as the ‘pressure reduction phase’. If the sensors indicate that the wheel is accelerating, the computer will signal the outlet valve D4 to close and the inlet valve C4 to open and further hydraulic pressure will be applied. This is known as the ‘pressure increase phase’. These three phases of ABS braking, i.e. pressure retention, pressure release and pressure increase, will continue until the threat of wheel lock has ceased or until the brake pedal is released. The system shown above (fig 2.6), illustrates one mode of ABS operation. The front right and rear right brakes are in the pressure retention phase, the front left brake is in the pressure increase phase, and the rear left brake is in the pressure reduction phase. This is indicated by the open and closed positions of the inlet valves C1–C4 and the outlet valves D1– D4.

The ABS control computer is incorporated into the ABS modulator and, with the aid of sensor inputs, provides the controlling actions that are designed to allow safe braking in emergency stops. ABS is not active below 7 km/h and normal braking only is available at lower speeds. When ABS is not operating, the inlet valves rest in the open position (to permit normal braking) and the outlet valves rest in the closed position. At each inlet valve there is a pressure sensitive return valve that permits rapid release of pressure when the brake pedal is released and this prevents any dragging of the brakes. The electronic control system of most ABSs includes sophisticated on-board diagnostics that, when accessed with the proper scan tool, can identify the source of a problem within the system. According to Erjavec (2010), ABS scan tools and testers can often be used to monitor and/or trigger input and output signals in the ABS. This allows you to confirm the

presence of a suspected problem with an input sensor, switch, or output solenoid in the system. Manual control of components and automated functional tests are also available when using many diagnostic testers. An ABS control module has five separate diagnostic modes. Data available for troubleshooting the ABS includes wheel-speed sensor readings, vehicle speed, battery voltage, individual motor and solenoid command status, warning light status, and brake switch status. Numerous trouble codes are programmed into the control module to help pinpoint problems. Other diagnostic modes store past trouble codes. This data can help Automobile mechanics determine if an earlier fault code, such as an intermittent wheel-speed sensor, is linked to the present problem, such as a completely failed wheel sensor. In the opinion of Erjavec (2010), electrical components of the ABS are generally very stable. Common electrical system failures are usually caused by poor or broken connections. Other common faults can be caused by malfunction of the wheel-speed sensors, pump and motor assembly, or the hydraulic module assembly.

ABS diagnostics requires three to five different types of testing that must be performed in the specified order listed in the vehicles service manual (Erjavec, 2010). These testing includes: Prediagnostic inspections and test drive; Warning light symptom troubleshooting; On-board ABS control module testing (trouble code reading); and Individual trouble code or component troubleshooting.

The prediagnosis inspection consists of a quick visual check of system components. Problems can often be spotted during this inspection, which can eliminate the need to conduct other more time-consuming procedures. This inspection should include the following:

- Check the master cylinder fluid level.
- Inspect all brake hoses, lines, and fittings for signs of damage, deterioration, and leakage.

- Inspect the hydraulic modulator unit for any leaks or wiring damage.
- Inspect the brake components at all four wheels. Make sure that no brake drag exists and that all brakes react normally when they are applied.
- Inspect for worn or damaged wheel bearings that may allow a wheel to wobble.
- Check the alignment and operation of the outer constant viscosity (CV) joints.
- Make sure the tires meet the legal tread depth requirements and that they are the correct size.
- Inspect all electrical connections for signs of corrosion, damage, fraying, and disconnection.
- Inspect the wheel-speed sensors and their wiring. Check the air gaps between the sensor and ring, and make sure these gaps are within the specified range. Also check the mounting of the sensors and the condition of the toothed ring and wiring to the sensor (Erjavec, 2010).

The control module monitors the electromechanical components of the system. A malfunction of the system will cause the control module to shut off or inhibit the system. However, normal power-assisted braking remains. Malfunctions are indicated by a warning indicator in the instrument cluster. The system is self monitoring. When the ignition switch is placed in the run position, the ABS control module that will perform a preliminary self-check on its electrical system indicated by a second illumination of the amber ABS indicator in the instrument cluster. During vehicle operation, the control module monitors all electrical ABS functions and some hydraulic functions during normal and antilock braking. With most malfunctions of the ABS, the amber ABS indicator

will be illuminated and a Diagnostic Trouble Code recorded. Each of the DTCs represents a specific possible problem in the system.

2.8 Safety measures required by automobile mechanics for the maintenance of Anti-lock Braking System (ABS)

Anti-lock Braking System also known as anti-skid braking system (ABS) is an automobile safety system which prevents the locking of wheels during braking and avoid uncontrolled skidding. The modern ABS system allows steering during braking which gives more control over the vehicle in case of sudden braking. The main advantages of using ABS system in vehicle is that it provides better control over the vehicle and decreases stopping distance on dry and slippery surfaces. Since in ABS installed vehicle the chance of skidding is very less and hence it provides a better steering control during braking. Without ABS system, even a professional driver can fail to prevent the skidding of the vehicle on dry and slippery surfaces during sudden braking. But with ABS system, a normal person can easily prevent the skidding of the vehicle and get better steering control during braking.

Anti-Lock Braking System, or ABS, is a safety feature on your car, truck, or SUV that helps you to maintain control during hard braking, especially on loose, wet, or slippery surfaces. Essentially required for use on all passenger cars since 2013, ABS serves to keep more of your tires in contact with the road by preventing the wheels from locking up and sending your vehicle into an uncontrolled skid.

Many drivers believe that ABS helps them to stop sooner when braking. That may or may not be the case. Sometimes ABS decreases stopping distances, but sometimes it increases them. It really depends on the road condition. But decreased stopping distance is not the primary objective of ABS.

When you slam on the brakes in a vehicle without ABS, the wheels and tires lock up - they stop rotating. As the tires begin to skid, only a small patch of the tire is in contact with the ground. When that happens, your ability to steer diminishes significantly. A tire that is skidding has no ability to steer. It only slides.

But a car equipped with ABS works differently. When you slam on the brakes, wheel speed sensors located at each wheel detect when your tires stop rotating and send that information to the ABS computer module. The ABS module, in turn, tells a special hydraulic device (the ABS actuator) to "pump" the brakes to those wheels, releasing them momentarily and effectively preventing them from locking up. This allows your tires to keep rolling in the right direction and helps you to steer your car. So, while ABS may or may not help you stop sooner, it will at least allow you to maintain steering control when braking hard. According to Mitchell (2008) outline safety measures required for the maintenance of Anti-lock braking system;

1. Never open a bleeder valve or loosen a hydraulic line while ABS is pressurized.
2. Never disconnect or reconnect any electrical connectors while ignition is on.
3. Damage to ABS control unit may result to accident
4. Do not attempt to bleed hydraulic system without first referring to the appropriate anti-lock brake system in the Brakes section.

5. Only use specially designed brake hoses/lines on ABS equipped vehicles.
6. Do not tap on speed sensor components (sensor, sensor rings).
7. Sensor rings must be pressed into hubs, not hammered into hubs. Striking these components can cause demagnetization or a loss of polarization, affecting the accuracy of the speed signal returning to the ABS control unit.
8. Do not mix tire sizes. Increasing the width, as long as tires remain close to the original diameter, is acceptable.
9. Rolling diameter must be identical for all 4 tires.
10. Do not contaminate speed sensor components with grease.
11. Only use recommended coating, when system calls for an anti-corrosion coating.
12. When speed sensor components have been removed, always check sensor-to-ring air gaps when applicable.
13. Only use recommended brake fluids.
14. Do not use silicone brake fluids in an ABS equipped vehicle.
15. When installing transmission devices (CB's, telephones, etc.) on ABS equipped vehicles, do not locate the antenna near the ABS control unit (or any control unit).
16. Disconnect all on-board computers, when using electric welding equipment.
17. Do not expose the ABS control unit to prolonged periods of high heat (185 ^{0}F/85^{0}C for 2 hours is generally considered a maximum limit).
18. Failure to depressurize ABS could lead to physical injury.
19. Use relevant tools and equipment for the maintenance of ABS
20. Never crawl under a vehicle that has not been properly supported

21. Take care not to get any dirt on the rotor, as it will affect the performance of the brakes
22. Turn the key to the off position when ready for operation
23. Do not use a block of wood or some other item to support the weight of the vehicle
24. Never crawl under a vehicle that has not been properly supported
25. Do not rush the job
26. Use first class car jacks while maintaining ABS
27. Apply recommended, brake shoes, brake lining, hoses and brake fluid
28. Use the right tools for the right job

2.9Related Empirical Studies

Yavala (2010) conducted a study to determine the work skills improvement need of graduates of technical colleges in motor vehicle mechanic practice for employment in modern Nigeria. The study was carried out in Taraba state of Nigeria. Three research questions were formulated to guide the research study. The study adopted a survey research design and the population of the study consisted of 40 graduates of motor vehicle mechanic practice from industries in the study area. There was no sample for the study, since the population was manageable. A structured questionnaire containing 43 work skill items was used for the collection of data from the respondents. The work skill questionnaire was divided into skills needed and performance with each having a 4-point response scale and a corresponding value of 4,3,2,1 for the two groups respectively. Split half method was employed to determine the internal consistency of the work skills questionnaire item with a reliability coefficient of 0.83. The instrument was analyzed using weighted mean and improvement needed index (INI). Findings of the study revealed that graduates of motor vehicle mechanics practice from technical colleges need improvement in work skills for

engine maintenance, steering and braking system and auto electricity in order to be employed in Taraba state. The study therefore recommended that all the identified work skills in engine maintenance, steering and braking system and auto electricity should be integrated into the curriculum of motor vehicle mechanic practice in technical colleges for training students.

In a related study carried out by Ogbuanya&Fakorede (2012) to ascertain the technical skills improvement needs of metal work technology teachers for entrepreneurship in response to Millennium Development Goal (MDG) for quality assurance, 16 technical colleges offering metal work technology in Lagos and Ogun states were used for the study. Three research questions were formulated to guide the study. A structured questionnaire was used to collect relevant data from 110 metal work teachers. Data collected were analyzed using the statistical mean and standard deviation. Cronbach Alpha Reliability technique of 0.98 was established for the instrument. The findings of the study revealed that metal work technology teachers in technical colleges need modern metal work technology skills for quality training of metal work technology students in technical colleges for occupation in metal work industry and productive self employment. The recommendations of the study among others include the organization of an extensive training for metal work technology teachers in technical colleges in Lagos and Ogun states to keep them abreast with the contemporary practices as well as update their skills in metal work technology; the management of metal work industries and in-house personnel should be co-opted to consolidate teachers teaching with actual work experience.

Doka (2014) also investigated the knowledge and skills needs of technical college graduates for self-employment in metalwork trades in FCT and Nasarrawa state. Three research questions were

designed for the study. Three hypotheses were postulated to guide the study and were tested at 0.05 level of significance. A survey research was adopted for the study. The total population of 124 respondent consisting of 45 metal work trade teachers, 39 welding and fabrication, 21 mechanical engineering and 19 foundry craft practice self employed technical college graduates. A 100 item structured questionnaire and four point rating scale was used as instrument for data collection after being subjected to face validation by three lecturers. The reliability coefficient of the instrument was 0.87 using cronbach alpha. Mean and standard deviation were used to answer the research question while t-test was used to test the hypotheses. A structured questionnaire was used to elicit information from 45 metalwork trade teachers, and 79 self-employed technical college graduates. The findings of the study showed that few technical college graduates of metal work trades are self employed in the study area. Based on these findings, the study recommends that the identified technical knowledge and skills needs of technical college graduates should form the basis for planning and teaching metal work trades namely, welding and fabrication, mechanical engineering practice and foundry craft practice. The State Ministry of Education and Federal Capital Territory education secretariat should fund and provide facilities needed to enhance the effective acquisition of tech knowledge and skills in the teaching-learning process. The study is related to the current study in the aspect of skills. However, it differs in the sense that Doka's study is focused on technical college graduates of metalwork while the present study is aimed at Motor Vehicle Mechanic's Work graduates in technical colleges.

Nwokolo (2011) conducted a study on training skills relevant for employment in metal work industries in Nigeria: the way forward. Three research questions and three hypotheses were formulated to guide the study. A total of 105 technical teachers were involved in the study. The

instrument used for the study was Metalwork Skill Training Questionnaire (MWSTQ). T-test statistical tool was used in the analysis of data. The findings showed that the young graduates need broad based technical skills which can be adapted to rapidly changing economic requirements as well as appropriate basic skills which they can benefit from. The recommendation of the study is that governments in collaboration with non-governmental and international organizations should provide funds for the purchase of adequate number of equipments tools and materials to facilitate skills acquisition. The study is related to the present study in the aspect of skills. Although, Nwokolo's study is based on training skills for employment, the present study is aimed at identifying emerging technology skills required by Technical College graduates of MVMW for establishing automobile enterprises.

Odigiri& Ede (2010) also carried out a study on the integration of new technological innovations in automobiles into the curriculum of Nigerian Technical College programmes. The area of the study was Benue, Enugu and Kaduna states. The population of the study comprised of 81 subjects made up of all mechanical engineering or technology staff of the two automobile plants and auto-mechanic teachers in the technical colleges in these selected states. The entire population was used for the study. The instrument for data collection was a 41item structured questionnaire designed by the researcher based on the research questions used for the study. The findings of the study revealed that 41 new innovations comprising of 10 in the engine; 11 in the transmission, suspension, steering and braking systems; 20 in the electrical/electronic and auxiliary systems were rated as important to be integrated into the curriculum. Included among these prominent new automobile innovations are: electronic fuel injection system (EFI), electronic ignition system, variable valve timing intelligence (VVV), super charging, emission control systems, On-Board

Diagnostic system, All Wheel Steering System (AWS), All Wheel Driving System (AWD) and Anti-lock Braking System (ABS) etc. The findings of this study also revealed that there is a significant difference in the mean responses of industrial workers and technical teachers on five of the identified new technological innovations in automobiles for which the null hypotheses were rejected. These items included the On-Board Diagnostic system, safety airbags and airbag curtains, automatic front windscreen wiper, automatic headlight brightness switch and multiplex wiring. Based on the findings and implications of the study, recommendations were made. These recommendations are as follows: Further studies should be conducted to identify all the other elements of the new innovations needed for the development of comprehensive curricular contents including the skills and theoretical contents entailed in their study as well as the new tools and equipment needed. The curriculum for teacher training programmes should be reviewed to include these innovations in order to prepare teachers who will be able to implement the curriculum with the new contents for the technical college programmes. The study is related to the current study in the aspect of new technological innovations in automobiles, though the study was conducted on mechanical staff of automobile plants and technical college teachers.

Igwe (2011) carried out a study on competency improvement needs of Teachers in On- Board Diagnostic System for effective teaching of petrol engine maintenance in technical colleges in Nigeria. The area of the study was South-Eastern Nigeria. Eight research questions were formulated for the study in line with the components of OBD system which include: input devices, Output devices, Diagnostic Software and Diagnostic tools. Survey research and Borich needs assessment model design was used in the study. The population of the study comprised of 50 subjects made up of MVMW teachers who responded to a 53 item structured questionnaire

designed by the researcher. The entire population was used. Three experts face validated the content of the instrument. Cronbach Alpha coefficient of reliability of 0.93 was established for the instrument. The major findings of the study revealed that teachers of MVMW in South-East states of Nigeria need skill improvement training in On-Board Diagnostic (OBD) systems for effective teaching of Petrol Engine Maintenance. This is necessary in order to teach the students who will service the petrol engine vehicles that make use of OBD system effectively. Based on the findings, the recommendation among others is that there should be in-service training in OBD system for the teachers of Motor Vehicle Mechanic's Work. Both studies are carried out on Motor Vehicle Mechanic's Work.

In another work, Abd-El-Aziz &Adio (2012) carried out a study on new technologies of imported used cars needed to be incorporated into Auto-mechanics trade curriculum of technical colleges. Oyo state was used for the study. The population of the study consisted of 29 Auto- mechanic teachers from five technical colleges and 241 industry workers who are graduates of technical colleges. Three research questions guided the study. An 89 item structured questionnaire grouped into 3 sections with Cronbach Alpha Reliability coefficient of 0.78, 0.88 and 0.96 respectively sought information on new technologies, tools and equipment and the competencies needed for inclusion into the auto-mechanic curriculum. The major findings in this study showed that out of the fifty items in section 1, forty-six were considered as technologies that should be incorporated into the curriculum while four items were considered as technologies that should not be considered. The study further found out that all the 26 items in section 2 were considered as important to be incorporated into the curriculum for training the students. The study also revealed

that all the 13 items in section 3 of the questionnaire were considered as highly needed for inclusion in the technical college curriculum of auto-mechanics trade.

The recommendations of the study include: Auto-mechanics curriculum should be reviewed and updated periodically to reflect new automotive technologies, teaching and learning tools, materials and equipment in technical colleges. In addition, the curriculum for auto- mechanics trade in technical colleges should be reviewed to include these new technologies now that transformation is going on in almost all facets of the economy. The finding also buttressed the need for high premium to be placed on the training and re-training of technical instructors in order to fast track getting them well groomed and acquainted with principles and methods of imparting the knowledge and skills to the students.

2.10 Summary of Related Literature

An extensive review of related literature on need for skill acquisition needs of road side automobile technicians in the maintenance of anti-lock braking system in Abuja (FCT) was carried out. The review of the study showed that Automobile technology in Nigerian institutions is a vocational trade designed to produce competent Automobile technologist with sound theoretical knowledge and who should be able to diagnose and carryout repairs and/or maintenance on all types' of cars. The successful completion of this programme enables its recipients the opportunity to secure employment either at the end of the whole course or after completing one or more modules of employable skills; Set up their own enterprises and become self-employed and be able to employ others. However, it has been observed that Automobile graduates in Nigeria possesses little or none

of the technology skills required to service and repair modern vehicles and as such, could not establish their own or even perform well in modern automobile industries.

The study also reviewed Stuart and Hubert Dreyfus Model of Skill Acquisition, which states that formal system of education is a gradual process that involves being embodied in different ways and developing skills that would make it possible for people to deal with the world; Dynamic Skill Theory by Kurt Fischer, which is of the view that skill within domains may promote or suppress other skills as they first develop resulting in spurts of growth in one skill concurrently with regression in another.

A lot of related empirical studies were also reviewed in order to guide the researcher in selecting appropriate methodology for this study. Many of the empirical studies which were found relevant, presented some empirical works on competency improvement skills of teachers in other parts of Nigeria, but no empirical study known to the researcher has been conducted to identify need for skill acquisition for automobile technologists in anti-lock braking system. This study is therefore timely as it is intended to close this critical gap.

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

3.1 Research Design

This study employed a descriptive survey method because it involves the use of questionnaire to help in determining the opinion of the respondents. Udogu (2014) stated that a survey research as a descriptive study are plans, strategies and structured employed towards obtaining answers to research questions and hypothesis. He further added that it covers the outline of what the researcher intends to do up till the final analysis. In the same angle, this study seeks the opinion the automobile workshop supervisors and automobile teachers on the skill acquisition needs for roadside automobile technicians in the maintenance of anti-lock braking system in Abuja

3.2 Area of Study

Abuja is located in latitude 9 4’ 20.1504” N and 7 29;28.6872” E. It is the largest city and the capital of Nigeria; Abuja can be found roughly in the central part of the country situated in the west central region of the African continent. Administratively, Abuja is the center of the Federal Capital

Territory and is a city with the area close to 275 square miles. Abuja is one of the most important cities of the African continent, as well as the place where many international events of various kinds are held. The capital city is the location where most of the major administrative bodies of the country can be found. It is a key political and economic center of the country, an important cultural and transportation hub. It is a modern city with a mixed and very diverse community, a multicultural and quite highly educated society, and a friendly atmosphere. There is a great number of tourist attractions in Abuja, including some local religious establishments, museums, and historic architecture, parks and gardens, etc. It is also one of the fastest growing communities, not only of the African continent but also of the whole world.

3.3 Population of the Study

The population of the study comprises of sixty-three (63) automobile workshop supervisors and thirty-seven (37) automobile teachers in Federal capital territory (FCT) Abuja. The sixty-three (63) automobile workshop supervisors were Registered Automobile Maintenance companies in Abuja and the thirty-seven (37) automobile teachers consists of technical schools and FCT institute of technical and vocational Education in Abuja respectively. The population of the study is classified as shown in table 3.1 below.

Table 3.1: Population of automobile workshop supervisors and automobile teachers in Abuja

Respondents	Number
Automobile workshop Supervisors	63
Automobile Teachers	37
Total	100

3.3 Sample and Sampling Techniques

There is no sampling technique for the study because the population of the study is of manageable size.

3.4 Instrument for Data Collection

A structured questionnaire titled; Skill Required by Road Side Automobile Mechanics in the Maintenance of Anti-Lock Braking System in Abuja (FCT). This was developed by the researcher and was used for data collection. The instrument consists of two parts I and II. Part I sought information on the respondents of automobile teachers and part II sought information on the respondents of automobile workshop supervisor. Each part of the questionnaire is divided into section A and section B. Section A sought for information on personal data while section B sought for information on the research questions. A four point rating scale of measurement will be used for section B. Section B consist of research question one with twelve (12) items which sought for information on the skills required by roadside automobile technician for servicing anti-lock braking system, research question two consist of twenty four (16) items which sought for information on the skills required by roadside automobile technician for repairing anti-lock braking system while research question three consist of twenty eight (16) items which sought for information on the safety measures required by automobile technologist when maintaining anti-lock braking system.

3.6 Validation of the Instrument

Copies of the drafted instruments was subjected to face and content validation by three lecturers in Department of Industrial and Technology Education, Federal University of Technology Minna. The experts were requested to suggest modifications on the structure of items, organization and assess appropriateness of the study. Their suggestions and corrections for improvement on the language

level, technical terms and content of the instrument will be used to refine the items before the final copy of the instrument was produced.

3.7 Reliability of the Instrument

A pilot study was conducted to test the internal consistency of the instruments by administering the questionnaire to Automobile teachers in Technical colleges in Niger state. The generated data was analyze using the Cronbach's alpha to test the reliability which gives 0.83.

3.8 Method of Data Collection

The method of data collection was through administration and collection of the questionnaire from the respondents by the researcher and two research assistants.

The questionnaire was administered to the respondent and collected after a week interval from the date of administration. The total questionnaire that was distributed is hundred (100).

3.9 Method of Data Analysis

Data collected for this study was analyzed by computing the mean and t-test statistics. Mean was used to answer the research questions while Independent t-test was used to test the hypotheses at 0.05 level of significance. A four-point Likert rating scale was used for research questions one to three. Decision on the research questions was based on the resulting mean scores. Standard deviation will be use to decide on the closeness of the respondents to the mean of their responses. Any item with a mean of 2.5 and above was consider required while item with a mean below 2.5 was considered not required. Independent t-test was used to test the hypothesis at 0.05 level of significance.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Research Question One

What are the skills required by roadside automobile technician for servicing anti-lock braking system?

Table 4.1: Shows the mean responses of the respondent on the skills required by roadside automobile technician for servicing anti-lock braking system.

N_1= 63, N_2 = 37

S/N	ITEMS	$\bar{X}_A$	SD	Remarks
1.	Identifyingtheneededtoolsforservicingof Anti-lock braking system.	2.54	1.27	Required
2.	Removing the wheels in order to clean the brakes	2.50	1.23	Required
3.	Manually clean the brakes on the car	2.74	1.18	Required
4.	Replacing the brake fluid as often as recommended by your vehicle's owner's manual	2.51	1.19	Required
5.	Recalibrating the speed sensors	2.31	1.23	Not Required
6.	Topping the brake fluid container as recommended by the manufacturers	2.57	1.01	Required
7.	Changing the brake lining if bad	2.52	1.17	Required
8.	Checking the positions of the brake sensors	2.70	1.37	Required
9.	Check the lines of the ABS for leakages and functionality	2.80	1.10	Required
10.	Identifying the causes of ABS delay for rectification	2.59	1.43	Required
11.	Checking the service manual for the voltage resistance values on various pins and sensors	2.27	1.13	Not Required
12.	Consulting the service manual for a chart of specific values of components	2.54	1.27	Required

Keys:
N_1= Number of Automobile workshop supervisors.
N_2= Number of Automobile Teachers.
$\bar{X}_A$ = Mean average of Automobile workshop supervisors and Automobile Teachers.
SD= Standard deviation of Automobile workshop supervisors and Automobile Teachers.
*The key above also applies to Table 4.2 and 4.3.

Table 4.1 revealed the results on the skills required by roadside automobile technician for servicing anti-lock braking system. It shows that item 1,2,3,4,6,7,8,9,10 and 12 are required skills with the mean range (2.50-2.74), while item 5 and 11 are not required skills with mean range (2.27-2.31). The Table also revealed that the standard deviations (SD) of all items are within the ranges from 1.01 to 1.43, each of these values was less than 1.96 indicated that respondents were not too far

from the mean and from one another in their responses on the skills required by roadside automobile technician for servicing anti-lock braking system.

4.2 Research Question Two

What are the skills required by roadside automobile technician for repairing anti-lock braking system**?**

Table 4.2: Shows the mean responses of the respondent on the skills required by roadside automobile technician for repairing anti-lock braking system.

N_1= 63, N_2 = 37

S/N	ITEMS	$\bar{X}_A$	SD	Remarks
1.	Selecting appropriate tools for Antilock braking system repair.	2.56	1.21	Required
2.	Pumpingthebrakes24to40timeswhilethekey is in the off position to relieve the ABS system of any build up pressure.	2.70	1.25	Required
3.	Placingthesupportstandsonthemetalframes on both sides.	2.54	1.23	Required
4.	Removing the tire to allow access to the rotor and caliper.	2.57	1.02	Required
5.	Removing the caliper.	2.53	1.05	Required
6.	Removing the worn-out pads and replace them with the new pads when necessary.	2.77	1.08	Required
7.	Checking the master cylinder, brake lines and vacuum hoses.	2.51	1.10	Required
8.	Replacing the damaged hose when faulty.	2.58	1.20	Required
9.	Replacing the brake fluid.	2.56	1.09	Required
10.	Pumping the brakes to remove any air that may have entered the lines during your repair.	2.56	1.21	Required
11.	Pumping the brakes several times to rebuild pressure in the ABS system.	2.70	1.25	Required
12.	Moving the key to the on position to see if the ABS warning lights come on	2.54	1.23	Required
13.	Turning the car on and gently, apply the brakes lightly	2.57	1.02	Required
14.	Re-inspecting the pad or lining if the brakes feel soft or spongy	2.53	1.05	Required
15.	Removing any bad principal components of the Anti-lock braking system such as wheel speed sensor, valves, pump, brake fluid and the Anti-lock braking controller.	2.74	1.08	Required
16.	Spending the required time to make sure that it is set up completely before moving to another tire	2.52	1.10	Required

Table 4.2 revealed the results on the skills required by roadside automobile technician for repairing anti-lock braking system. It shows that all the item are required skills with the mean range (2.51-2.77). The Table also revealed that the standard deviations (SD) of all items are within the ranges from 1.01 to 1.25, each of these values was less than 1.96 indicated that respondents were not too

far from the mean and from one another in their responses on the skills required by roadside automobile technician for repairing anti-lock braking system.

4.3 Research Question Three

What are the safety measures required by automobile technologist when maintaining anti-lock braking system?

Table 4.3: Shows the mean responses of the respondent on safety measures required by automobile technologist when maintaining anti-lock braking system.

N_1= 63, N_2 = 37

S/N	ITEMS	$\bar{X}_A$	SD	Remarks
1.	Using relevant tools and equipment for the maintenance of ABS.	2.64	1.02	Agreed
2.	Never crawl under a vehicle that has not been properly supported.	2.60	1.21	Agreed
3.	Take care not to get any dirt on the rotor, as it will affect the performance of the brakes.	2.64	1.20	Agreed
4.	Turning off vehicle completely when ready for operation.	2.61	1.19	Agreed
5.	Use an axle stand and wedge to support the weight of the vehicle after removing the vehicle tyre.	2.51	1.27	Agreed
6.	Do not rush the job.	2.67	1.01	Agreed
7.	Use first class car jacks while maintaining Anti-braking system.	2.62	1.17	Agreed
8.	Applying recommended, brake shoes, brake lining, hoses and brake fluid.	2.72	1.37	Agreed
9.	Using the right tools for the right job.	2.81	1.10	Agreed
10.	Never open a bleeder valve or loosen a hydraulic line while ABS is pressurized.	2.53	1.43	Agreed
11.	Never disconnect or reconnect any electrical connectors while ignition is on.	2.68	1.02	Agreed
12.	Do not attempt to bleed hydraulic system without first referring to the appropriate anti-lock brake system in the Brakes section.	2.87	1.24	Agreed
13.	Only use specially designed brake hoses/lines on ABS equipped vehicles.	2.76	1.31	Agreed
14.	Do not tap on speed sensor components (sensor, sensor rings).	2.53	1.21	Agreed
15.	Sensor rings must be pressed into hubs and not hammered into hubs, to prevent demagnetization or a loss of polarization, affecting the accuracy of the speed signal returning to the ABS control unit.	2.63	1.27	Agreed
16.	Do not mix tire sizes. Increasing the width, as long as tires remain close to the original diameter, is acceptable.	2.52	1.13	Agreed

Table 4.3 revealed the results on the safety measures required by automobile technologist when maintaining anti-lock braking system. It shows that all items agreed on the safety measures required by automobile technologist when maintaining anti-lock braking system mean range (2.51-

2.74). The Table also revealed that the standard deviations (SD) of all items are within the ranges from 1.01 to 1.43, each of these values was less than 1.96 indicated that respondents were not too far from the mean and from one another in their responses on the safety measures required by automobile technologist when maintaining anti-lock braking system.

4.4 Hypothesis One

There is no significant difference in the mean responses of automobile supervisor and automobile teachers on the skills required by roadside automobile technician for servicing anti-lock braking system

Table 4.4 T-test Analysis of Mean Difference between Responses of automobile supervisor and automobile teachers on the skills required by roadside automobile technician for servicing anti-lock braking system

N1 = 63, N2 =37

	N	Mean	SD	Df	P	t-value	Decision
Automobile Supervisors	63	3.4	0.622	98	`0.01	5.47	NS
Automobile Teachers	37	3.4	0.622				

Table 4.4 shows the t-test analysis of differences in the responses of automobile supervisor and automobile teachers on the skills required by roadside automobile technician for servicing anti-lock braking system. The table reveals that the significant criterion (sig. 2-tailed) was found to be 0.52 which is greater than the level of significance 0.05 in comparison. The null hypothesis was therefore accepted. Therefore, there is no significant difference between the mean responses of automobile supervisor and automobile teachers on the skills required by roadside automobile technician for servicing anti-lock braking system.

4.5 Hypothesis Two

There is no significant difference in the mean responses of automobile supervisor and automobile teachers on the skills required by automobile technician for repairing anti-lock braking system.

Table 4.5 T-test Analysis of Mean Difference between Responses of automobile supervisor and automobile teachers on the skills required by roadside automobile technician for servicing anti-lock braking system

N1 = 63, N2 = 37

	N	Mean	SD	Df	P	t-value	Decision
Automobile supervisors	63	2.18	0.6	98	0.01	3.65	NS
Automobile teachers	37	2.18	0.6				

Table 4.5 shows the t-test analysis of differences in the responses of automobile supervisor and automobile teachers on the skills required by roadside automobile technician for repairing anti-lock braking system. The table reveals that the significant criterion (sig. 2-tailed) was found to be 0.30 which is greater than the level of significance 0.05 in comparison. The null hypothesis was therefore accepted. Therefore, there is no significant difference between the mean responses of automobile supervisor and automobile teachers on the skills required by roadside automobile technician for repairing anti-lock braking system.

4.6 Hypothesis Three

There is no significant difference in the mean responses of automobile supervisor and automobile teachers on the safety measures required by automobile technicians for servicing anti-lock braking system**.**

Table 4.6 T-test Analysis of Mean Difference between Responses of automobile supervisor and automobile teachers on the safety measures required by automobile technicians for servicing anti-lock braking system.

N1 = 63, N2 = 37

	N	Mean	SD	Df	P	t-value	Decision
Automobile supervisors	63	2.78	0.53	98	0.01	5.22	NS
automobile teachers	37	2.78	0.53				

Table 4.6 shows the t-test analysis of differences in the responses of automobile supervisor and automobile teachers on the safety measures required by automobile technicians for servicing anti-lock braking system. The table reveals that the significant criterion (sig. 2-tailed) was found to be 0.15 which is greater than the level of significance 0.05 in comparison. The null hypothesis was therefore accepted. Therefore, there is no significant difference between the mean responses of automobile supervisor and automobile teachers on the safety measures required by automobile technicians for servicing anti-lock braking system.

4.7 Findings of the Study

1. The findings of the study revealed that the results on the skills required by roadside automobile technician when servicing anti-lock braking system shows that all respondents agreed mean range from (2.51-2.74). The Table also revealed that the standard deviations (SD) of all items are within the ranges from 1.01 to 1.43, each of these values was less than 1.96 indicated that respondents were not too far from the mean and from one another in their responses.
2. The findings of the study revealed that the results on the skills required by roadside automobile technician when repairing anti-lock braking system shows that all the item are required skills

with the mean range (2.51-2.77). The Table also revealed that the standard deviations (SD) of all items are within the ranges from 1.01 to 1.25, each of these values was less than 1.96 and indicated that respondents were not too far from the mean and from one another in their responses.

3. The findings of the study revealed the results on the safety measures required by automobile technologist when maintaining anti-lock braking system shows that all respondents agreed on the safety measures required by automobile technologist when maintaining anti-lock braking system mean range (2.51-2.74). The Table also revealed that the standard deviations (SD) of all items are within the ranges from 1.01 to 1.43, each of these values was less than 1.96 indicated that respondents were not too far from the mean and from one another in their responses.

4.8 Discussion of Results

Research Question One

The result on the skills required by roadside automobile technician for servicing anti-lock braking system revealed that item 1,2,3,4,6,7,8,9,10 and 12 are required skills with the mean range (2.50-2.74), while item 5 and 11 are not required skills with mean range (2.27-2.31) among them are; Identifying the needed tools for servicing of Anti-lock braking system, removing the wheels in order to clean the brakes, manually clean the brakes on the car and replacing the brake fluid as often as recommended by your vehicle's owner's manual. The study of the findings is in line with Yavala (2010) conducted a study to determine the work skills improvement need of graduates of technical colleges in motor vehicle mechanic practice for employment in modern Nigeria. The study was carried out in Taraba state of Nigeria. Three research questions were formulated to guide

the research study. The study adopted a survey research design and the population of the study consisted of 40 graduates of motor vehicle mechanic practice from industries in the study area. There was no sample for the study, since the population was manageable. A structured questionnaire containing 43 work skill items was used for the collection of data from the respondents. The work skill questionnaire was divided into skills needed and performance with each having a 4-point response scale and a corresponding value of 4,3,2,1 for the two groups respectively. Split half method was employed to determine the internal consistency of the work skills questionnaire item with a reliability coefficient of 0.83. The instrument was analyzed using weighted mean and improvement needed index (INI). Findings of the study revealed that graduates of motor vehicle mechanics practice from technical colleges need improvement in work skills for engine maintenance, steering and braking system and auto electricity in order to be employed in Taraba state. The study therefore recommended that all the identified work skills in engine maintenance, steering and braking system and auto electricity should be integrated into the curriculum of motor vehicle mechanic practice in technical colleges for training students.

Research Question Two

The result on the skills required by roadside automobile technician for repairing anti-lock braking system revealed that all the item are required skills with the mean range (2.51-2.77). The Table also revealed that the standard deviations (SD) of all items are within the ranges from 1.01 to 1.25, each of these values was less than 1.96 indicated that respondents were not too far from the mean and from one another in their responses on the skills required by roadside automobile technician for repairing anti-lock braking system. Among the findings are; Selecting appropriate tools for

Antilock braking system repair, pumping the brakes 24 to 40 times while the key is in the off position to relieve the ABS system of any build up pressure, placing the support stands on the metal frames on both sides, removing the tire to allow access to the rotor and caliper, Removing the caliper, removing the worn-out pads and replace them with the new pads when necessary, Checking the master cylinder, brake lines and vacuum hoses, replacing the damaged hose when faulty and replacing the brake fluid. The findings of the study corroborate with Nwokolo (2011) conducted a study on training skills relevant for employment in metal work industries in Nigeria: the way forward. Three research questions and three hypotheses were formulated to guide the study. A total of 105 technical teachers were involved in the study. The instrument used for the study was Metalwork Skill Training Questionnaire (MWSTQ). T-test statistical tool was used in the analysis of data. The findings showed that the young graduates need broad based technical skills which can be adapted to rapidly changing economic requirements as well as appropriate basic skills which they can benefit from. The recommendation of the study is that governments in collaboration with non-governmental and international organizations should provide funds for the purchase of adequate number of equipments tools and materials to facilitate skills acquisition. The study is related to the present study in the aspect of skills. Although, Nwokolo's study is based on training skills for employment, the present study is aimed at identifying emerging technology skills required by Technical College graduates of MVMW for establishing automobile enterprises.

Odigiri& Ede (2010) also carried out a study on the integration of new technological innovations in automobiles into the curriculum of Nigerian Technical College programmes. The area of the study was Benue, Enugu and Kaduna states. The population of the study comprised of 81 subjects made up of all mechanical engineering or technology staff of the two automobile plants and auto-

mechanic teachers in the technical colleges in these selected states. The entire population was used for the study. The instrument for data collection was a 41 item structured questionnaire designed by the researcher based on the research questions used for the study. The findings of the study revealed that 41 new innovations comprising of 10 in the engine; 11 in the transmission, suspension, steering and braking systems; 20 in the electrical/electronic and auxiliary systems were rated as important to be integrated into the curriculum. Included among these prominent new automobile innovations are: electronic fuel injection system (EFI), electronic ignition system, variable valve timing intelligence (VVV), super charging, emission control systems, On-Board Diagnostic system, All Wheel Steering System (AWS), All Wheel Driving System (AWD) and Anti-lock Braking System (ABS) etc. The findings of this study also revealed that there is a significant difference in the mean responses of industrial workers and technical teachers on five of the identified new technological innovations in automobiles for which the null hypotheses were rejected. These items included the On-Board Diagnostic system, safety airbags and airbag curtains, automatic front windscreen wiper, automatic headlight brightness switch and multiplex wiring. Based on the findings and implications of the study, recommendations were made. These recommendations are as follows: Further studies should be conducted to identify all the other elements of the new innovations needed for the development of comprehensive curricular contents including the skills and theoretical contents entailed in their study as well as the new tools and equipment needed. The curriculum for teacher training programmes should be reviewed to include these innovations in order to prepare teachers who will be able to implement the curriculum with the new contents for the technical college programmes. The study is related to the current study in

the aspect of new technological innovations in automobiles, though the study was conducted on mechanical staff of automobile plants and technical college teachers.

Research Question three

The result on the safety measures required by automobile technologist when maintaining anti-lock braking system shows that all items agreed on the safety measures required by automobile technologist when maintaining anti-lock braking system mean range (2.51-2.74). among them are; Take care not to get any dirt on the rotor, as it will affect the performance of the brakes, turning off vehicle completely when ready for operation, use an axle stand and wedge to support the weight of the vehicle after removing the vehicle tyre, do not rush the job, use first class car jacks while maintaining Anti-braking system, applying recommended, brake shoes, brake lining, hoses and brake fluid, using the right tools for the right job, never open a bleeder valve or loosen a hydraulic line while ABS is pressurized and never disconnect or reconnect any electrical connectors while ignition is on. The findings of the study isin line with Ogbuanya&Fakorede (2012) to ascertain the technical skills improvement in the safety needs of metal work technology teachers for entrepreneurship in response to Millennium Development Goal (MDG) for quality assurance, 16 technical colleges offering metal work technology in Lagos and Ogun states were used for the study. Three research questions were formulated to guide the study. A structured questionnaire was used to collect relevant data from 110 metal work teachers. Data collected were analyzed using the statistical mean and standard deviation. Cronbach Alpha Reliability technique of 0.98 was established for the instrument. The findings of the study revealed that metal work technology teachers in technical colleges need modern metal work technology skills for quality training of

metal work technology students in technical colleges for occupation in metal work industry and productive self-employment. The recommendations of the study among others include the organization of an extensive training for metal work technology teachers in technical colleges in Lagos and Ogun states to keep them abreast with the contemporary practices as well as update their skills in metal work technology; the management of metal work industries and in-house personnel should be co-opted to consolidate teachers teaching with actual work experience.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The study is to determine the Skills Required by Roadside Automobile Mechanics in the Maintenance of Anti-lock Braking System in the Federal Capital Territory, Abuja. The study possesses three specific objectives to guide the study which are to identify the skills required by roadside automobile technician for servicing anti-lock braking system, identify the skills required by roadside automobile technician for repairing anti-lock braking system and identify the safety measures required by roadside automobile technician when maintaining anti-lock braking system. Three (3) corresponding research questions and null hypotheses were raised. The research design is a descriptive survey, the population of the study comprises of fifteen (15) automobile supervisor and twenty (20) automobile teachers. The study concluded that the need for high premium skills are required to be placed on the training and re-training of automobile supervisor and automobile teachers in order to fast track getting them well groomed and acquainted with principles and methods of imparting the knowledge and skills to automobile students and satisfying the customers needs in terms of servicing, repairing and safety measures.

5.2 Recommendations

Based on the findings of the study the following recommendations were made;

1. The automobile instructors should possess the required skills in identifyingtheneededtoolsforservicingof Anti-lock braking system.
2. The automobile instructors should possess the required skills in identifyingtheneededtoolsforrepairingof Anti-lock braking system.
3. Automobile teachers should be well equipped with the knowledge and skills in training automobile students for self-reliance and gainful employment in the automobile industries.
4. The government should provide devices and machines for repairs and servicing of ABS in institutions offering automobile as a discipline
5. The automobile supervisor should ensure that all safety measures are put in place when servicing and repairing ABS.

5.3 Suggestion for Further Studies

1. Assessment on the teaching of ABS system as a practical class in Technical Colleges Nassarawa State.
2. Assessment on the skills required by Automobile Students in Repairing ABS in Lagos State.

5.4 Contribution to Knowledge

This study has added to the existing body of literature on the skills required by roadside automobile mechanics in the maintenance of anti-lock braking system in the Federal Capital Territory, Abuja. This study has also established empirical evidence on the skills required by roadside automobile

technician for servicing and repairing anti-lock braking system as well as the safety measures required by roadside automobile technician when maintaining anti-lock braking system. The study provided a basis for future researches in the maintenance of anti-lock braking system in automobiles.

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APPENDIX A

QUESTIONNAIRE ON SKILLS REQUIRED BY ROADSIDE AUTOMOBILE MECHANICS IN THE MAINTENANCE OF ANTI-LOCK BRAKING SYSTEM IN THE FEDERAL CAPITAL TERRITORY, ABUJA

Dear respondent,

This Questionnaire is designed to obtain information on **Skills Required by Roadside Automobile Mechanics in the Maintenance of Anti-lock Braking System in the Federal Capital Territory, Abuja**. Please, kindly assist by filling the necessary information where appropriate. Any information obtained will be held in strict confidence and will be used solely for the purpose of this academic study. Please tick or write in the appropriate location.

SECTION A

Automobile Teacher [ ]

Automobile workshop Supervisor [ ]

HR= Highly Required (4 points)

R= Required (3 points)
MR= Moderately Require (2 points)
NR= Not required (1 point).

SA= Strongly Agree (4 points)
A= Agree (3 points)
DA= Disagree (2 points)
SD= Strongly Disagree (1 point).

SECTION B

ResearchQuestionOne

What are the skills required by roadside automobile technician for servicing anti-lock braking system?

HR= Highly Required (4 points), R= Required (3 points), MR= Moderately Require (2 points), NR= Not required (1 point).

S/N	ITEMS	HR	R	MR	NR
13.	Identifyingtheneededtoolsforservicingof Anti-lock braking system.				
14.	Removing the wheels in order to clean the brakes				
15.	Manually clean the brakes on the car				
16.	Replacing the brake fluid as often as recommended by your vehicle's owner's manual				
17.	Recalibrating the speed sensors				
18.	Topping the brake fluid container as recommended by the manufacturers				
19.	Changing the brake lining if bad				
20.	Checking the positions of the brake sensors				
21.	Check the lines of the ABS for leakages and functionality				
22.	Identifying the causes of ABS delay for rectification				
23.	Checking the service manual for the voltage resistance values on various pins and sensors				
24.	Consulting the service manual for a chart of specific values of components				

ResearchQuestionTwo

What are the skills required by roadside automobile technician for repairing anti-lock braking system?

HR= Highly Required (4 points), R= Required (3 points), MR= Moderately Required (2 points), NR= Not Required (1 point).

S/N	ITEMS	HR	R	MR	NR
1.	Selecting appropriate tools for Anti-lock braking system repair.				
2.	Pumpingthebrakes24to40timeswhilethekey is in the off position to relieve the ABS system of any build up pressure.				
3.	Placingthesupportstandsonthemetalframes on both sides.				
4.	Removing the tire to allow access to the rotor and caliper.				
5.	Removing the caliper.				
6.	Removing the worn-out pads and replace them with the new pads when necessary.				
7.	Checking the master cylinder, brake lines and vacuum hoses.				
8.	Replacing the damaged hose when faulty.				
9.	Replacing the brake fluid.				
10.	Pumping the brakes to remove any air that may have entered the lines during your repair.				
11.	Pumping the brakes several times to rebuild pressure in the ABS system.				
12.	Moving the key to the on position to see if the ABS warning lights come on				
13.	Turning the car on and gently, apply the brakes lightly				
14.	Re-inspecting the pad or lining if the brakes feel soft or spongy				
15.	Removing any bad principal components of the Anti-lock braking system such as wheel speed sensor, valves, pump, brake fluid and the Anti-lock braking controller.				
16.	Spending the required time to make sure that it is set up completely before moving to another tire				

ResearchQuestionThree

What are the safety measures required by automobile technologist when maintaining anti-lock braking system?

SA= Strongly Agree, (4 points), A= Agree (3 points), DA= Disagree (2 points), SD= Strongly Disagree (1 point).

S/N	ITEMS	SA	A	D	SD
1.	Using relevant tools and equipment for the maintenance of ABS.				
2.	Never crawl under a vehicle that has not been properly supported.				
3.	Take care not to get any dirt on the rotor, as it will affect the performance of the brakes.				
4.	Turning off vehicle completely when ready for operation.				
5.	Use an axle stand and wedge to support the weight of the vehicle after removing the vehicle tyre.				
6.	Do not rush the job.				
7.	Use first class car jacks while maintaining Anti-lock braking system.				
8.	Applying recommended, brake shoes, brake lining, hoses and brake fluid.				
9.	Using the right tools for the right job.				
10.	Never open a bleeder valve or loosen a hydraulic line while ABS is pressurized.				
11.	Never disconnect or reconnect any electrical connectors while ignition is on.				
12.	Do not attempt to bleed hydraulic system without first referring to the appropriate anti-lock brake system in the Brakes section.				
13.	Only use specially designed brake hoses/lines on ABS equipped vehicles.				
14.	Do not tap on speed sensor components (sensor, sensor rings).				
15.	Sensor rings must be pressed into hubs and not hammered into hubs, to prevent demagnetization or a loss of polarization, affecting the accuracy of the speed signal returning to the ABS control unit.				
16.	Do not mix tire sizes. Increasing the width, as long as tires remain close to the original diameter, is acceptable.				

Department of Industrial and Technology Education,
Federal University of Technology Minna,
Niger State.

Dear respondent,

I am an undergraduate student of Industrial and Technology Education in the above university. I am presently conducting research on **Skills Required by Roadside Automobile Mechanics in The Maintenance of Anti-lock Braking System in the Federal Capital Territory, Abuja**.

The questionnaire is designed as part of the study to collect relevant information for successful completion of this research.

Please kindly provide response to these questions I assure you that it will purely be used for academic purposes alone.

Thank you for your anticipated cooperation.

Yours sincerely,

Abah Leonard Ochidoma
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