CAPACITY BUILDING NEEDS OF AUTOMOTIVE MECHATRONICS INSTRUCTORS IN VOCATIONAL ENTERPRISE INSTITUTIONS IN ABUJA AND KOGI STATE, NIGERIA

BY

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A THESIS SUBMITTED TO THE POSTGRADUATE SCHOOL, FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, NIGER STATE IN PARTIAL FUFILMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER DEGREE IN INDUSTRIAL AND TECHNOLOGY EDUCATION, (AUTOMOBILE TECHNOLOGY)

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ABSTRACT

The study was designed to identify the capacity building needs of automotive Mechatronics Instructors in Vocational Enterprise Institution in Abuja and Kogi State, Nigeria, five research questions and five null hypotheses guided the study. Relevant literatures were reviewed in line with the objectives of the study. A descriptive research design was adopted for the study. The study was carried out in FCT, Abuja and Kogi state, Nigeria. A proportional stratified random sampling technique was used to drawn 10% of automotive industrial technicians for the study. Therefore, the sample population for the study was 115 respondents which comprise of 77 automotive industrial technicians and 38 automotive mechatronics instructors were used as population for the study. The instrument used for data collection was Automotive Mechatronics Instructors Capacity Building Needs Questionnaire (AMICBNQ) developed by the researcher and validated by three experts. The reliability coefficient of the instrument was 0.88 through Cronbach Alpha statistics. Statistical Package for Social Science (SPSS Version 23) was used for the data analysis, weighted mean, standard deviation and improvement needed index (INI) were the statistical instrument for answering research questions. While z-test statistics was used to test the null hypotheses formulated for the study at .05 level of significant. The findings on the capacity building needs of automotive mechatronic instructors on the maintenance of braking system with a grand capacity building need value (CBN=0.74) shows that the respondents agreed with all the items as capacity building needs of automotive mechatronics instructors in maintenance of braking system, likewise the findings on the capacity building needs of automotive mechatronic instructors on the maintenance of ignition system with a grand capacity building need value (CBN=0.82) revealed that the respondents agreed with all the items as capacity building needs of automotive mechatronics instructors in maintenance of ignition system, furthermore the findings on the capacity building needs of automotive mechatronic instructors on the maintenance of transmission system with a grand capacity building need value (CBN=0.71) shows that the respondents agreed with all the items as capacity building needs of automotive mechatronics instructors in maintenance of transmission system, meanwhile the findings on the capacity building needs of automotive mechatronic instructors on the maintenance of fuel supply system with a grand capacity building need value (CBN=0.79) shows that the respondents agreed with all the items as capacity building needs of automotive mechatronics instructors in maintenance of fuel supply system, finally the findings on the capacity building needs of automotive mechatronic instructors on the maintenance of suspension system with a grand capacity building need value (CBN=0.60) shows that the respondents agreed with all the items as capacity building needs of automotive mechatronics instructors in maintenance of suspension system, Based on the findings it was recommended that: Workshop and seminars should be organized for automotive mechatronics instructors in order to build their capacity in braking, ignition, transmission, fuel supply and suspension systems. Management of VEIs should sent automotive mechatronics instructors for further training in automotive mechatronics courses in order to update their knowledge/competencies. It was concluded that the trainees in VEIs at all levels can only acquire skills for employments or self-reliant under competent instructors. The inclusion of these identified areas of competences in the training manual of automotive mechatronic instructors will in no doubt help the instructors in effective teaching of automotive mechatronics courses.

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CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the Study

Vocational Enterprise Institutions (VEIs) are institutions approved as part of the ongoing reform of the technical and vocational education sector. They are institutions which offer competency based-skills in vocational, technical or professional education and training at post-basic and post-secondary levels to equip the youths as well as working adults with vocational skills and knowledge to meet the increasing demand for skilled man-power in the various sectors of the nation's economy National Board for Technical Education (NBTE, 2007). Specifically, the objectives of VEIs according to (NBTE, 2009) are to equip the youth as well as working adults with vocational skills and knowledge to meet the increasing demand for skilled manpower in the various sectors of the nation's economy and to widen access to vocational education and offer credible alternative to higher education.

(Federal Republic of Nigeria, 2014) in national policy on education stated that, VEIs are aimed at providing appropriate skills and certification to pursue a chosen trade or career, such as fashion design, agriculture, office secretarial, carpentry and joinery, computer studies, fabrication and welding, block laying and concreting, printing technology, electrical installation and wire repair works, motor vehicle mechanics and automotive mechatronics.

Automotive mechatronics is one of the vocational trades offered in VEIs in Nigeria which is aimed at producing competent vehicle mechanics with sound practical skills, knowledge and ability to diagnose and carryout repairs and/or maintenance on all types of modern vehicles equipped with electronics and computer systems. According to Abubakar *et al,.* (2015) automotive mechatronics is the synergic application of physics, namely, mechanics, fluid (hydraulics or pneumatics), electrics, electronics, overall control theory, computer science, and sensor and actuator technology to design improved automotive products and manufacturing. However, the process of developing competencies and capabilities in individuals, groups, organization is referred to as capacity building.

Capacity building is the process of developing competencies and capabilities in individuals, groups, organization sectors or countries which leads to sustainable and self-generating performance improvement in specific area or aspect of human development. Akbar (2013) defines capacity building as a process of developing and strengthening the skills, instincts, abilities, processes and resources that individuals, organizations and communities need to survive, adapt and thrive in the fast changing world. It focuses on understanding the obstacles that inhibit people, institution, government, international organizations and non-governmental organization from realizing their developmental goals while enhancing the abilities that will allow them to achieve measurable and sustainable results. In automotive mechatronics the fundamental goal of capacity building is to enhance the ability of instructors based on perceived needs.

Capacity building needs are set of activities that expand the scale, reach, efficiency or effectiveness of an individual, organization or programme. These activities may expand services, enhance delivery of services, or generate additional resources for the individual or organization. The Canadian International Development Agency (CIDA) (2013), viewed capacity building needs as the activities, approaches, strategies, and methodologies which help organizations, groups and individuals to improve their performance, generate development benefits and achieve their objectives. Therefore, capacity building needs in the context of this study refers to strengthening the skills, competences and abilities that automotive mechatronic instructors should possessed so that they can produce competent automotive mechatronics craftsmen. Since automobile industries advance every day, automotive mechatronics instructors need consistent capacity building so as to kept in pace with the technological advancement in the industry. Moreover, adequate knowledge and skills cannot be transfer to the trainee without an instructor.

An instructor is one who influences another to change his attitude and behavior on the basis of new skill, knowledge, values, habit and practical skills. On the other hand, an automotive mechatronic instructor is one whose role extends from the development of intellectual activities and cognition to the development of practical skills in modern vehicles, (psychomotor), emotions, attitudes and morals (affective) (Adamu, 2015). The foregoing clearly revealed that an automotive mechatronic instructor should be familiar with the current technological changes in automotive industry, be computer literate, and plan the learning activities and experiences with the view of current global changes and practices in the technological world. However, one of the major challenges of automotive mechatronics instructors is the changes in the present day modern vehicle systems; these changes according to Jimoh (2017) have affected automotive instructors in the areas of understanding, interpreting and maintenance of modern vehicles.

Maintenance involves taking specific approved steps and precautions to care for a piece of equipment, machinery or facility and ensure it attains its maximum shelf life. Maintenance is defined as actions necessary for retaining or restoring a piece of equipment, machine, or system to the specified operable condition to achieve its maximum useful life (Olaitan *et al.,* 2009b). This signifies that the automotive mechatronic instructors need to know how to carry out maintenance on modern vehicle. Maintenance in the context of this study is a set of organized activities that should be carried out in order to prolong the service life of a vehicle and keep its best operational condition with minimum cost acquired. Parts of these modern vehicle system and sub systems equipped with mechatronics in the words of Malone (2016) include: Braking system, Ignition system, Transmission system, Fuel supply system and suspension system. However, vehicle system which serves to either reduces the speed of the vehicle or brought it to rest when the need arises is the braking system.

The braking system converts the mechanical energy possessed by the vehicle into heat energy by the means of friction in other to slow down the vehicle or completely stop the vehicle safely when the need arises. Giri (2013) revealed that the operation performed in braking system is the reverse of that carried out in accelerating. In the latter the heat energy of the fuel is converted into the kinetic energy of the vehicle, is converted into heat. Accordingly, the vehicle system responsible for providing spark necessary to ignite the mixture of air/fuel inside the engine cylinder is the ignition system.

The ignition system supplies a suitable spark inside the engine cylinder under all varying condition of engine operation. The spark ignites the compressed air/fuel mixture in the combustion chamber; each spark is timed to appear at the plug gap just as the piston approaches Top Dead Centre (TDC) on the compression stroke (Giri, 2013). The main component of the conventional ignition system includes; ignition coil, distribution, centrifugal advance mechanism, spark plug, switch and condenser. Gscheidle (2016) argued that most engines produced today are distributor less and rely on sensor and electronic component to perform this task. Consequently, the power developed by the engine through the downward movement of the piston is conveys to the driving road wheels through the vehicle transmission system.

Transmission system transfer power from the engine to the drive shaft and the wheel. The main function of the transmission system is to transfer the torque produced by the engine crankshaft to the road wheels. The transmission system could be manually operated or automatically operated. Mayur (2012) stated that conventional transmission system consist of clutch plates and disc, clutch cylinder, gearbox, propeller shaft, universal joint, differentiate unit, driving shaft and sliding joint. In order to have an efficient running engine, correct amount of fuel most be supply to the engine by the fuel supply system.

The fuel supply system supplies correct amount of fuel to the fuel injectors, which is delivered to the combustion chamber. Erjavec (2010) asserted that in the old fuel supply system the fuel pump delivered fuel under pressure to the fuel injectors. The old fuel supply system consists of fuel tank, mechanically operated fuel pump, carburetor and fuel pipes.

Most modern vehicle according to Mayur (2012) has their tank positioned lower at the rear of the vehicle to lower the centre of gravity and reduce the risk of fire. Modern fuel supply system make use of electronic fuel injection (EFI) system which are controlled by computers and designed to provide the correct air fuel ratio to all engine loads, speeds, and temperature conditions. Rolling, pitching galloping as well as the oscillation action of the vehicle entirely is counteracted by means of suspension system.

The suspension system reduce the shocks to passenger and vehicle, even under good road condition a vehicle may subject its passengers both to bounce, roll or sway when concerning and to pitching when the front wheels are suddenly lifted or dropped in relation to the rear wheel. The main components of the suspension system as indicated by Konrad (2015) are the springs and the shock absorbers. This shock absorber could be (dependent suspension or independent front suspension or fully independent suspension system). The various types of suspension system use in modern vehicle in the words of Konrad (2015) includes telescopic fluid filled suspension, leaf spring suspension, torsion spring suspension, hydro-elastic suspension and electro actuated suspension. The Electronic Damping Control (EDC) has electronically controlled suspension systems using air, nitrogen gas and hydraulic oil as suspension agent. Hence the experts that are in better position to identify the capacity building needs of automotive mechatronics instructors at VEIs are automotive industrial technicians.

Automobile industrial technicians in the context of this study refers to the highly skilled individual or group of individual whose major works are to maintain vehicle functional condition by listening to operator complains, conditioning inspection, repairing engine failures, repairing mechanical and electrical system malfunctions, replacing parts and components as well as body damage. Even though automotive instructors are involves directly in imparting practical skills aspects of modern vehicle to the trainees (Abdulkadir, *et al* 2019). They can only do so in the aspect that they can perform through the skills they possessed. Hence, this will enable them to identify those aspects of modern vehicle performance skills they possessed in term of maintenance and repairs.

The foregoing clearly revealed that modern automobiles are blend of 20th and 21st century technology. The designs of modern vehicles have advanced to a very sophisticated level. Unlike the old mechanical operated vehicle systems, the modern vehicles are being operated and controlled by computerized electrical sensors. Indeed almost every other function within the engine is controlled by an onboard computer. However, Michika (2019) pointed out that the use of electronic circuit and advents of computers have changed the operating systems in modern vehicles. Many stakeholders involved in ensuring effective integration of modern technologies in the education system, instructors have a particular important role to play. Carlson and Gadio (2012) opined that instructors are the key to whether technology is used appropriately and effectively. Appropriate use of modern technologies can catalyze the paradigm shift from instructors-centered pedagogy to a more effective learner-centered pedagogy; Capacity building of instructors can play a major role in enabling this shift. This study is therefore design to identify the capacity building needs of automotive mechatronics instructor in vocational enterprise institutions in Abuja and Kogi state.

1.2 Statement of the Research Problem

The responsibility of Automotive Mechatronics Instructor in VEIs in Nigeria is to facilitate learning in theoretical, practical aspect of automotive mechatronics courses and evaluate the trainees for effectiveness of training and individual growth. In addition they should be able to conduct practical demonstration of automotive mechatronics in the workshop through the capacity building possessed by them. These will enable graduates of VEIs to function effectively as craftsmen and women in automotive establishments, carryout necessary general tests procedures, standard diagnosis and faults rectification in modern vehicles (Federal Republic of Nigeria, 2014). Automotive mechatronics instructors are expected to be able to demonstrate the use of different sophisticated diagnostic equipment for fault detection and rectification in various modern vehicles brands, observe relevant safety in automotive Mechatronics Engineering practice, interpret wiring diagrams, fault codes, as well as technical reference materials (NBTE, 2009).

However, it has been observed that graduates of automotive mechatronic from VEIs who are expected to, upon completion of their training programme have acquired practical skills that will enable them to secure paid employment or set up their own workshop and become self-employed and employer of labour cannot do so because of the limited competencies possessed by them (Michika, 2019). Although literatures attributed these low competencies possessed by these trainees upon graduation to low capacity building of automotive mechatronic instructors. Jimoh (2017) attributed the low capacity building in those instructors to recent advancement in automotive industry. Although these might not be unconnected with the fact that these instructors do not have up to date the technical know-how and seems to lack capacity building in automotive mechatronic systems such as braking system, ignition system, transmission system, fuel supply system and suspension system. The problem of this study therefore is to determine the capacity building needs of automotive mechatronics instructors in Vocational Enterprise Institutions in Abuja and Kogi state.

1.2 Aim and Objectives of the Study

The aim of this study was to identify the capacity building needs of automotive mechatronics instructor in vocational enterprise institutions in Abuja and Kogi state; specifically, the study sought to achieve the following objectives:

1. Determine the capacity building need of automotive mechatronics instructors in the maintenance of braking system
2. Identify the capacity building needs of automotive mechatronics instructors in maintenance of ignition system
3. Determine the capacity building needs of automotive mechatronics instructors in maintenance of transmission system
4. Identify the capacity building needs of automotive mechatronics instructors in maintenance of fuel supply system
5. Identify the capacity building needs of automotive mechatronics instructors in maintenance of suspension system

1.3 Significance of the Study

The study will be of immense benefit to the management of VEIs, NBTE, Automotive Mechatronics Instructors, Automotive Industries, Policy Makers, Ministry of Labour and Productivity, academics Researchers and the Society.

The findings of the study will also be of great benefit to the management of VEIs on the capacity building needs of their automotive mechatronics instructors. The information from this study will help the management of VEIs to grant instructors study leave or seek for sponsorship from the government and non-governmental organizations for retaining the instructors for effectiveness

To the NBTE the finding of the research will assist in curriculum planning, programme evaluation, quality assurance of National Vocational Certificate in Automotive Mechatronic to achieve its aim of providing solution to the service maintenance problems of high technology motor vehicles through the production of competent craftsmen and women who will be enterprising and self-reliant. The study will provided information to the NBTE on the capacity building needs of automotive mechatronics instructors in vocational enterprise institution. The board could also help to persuade the Education Trust Fund (ETF) to grant the automotive mechatronics instructors some allowance or scholarship to enable them attend capacity building programme, locally or abroad. This can be achieved if the capacity building needs identify is utilized by NBTE

The study will benefit the Automotive Mechatronics Instructors in their multitudinous duties and responsibilities as the area they needed capacity building identifies will help the instructors to discharge their duties without stress. Also, this study will serve as eye opener or provide information for automotive mechatronic instructor on capacity building needs to improve themselves. The knowledge provides will help the Automotive Mechatronics Instructors in their instructional design and delivery with adequate skills and competency which is essential in automotive mechatronics. The findings will also be utilized by the automotive mechatronics instructors to write for sponsorship from the school administration for retraining in modern automotive technologies to improve their capabilities. This can be achieved if the capacity building needs identified can be packaged in form of training manual and used to build the capacity of Automotive

Mechatronics Instructors in the areas identified through seminars and workshop

The Automotive Industries will benefit from the finding of the study if implemented; the industries will have automotive mechatronic graduates who are skilled and knowledgeable in automotive mechatronics to provide solution to the service maintenance problems of high technology vehicles. Thereby enhancing the effectiveness and the efficiencies of the automotive industries. This can be achieved if the capacity building needs identify are accessed and utilized by administrators in vocational enterprise institution in Nigeria.

The study will provide empirical data and information to the Nigerian policymakers on the areas where instructors need capacity building in emerging automotive technologies for teaching in vocational enterprise institution. This can be used in organizing seminars/workshops on capacity building of automotive mechatronic instructors in vocational enterprise institution in the country, as this is part of their primary duties. The capacity building needs identifies will assist in policy formation that will help in achieving the national objectives. This can be achieved if the capacity building needs identify is included in training manual of automotive mechatronics.

Ministry of labour and productivity will also use the findings of the study to suggest to the government the areas of improvement and areas of weakness in the provision of input facilities, tolls and equipment to enhance the technological development of the nation. This can be achieved through implementation of the findings and adopting the suggestions and the recommendation that will be made based on the findings of the study.

Academic researchers in the area of Automotive Mechatronics will find the study of much relevance as the capacity building needs of Automotive Mechatronics instructors identified will contain valuable information on the requisite skills required by Automotive Mechatronics instructors which can be used for referencing purposes. The information on capacity building need to be identified will tremendously contribute to the world of knowledge which will be useful to students of researchers in Automotive Mechatronics and related fields

The findings of study will be of benefit to the society as the implementation of the curriculum so design with the incorporation of practical skill will produce poll of automotive mechatronic craft men who will be able to handle modern vehicles using modern technology, enterprising and productive in the society. Invariably, this will help to reduce the rate of unemployment in this country and its associated social evil. The society will benefit from the study, as automotive mechatronic technicians who are skilled, competent and ready to find solution to automotive related problems will be produced. The crop of craftsmen and women that can set up their private automotive workshops and produce all kinds of servicing and repairs for the members of the society will be produced. this can be achieve through implementation of the findings and adopting the suggestions and the recommendation that will be made based on the findings of the study.

1.5 Scope of the study.

The study covered the following aspect of modern vehicles that operates on gasoline (spark ignition engines) braking system, ignition system, transmission system, fuel supply system and suspension system. However, heavy duty vehicle such as those operating on diesel (compression ignition engine) were not covered in this study, simply because their constructional features and principles of operation differs from that of modern spark ignition engines.

1.6 Research Questions

The following research questions guided the study

1. What are the capacity building needs of automotive mechatronics instructors in maintenance of braking system?
2. What are the capacity building needs of automotive mechatronics instructors in maintenance of ignition system?
3. What are the capacity building needs of automotive mechatronics instructors in maintenance of transmission system?
4. What are the capacity building needs of automotive mechatronics instructors in maintenance of fuel supply system?
5. What are the capacity building needs of automotive mechatronics instructors in maintenance of suspension system?

1.7 Hypotheses

The following null hypotheses guided the study and were tested at 0.05 level of significance

HO_1: There is no significant difference in the responses of the automotive industrial technicians and automotive mechatronics instructors as regard the capacity building needs of automotive mechatronics instructors in maintenance of braking system.

HO_2: There is no significant difference in the responses of the automotive industrial technicians and automotive mechatronics instructors as regard the capacity building needs of automotive mechatronics instructors in maintenance of instructors in maintenance of ignition system.

HO_3: There is no significant difference in the responses of the automotive industrial technicians and automotive mechatronics instructors as regard the capacity building needs of automotive mechatronics instructors in maintenance of transmission system.

HO_4: There is no significant difference in the responses of the automotive industrial technicians and automotive mechatronics instructors as regard the capacity building needs of automotive mechatronics instructors in maintenance of fuel supply system.

HO_5: There is no significant difference in the responses of the automotive industrial technicians and automotive mechatronics instructors as regard the capacity building needs of automotive mechatronics instructors in maintenance of suspension system.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Theoretical Framework

2.1.1 Dreyfus model of skill acquisition

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 he makes 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 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. He 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 originator of model proposes that a student passes through five distinct stages: novice, competence, proficiency, expertise, and mastery. However, these stages of skill acquisition relates to this study in the following ways:

1. Novice Stage: At this first stage, an individual observes rules as given, without setting, with no feeling of obligation and adhering to the guidelines precisely. In this stage the learner or agent has some general ideas and is the process of learning the guidelines which upon graduation will set them up for arising innovation abilities for the upkeep of modern vehicles.

2. Advanced Beginner: The student at this stage perceives new circumstances in which the guidelines might be applied. Understudy's exhibition improves to a generally satisfactory level exclusively after the fledgling has had enough involvement with replicating the genuine circumstance, the understudies begins to show interesting execution through close to home insight.
3. Competency Stage: Competence created when the individual creates coordinating standards to rapidly get to the specific principles that are applicable to the particular job needing to be done; consequently, skill is described by dynamic in picking a strategy. Understudy's at this stage starts to get included actually with the undertaking. They begin seeing more than one choice from which they need to pick the best one for ideal execution.
4. Proficiency Stage: Proficiency is appeared by people who create instinct to control their choices and devise their own guidelines to figure plans. The movement is hence from inflexible adherence to rules to a natural method of thinking dependent on unsaid information. This is where the understudy while instinctively understanding his errand, actually considers his activities. The understudy more likely than not procured essential abilities that will empower him think inventively towards getting independently employed after graduation. Subsequently, examining methods of raising capital, area of business and other business procedures turns into his need.
5. Mastery Stage: Experts as a rule realize what to do base on develop comprehension of the errand. A specialist has had such a lot of involvement in the undertaking that the ability of completing the assignment is important for him. He follows up on right instincts without scientifically considering everything he might do. They

likewise underscore on the way that training is needed for the specialist to keep up the knowing-how.

Without capacity building automotive mechatronic instructors will step by step lose their ability also, well on the way to relapse the extent that the capability stage. This revealed that automotive mechatronics instructors constantly need capacity building.

2.1.2 Theory of needs

The theory of needs assessment was propounded by Maslow's in 1968. He explains why people are driven by particular needs at particular times. Maslow (1968), note that personality development can be described has a combination of a press and a need. According to Maslow each theme in an individual life is characterized by the existence of a need in relation to a particular press, a stimulus- situation that has a potential influence upon the life of the organism. In his view, Anyakaoha, (2009), saw need gratification as the basis for most human behaviors he argue that needs are arrange in hierarchy

i. Aesthetic needs
ii. Desire to know or understand
iii. Self-actualization needs
iv. Esteem needs
v. Love and belonging needs
vi. Safety needs
vii. Physiological Needs

Thus as one general type of need is satisfied another higher order of need will emerge and become operative in life. The above concept of need, have implications, among other things for capacity building needs of automotive mechatronic instructors in Vocational Enterprise Institutions. The automotive mechatronic instructors should concern himself with effort to find out how best to structure his instructional activities so that to improve the automotive mechatronics trainee. Thus the key concept to bear in mind is the occasional and appropriate involvement of capacity building needs in maintenance of automotive mechatronics system such as braking system, electronic ignition system, transmission system, fuel supply system and suspension system. Since these automotive mechatronics instructors have skills already but need capacity building. In this case, automotive mechatronics instructors' needs capacity building to strive and improve their skill needs. However, these automotive mechatronics instructors got their certificate with relevant skills but they are supposed to improve skill in their working place through capacity building.

2.1.3 Self-concept theory of career development

Capacity building needs is the process of identifying, developing and strengthening the skill, instincts, abilities, process and resources that are particular to career development and thrive in a fast changing world. Savickas (2011) stated that the process of career building is essentially that of developing and implementing practical skills in work roles. A relatively stable self-concept emerge in late adolescence to serve as a guide to career development and adjustment, self-concept evolve as person encounters new experience and progress through the developmental stages. Career development theory of Savickas (2011) identifies developmentally appropriate tasks and interventions at different educational level and focuses on decision making, self-knowledge, occupational information, planning and problem solving through four intervention methods. These four intervention methods are career orientation, teaching skills for planning and exploring career possibilities, coaching of career management techniques, and role rehearsal of job problems. The major task according to this approach is increasing development awareness by seeking information and skills, then planning to implement the skill. This can be accomplished by instructors to explore and participate in the widest possible range of capacity building. This theory is appropriate for the study because using self-concept theory will enhances the capacity building needs of automotive mechatronic instructors through identifying the skills needs, exploring career possibilities and development of appropriate task in solving problems on maintenance of automotive systems such as braking system, electronic ignition system, transmission system, fuel supply system and suspension system will be enhanced

2.1.4 Need assessment theory

Need assessment theory was propounded by Graham and Mihal (1986). The use of need assessment theory for identifying and justifying gaps in result and placing the gap in prioritized order for attention is of great importance in building the capacity of automotive mechatronic instructors in vocational enterprise institutions. According to Kaufman (1985) need assessment involve identifying and justifying gaps in results, and placing the gap in prioritized order for attention?

In relation to the capacity building needs of automotive mechatronics instructors in vocational enterprise institution in Abuja and kogi state, learning is more likely to lead to change in practice when needs assessment has been conducted. This will help to identify practices needed for improvement and ensure that educational and organizational interventions are made to address these needs. Grant and Osanloo, (2014) classified methods of needs assessment into seven main types, each of which can take many different forms in practice.

1. Gap or discrepancy analysis
2. Reflection on action and reflection in Action
3. Self-assessment by diaries journals, log books, weekly reviews
4. Peer Review
5. Observation
6. Critical incident review and significant event auditing
7. Practice review:

McArdle (1996) concluded that there is no one model or conceptual framework for needs assessment that has been universally accepted and there is little empirical evidence of the superiority of one approach over another. Sunita and Ajeya (2011) took this one step further and added feedback to each step. Their eight-step process included the following:-

1. Identify the purpose and then allow for response.
2. Identify the information needs and then allow for response.
3. Identify the target population and then allow for response.
4. Collect the data and then allow for response.
5. Analyze the data and then allow for response
6. Report the results and then allow for response.
7. Apply or use the results and then allow for response.
8. Evaluate the outcomes and then allow for response.

Grant and Osanlo (2014), stress that need assessment might be to help curriculum planning, diagnose individual problems, assess students learning, demonstrate accountability, improve practice and safety or offer individual feedback education intervention. Three basic survey methods for collecting needs assessment data include, questionnaires, interviews and the critical incidents technique, of these, the written questionnaire is the most common method of collecting needs assessment data (Witkin & Attschuld, 1995). For the purpose of this study, descriptive survey method will be used for collecting assessment data. Need assessment theory is related to this study in that what is needed by automotive mechatronics instructors will be subtracted from their performance to know the gap. This gap will now show whether the automotive mechatronics instructors will need capacity building or not.

2.2 Conceptual Framework

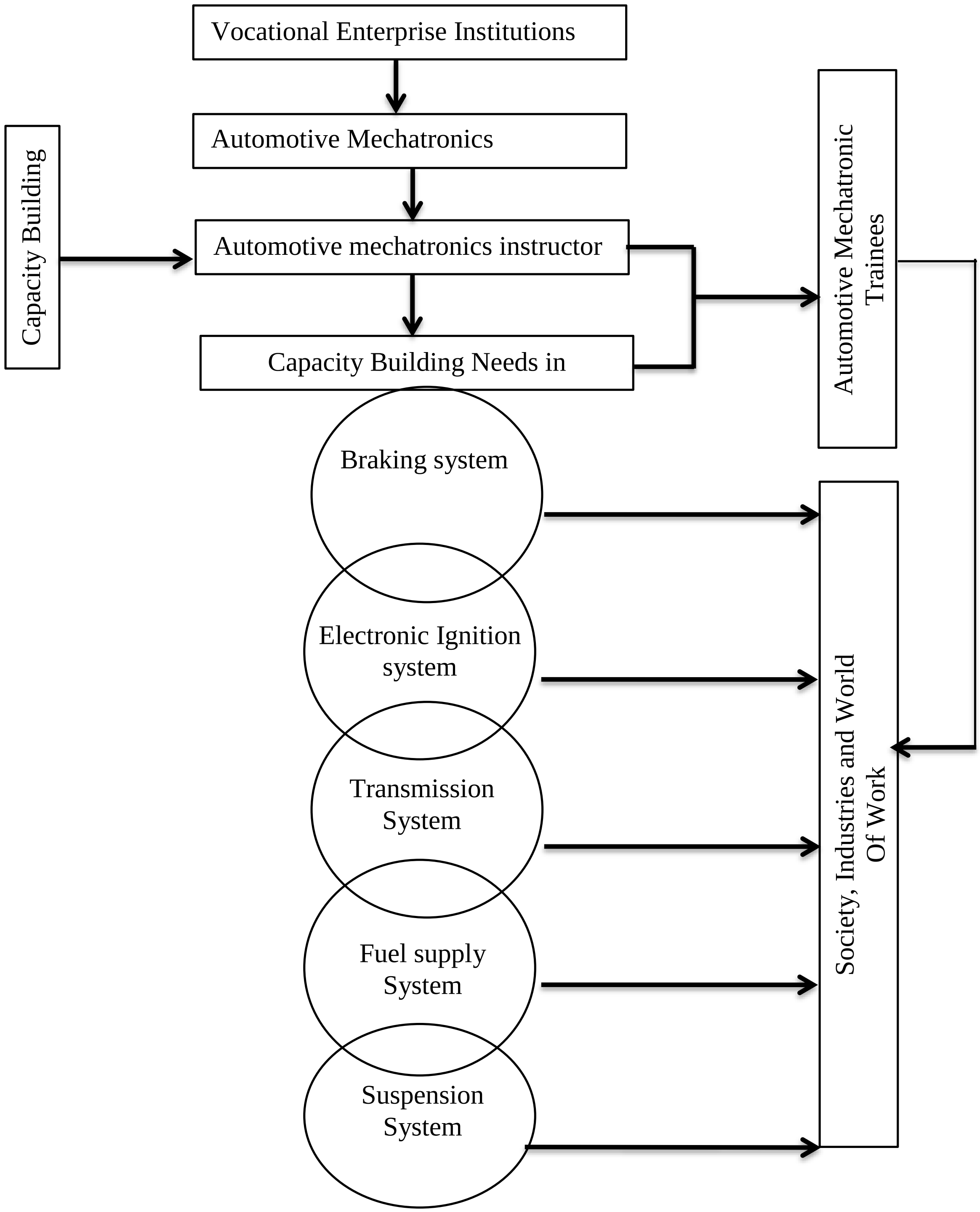

Fig 2.1 Conceptual Frame Work of the Study
Source: Researcher (2021)

The conceptual framework of this study is based on capacity building needs of automotive mechatronics instructors in VEIs. VEIs are vocational institutions that offer competency based skills in technical vocational education and training (TVET). Automotive mechatronics is one of the vocational trades offered in VEIs which is aimed at producing competent vehicle mechanics; however, competent vehicle mechanics cannot be produce without competent automotive mechatronics instructor. Automotive mechatronics instructors is one whose role extent from development of intellectual activities and cognitive to development of practical skills in modern vehicle. Automotive mechatronics instructors cannot successfully carryout this responsibility without adequate capacity building. Capacity building refers to strengthening the skills competency and abilities of an individual, group and organization according to perceived need. Since automotive industries advance everyday automotive mechatronics instructors needs capacity building in braking, ignition, transmission, fuel supply and suspension systems, so that they can produce competent automotive mechatronics trainee that will in turn serve the society, industries and world of work.

2.2.1 Vocational Enterprise Institutions in Nigeria

The literature reviewed revealed that Vocational enterprise institutions (VEIs) are institutions approved by federal government to provide an alternative route to higher education, as part of the on-going reform of the technical and vocational education sector. They are private institution which offer competency based skills in vocational, technical or professional education and training at post basic and post-secondary school levels to equip the youth as well as working adults with vocational skills and knowledge to meet the increasing demand for skilled manpower in the various sectors of the nation's economy.(

National Board for Technical Education, 2009) a large part of these responsibility for preparing citizen rest on higher education institutions, but which are constrained by several challenges including lack of capacity to accommodate increasing number of applicant, low participation of private sector in skill training and development of manpower and mismatch between training provided and needs of employer (Adamu, 2015). These challenges pose serious threats to the attainment of the vision. To address these and many other challenges government has approved establishment of the private sector led vocational enterprise institutions with major aim of widening access to technical and vocational education and training(TVET) to serve the needs of the industry and self-empowerment of the nation's citizen (NBTE, 2007).

Vocational enterprise institution in Nigeria evolved in response to technological and industrial needs of the people, vocational enterprise institutions is a type of training that broader on the acquisition of knowledge and skills in occupational trades such as office secretarial assistant, fabrication and welding, carpentry and joinery, computer studies, block laying and concrete, hospitalism and tourism studies, printing technology, motor vehicle mechanic, fashion design, electrical installation and repair works, refrigerator and air-conditioning, cosmetology and beauty therapy, oil and gas facilities engineering technology, workshop organisation and management and automotive mechatronics (NBTE, 2009).

2.2.2 Automotive mechatronics programme in Nigerian Vocational Enterprise Institutions

Automotive mechatronic is a vocational trade that prepares individuals for the world of work. It is one of the trades offered in VEIs in Nigeria (NBTE, 2011). The National Vocational Certificate in Automotive Mechatronics is aimed at providing solutions to the service maintenance problems of high technology motor vehicles through the production of competent craftsmen and women who will be enterprising and self-reliant. On completion of this programme, the Trainees should be able to:

i. Function as technicians in automotive and related establishments
ii. Carryout necessary general tests procedures, standard diagnosis and faults rectification in modern vehicles
iii. Demonstrate the use of different sophisticated diagnostic equipment for fault detection and rectification in various modern vehicles brands
iv. Observe relevant safety in Automotive Mechatronics Engineering practice
v. Interpret wiring diagrams, fault codes, as well as technical reference materials.

Entry Qualification:

The minimum entry qualification into the National Vocational Certificate in Automotive Mechatronics programme is Post Basic Education Certificate (Post Junior Secondary School Certificate).

Structure of the Programme

The National Vocational Certificate (NVC) in Automotive Mechatronics Programme is in flexible modular form, and is structured to have three parts (i.e. NVC Part I, NVC Part II, and NVC Final each taken in a span of one year. Each part has a cogent and flexible structure and content that allow the trainee a practical working skill unit and the possibility to exit at that level. Each part incorporates six months intensive training in the school and three months of supervised industrial work experience (SIWES). In a 14 weeks term, 12 weeks are for academic activities while 2 weeks are for registration and evaluation. For a 40hrs week, 6hrs are for core theory courses; 2hrs General education courses and 32 hrs are for practical.

Evaluation Scheme

The National Vocation Certificate Examination must be externally moderated. In grading the awards; theory shall constitute- 20%, practical – 50% and SIWES - 30%. If there are group practical/projects, trainees must be assessed periodically on individual basis and records kept. Note that trainees are to be assessed on completion of every module. The grading shall be Distinction (70 and above).

The trade, theory and practice component for automotive mechatronics is presented as follows:

i. Introduction to Computer
ii. Fundamental of Internet Technology
iii. Introduction to Computer Design and Drafting
iv. Technical Drawing
v. Vehicle Routine Maintenance
vi. Basic Mechanics
vii. Conventional Coil ignition System Maintenance
viii. Workshop Safety Measures and Ethics

ix. Engine Maintenance

x. Automotive Electricity and Electronics

xi. Auto-Electrical System Maintenance

xii. Battery Maintenance

xiii. Basic Engineering Materials

xiv. Introduction to Engineering Measurement

xv. Automotive Sensor Technology

xvi. Alternator and Stator Motor Maintenance

xvii. Automotive Lighting System

xviii. Electric Power-assisted Steering System

xix. Transistorized Ignition System Maintenance

xx. Fuel injection System Maintenance

xxi. Modern Brake System

xxii. Diesel Engine Fuel System Maintenance

xxiii. Workshop Management and Organization

xxiv. Vehicle Communication Systems

xxv. Safety & Comfort System

xxvi. Electronic Wheel Alignment

xxvii. Automotive Gear Box System

xxviii. Electronic Diesel engine Maintenance

xxix. Electronic Ignition System

xxx. Electronic Vehicle Diagnosis

The Table 2.1, 2.2 and 2.3 shows the minimum` workshop requirement for automotive mechatronics

Table 2.1 workshop requirement

S/N	Description	Quantities
1.	Digital Multimeter (DMM)	5
2.	Potentiometer	5
3.	Ohmmeter	5
4.	Oscilloscope	5
5.	Independent Power supply panel	5
6.	Personal Computers	20
7.	Printers	2
8.	Scanner	1
9.	Function Generator (A.C.)	5
10.	Function Generator (D.C.)	5
11.	Multimedia Data acquisition & Control board	2
12.	Lab View Software (data acquisition & process control)	1 packet
13.	MATLAB software	1
14.	Bench link software (HP, LG, IBM, etc.)	1
15.	Engine analysis, Part sourcing & assembling techniques tools	1
16.	Training board (Auto-electric)	1
17.	Plug-in-cables	1
18.	Pneumatic training unit	1
19.	Hydraulic board	1
20.	Bearing and Precision assembly kit	1

Source: NBTE 2009

Table 2.2 Drawing Room/Studio Requirement

S/No.	**Description**	**Quantity**
1	Drawing table complete with drafting machine/stools	30
2	Drawing set complete with pens for ink work	2
3	45^o set squares	2
4	60^o set squares	2
5	Blue printing machine	1
6	Adjustable set squares	5
7	Desk sharpener	5
8	Triangular scale rule (30 mm)	5
9	Flat scale rule (300 mm)	5
10	Blackboard ruler (1m)	4-1

Table 2.2 continues

11	Blackboard Tee squares	4-1
12	Blackboard set square (45° 60°)	2 each
13	Blackboard compasses	4-1
14	Blackboard protractor	4-1
15	French curve set	5
16	Letter stencils (3 mm, 6 mm, 7 mm and 10 mm)	5 each
17	Rubber stencils (3 mm, 6 mm, 7 mm, 6 mm and 10 mm)	5 each

Source: NBTE 2009

Table 2.3 Metrology Laboratory

S/N	Description	Quantities
1	Comparator (Mechanical)	**1**
2	Universal measuring microscope	**1**
3	Bench testing centers	**1**
4	Angle gauge	**1**
5	Set of slip gauge	**1**
6	Sine bars with centers	**1**
7	Engineers level	**1**
8	Micrometers (assorted denomination)	**2 each**
9	Vee blocks (assorted sizes)	**2 each**
10	Magnetic vee block	**1**
11	Vernier calipers	**3**
12	Vernier height gauge	**2**
13	Angle plate	**1**
14	Limit gauges for holes, shafts, and threads	**3 each**
15	Surface plate	**1**
16	Marking out table	**1**
17	Parallel strips	**4 pairs**
18	Bevel protractor	**2**
19	Dial gauges and magnetic stand	**2**
20	Engineers' square	**2**
21	Thread gauge	**2**

Table 2.3 continues

22	Radius gauge	**2**
23	Feeler gauge	**2**
24	Steel rule	**4**
25	Combination set	**2**

Source: NBTE 2009

Automotive mechatronics is an occupation that has been affected by the changes in technology and industrial standards. The current trend, innovations and the emerging technology in automobiles is a challenge to fault diagnosis, maintenance and repairs. This advanced and continuously evolving technology will require capacity building for instructors in the vocational enterprise institutions to acquire sufficient knowledge and skills in the areas of both maintenance and repair, since advanced knowledge is needed to deal with the changes brought about by latest technology in the automobile industry. Hence, as new development arises, the vehicle system becomes more complex. Therefore capacity building needs of automotive mechatronics instructors in vocational enterprise institution is of necessity to achieve the aim of the institution.

2.2.3 Concept of capacity building and capacity building needs

Capacity building is the process of developing competencies and capacity in individuals, groups, organization, sectors or countries which leads to sustainable and self-generating performance improvement. Philbin (2006) defined capacity building as the process of developing and strengthening the skills, instincts, abilities, processes and resources that individuals, organizations and communities need to survive, adapt and thrive in the fast changing world. It focuses on the understanding the obstacles that inhibit people, institutions, governments, international organisations and non-governmental orgnisation from realizing their developmental goal while enhancing the abilities that allow them to achieve measurable and sustainable results. He further stated that the fundamental goal of capacity building is to enhance the ability of individuals based on the perceived needs.

Capacity building is defined as upgrading of existing skill or acquiring a new one. Therefore automotive mechatronics instructors should attend capacity building training periodically to improve the performance and knowledge especially to make the trainee acquire the needed skill during the teaching and learning process. The capacity building of automotive mechatronics instructors is as vital as training of the industrial workers. The Capacity building process should be a continuous process. Amaechi (2013) maintained that capacity building is not something that is done to new employees only but is used continuously in every well ran organistion. The capacity building therefore, involves acquisition of special skills and evidence of learning is manifested through the successful performance of these skills acquired. Automotive mechatronics instructors in vocational enterprise institutions must therefore keep abreast with the new technological development and must keep on learning and acquiring new skills in order to be able to demonstrate knowledge and new skills to their students. Their capacity building should not be confined to the class work or workshop alone, but engaged in conducting intensive research in maintenance of automotive mechatronics systems such as braking system, electronic ignition system, transmission system, fuel supply system and suspension system.

Vocational enterprise institutions must provide her instructors with the quickest possible methods at its disposal to be able to function effectively on the job. Capacity building should provide instructors with skills and change of attitude to work, thereby improving their efficiency and productivity. Capacity building can also be visualized as the acquisition of knowledge, skills techniques, attitudes and experiences which enable an individual to make effective contribution to the combine effort of the team in the service delivery. The need for basic knowledge and skills needed for the roles the automotive mechatronics instructors would play in the teaching learning process is of vital concerned of the vocational enterprise institutions, if the institutions is to survive. Capacity building is the process of imparting specific skill which will equip the individual or group of people to perform specific jobs effectively, efficiently and diligently Ugowoke *et al* (2016). Capacity building programme should expose the automotive mechatronics instructors to the necessary facilities they have to work with in the field.

Capacity building needs as explained by Corporation for National Community Service (CNCS, 2012), are set of required activities that expand the scale, reach, efficiency or effectiveness of an individual, organisation or a programme. These require activities may expand service, enhance delivery of service, or generate additional resources for the individual or organization. The Canadian International Development Agency (CIDA, 2013) also viewed capacity building needs as the activities, approaches, strategies and methodologies which help organizations, groups and individual to improve their performance, generate development benefits and achieve their objectives. Capacity building needs refers to the efforts geared towards improving the level of knowledge, skills and attitudes possessed by an individual for proficiency in a given task or job (Olaitan *et al.*, 2009a)

Capacity building needs according to United Nations Environment Programme (2006) is building abilities, relationships and values that will enable organizations, group and individual to improve their performance and achieve their developmental objectives. It often refers to strengthing the skills, competences and abilities of people and communities in developing societies so they can overcome the causes of their exclusion and suffering. It includes human resource development which is the process of equipping individual with the understanding, skills and access to information, knowledge and training that enables them to perform effectively. The United Nations Committee of Experts on Public Administration (2016) points out that capacity building needs take place on individual level, institutional level, and societal level. on an individual level, it requires the development of conditions that allows individual participants to build and enhance existing knowledge and skills. It also calls for the establishment of conditions that will allow individual to engage in the process of learning and adapting to change Triki (2013). On the institutional level, it involves aiding pre-existing institutions and supporting them in forming sound policies, organizational structures and effective method of management Ojimba (2013). Therefore capacity building needs refer to set of activities directed towards improving competencies and capacities of automotive mechatronics instructors for effective delivery of their duties.

2.2.4 Capacity building needs of automotive mechatronics instructors in maintenance of braking system

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 2.2 shows the principle of operation of ABS

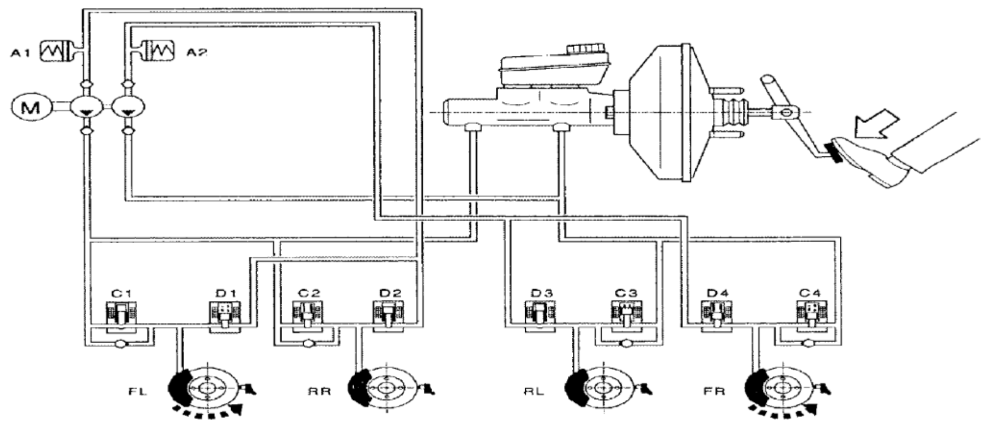

Figure 2.2 principle of operation of ABS

Source: Bonnick 2001

At the bottom of the diagram are the four wheel brakes and above these are the inlet and outlet valves (labeled 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, 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 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 technicians 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.

Anti-lock Braking System (ABS) Diagnostics

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.

i. Inspect all brake hoses, lines, and fittings for signs of damage, deterioration, and leakage.
ii. Inspect the hydraulic modulator unit for any leaks or wiring damage.

iii. 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.
iv. Inspect for worn or damaged wheel bearings that may allow a wheel to wobble.
v. Check the alignment and operation of the outer constant viscosity (CV) joints.
vi. Make sure the tires meet the legal tread depth requirements and that they are the correct size.
vii. Inspect all electrical connections for signs of corrosion, damage, fraying, and disconnection.
viii. 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 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.

2.2.5 Capacity building needs of automotive mechatronics instructors in maintenance of ignition system

The ignition system provides the spark necessary to ignite the air/fuel mixture inside the engine for it to burn. The spark must be provided at the correct time and sequence to the various cylinders in order to produce maximum horsepower with the least amount of fuel thus emitting the lowest amount of harmful emissions (Julian, 2015). The basic components of an electronic ignition system include: trigger wheel, pick up coil and electronic control unit amplifier (ECU). The ignition system is used on gasoline engines to start combustion. An ignition system is needed on gasoline engines to ignite the air-fuel mixture. It produces an extremely high voltage surge, which operates the spark plugs. A very hot electric arc jumps across the tip of each spark plug at the correct time. This causes the air-fuel mixture to burn, expand, and produce power.

The fundamental purpose of ignition systems is to supply a spark inside the cylinder, near the end of the compression stroke to ignite the compressed charge of air- fuel vapour. Bonnick (2001) stated that without a good quality spark, in the right place at the right time, the engine performance will be affected, as will the operation of the emissions control system. A misfire can lead to unburnt fuel reaching the exhaust and this will quickly harm the catalyst, often irreparably. For this reason, modern ignition systems monitor the performance of each cylinder, in relation to combustion. One method of doing this is to sense the angular acceleration of the engine flywheel; a firing cylinder will produce more acceleration than a misfiring one. In order to identify the cylinder that is misfiring, the electronic control module (ECM) requires a reference signal and this is often provided by the camshaft position sensor.

On modern ignition systems also refer to as distrubutorless ignition system, the ECM has the ability to detect misfires because the unburnt fuel that results can cause serious damage to the exhaust catalyst. The ECM achieves this diagnosis by reading the time interval between pulses from the crankshaft speed sensor. Persistent misfires will activate the MIL and a fault code (DTC) will be recorded. Urgent remedial work will then be required if serious catalyst damage is to be avoided (Bonnick, 2001). On most engines, the motion of the piston and the rotation of the crankshaft are monitored by a crankshaft position sensor. The sensor electronically tracks the position of the crankshaft and relays that information to an ignition control module. Based on input from the crankshaft position sensor, and, in some systems, the electronic engine control computer and the ignition control module then turns the battery current to the coil "on and off" at just the precise time so that the voltage surge arrives at the cylinder at the right time. The voltage surge from the coil must be distributed to the correct cylinder because only one cylinder is fired at a time. In earlier systems, this was the job of the distributor (Erjavec, 2010).

Today, most engines produced are distributor less and rely on engine sensors and electronic components to accomplish this task. The distributor less ignition system is used in the four-cylinder engines of modern vehicles (Bonnick, 2001). There are two ignition coils, one for cylinders 1 and 4, and another for cylinders 2 and 3. A spark is produced each time a pair of cylinders reaches the firing point which is near top dead center (TDC). This means that a spark occurs on the exhaust stroke as well as on the power stroke. For this reason, this type of ignition system is sometimes known as the 'lost spark' system. There are two sensors at the flywheel: one of these sensors registers engine speed and the other is the trigger for the ignition. They both rely on the variable reluctance principle for their operation. Figure 2.3

show the distributor less ignition system

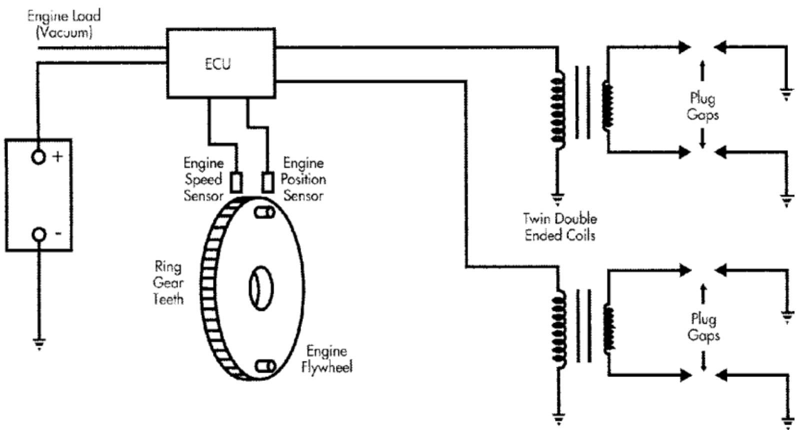

Figure 2.3 Distributor less Ignition System

Source: Bonnick (2016)

A conventional ignition system uses a distributor. Until 1984, all gas engines used a distributor driven by the camshaft to send a spark on its way to each cylinder at the proper time. These systems were called Distributor Ignition (DI) systems. Distributor systems since the mid-1970s have used electronic components and were once referred to as electronic ignition. Figure 2.4 shows the distributor ignition

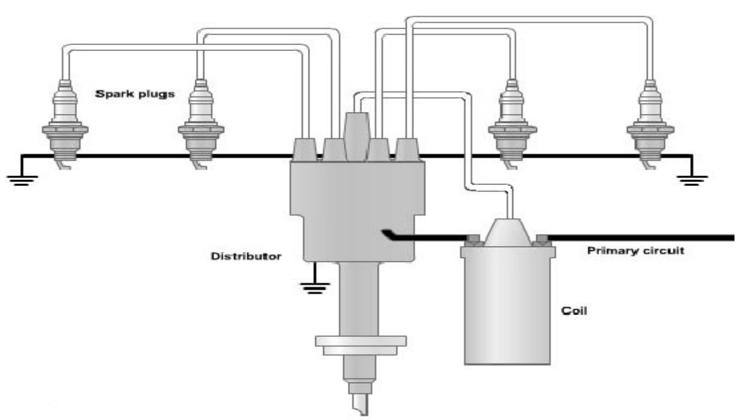

Figure 2.4 Distributor Ignition

Source: Melior (2015).

Ignition systems have several ignition coils, one for each spark plug or pair of spark plugs. When a coil is activated by the electronic control module, high voltage is sent through a spark plug circuit. The electronic` control module has total control of the timing and distribution of the spark-producing voltage to the various cylinders. A distributor is driven by a gear on the camshaft at one-half the crankshaft speed. It transfers the high-voltage surges from the coil to spark plug wires in the correct firing order. The spark plug wires then deliver the high voltage to the spark plugs, which are screwed into the cylinder head. The voltage jumps across a space between two electrodes on the end of each spark plug and causes a spark. This spark ignites the air-fuel mixture.

2.2.5 Capacity building needs of automotive mechatronics instructors in maintenance of transmission system

A transmission basically transfers the power from a car's engine to drive shaft and the wheels. The gears present inside the transmission change the drive wheel speed and torque in relation to the engine speed and torque (pulling power), Lower gear ratios helps the engine to build up enough of power so that the car can easily accelerate from a halt. The transmission is a device that is connected to the back of the engine and sends the power from the engine to the drive wheels. According to Mayur (2012), an automobile engine runs at its best at a certain RPM (Revolutions per Minute) range and it is the transmission's job to make sure that the power is delivered to the wheels while keeping the engine within that range. Automotive transmission is a key element in the power train that connects the power source to the wheels of a vehicle.

The purpose of the transmission or transaxle is to use gears of various sizes to give the engine a mechanical advantage over the driving wheels. During normal operating conditions, power from the engine is transferred through the engaged clutch to the input shaft of the transmission /transaxle. Gears in the transmission housing alter the torque and speed of this power input before passing it on to other components in the drive train. Without the mechanical advantage the gearing provides, an engine can generate only limited torque at low speeds. Without sufficient torque, moving a vehicle from a standing point would be impossible (Erjavec, 2010). The transmission uses various gear combinations, or ratios, to multiply engine speed and torque to accommodate driving conditions.

Low gear ratios allow the vehicle to accelerate quickly and high gear ratios permit lower engine speed, providing good gas mileage. The basic function of any type of automotive transmission is to transfer the engine torque to the vehicle with the desired ratio smoothly and efficiently. The most common control devices inside the transmission are clutches and hydraulic pistons. Such clutches could be hydraulic actuated, motor driven or actuated using other means. The clutch allows the driver to engage or disengage the engine and manual transmission or transaxle. When the clutch pedal is in the released position, the clutch locks the engine flywheel and the transmission input shaft together. This causes engine power to rotate the transmission gears and other parts of the drive train to propel the vehicle. When the driver presses the clutch pedal, the clutch disengages power flow and the engine no longer turns the transmission input shaft and gears. A manual transmission lets the driver change gear ratios to better accommodate driving conditions. Manual transmission uses gears and shafts to achieve various gear ratios. The speed of the output shaft compared to the speed of the input shaft varies in each gear position. This allows the driver to change the amount of torque going to the drive wheels. In lower gears, the car accelerates quickly. When in high gear, engine speed drops while vehicle speed stays high for good fuel economy

An automatic transmission, on the other hand, does not have to be shifted by the driver. It uses an internal hydraulic system and, in most cases, electronic controls to shift gears. An automatic transmission serves the same function as a manual transmission. However, it uses a hydraulic pressure system to shift gears. An automatic transmission does not need a clutch pedal and shifts through the forward gears without the control of the driver. Instead of a clutch, it uses a torque converter to transfer power from the engine's flywheel to the transmission input shaft. The torque converter allows for smooth transfer of power at all engine speeds. Shifting in an automatic transmission is controlled by a hydraulic and/or electronic control system.

In a hydraulic system, an intricate network of valves and other components use hydraulic pressure to control the operation of planetary gear sets. These gear sets provide the three or four forward speeds, neutral, park, and reverse gears normally found in automatic transmissions. Newer electronic shifting systems use electric solenoids to control shifting mechanisms. Electronic shifting is precise and can be varied to suit certain operating conditions. All automatic transmission-equipped vehicles with OBD II have electronic shifting.

The input shaft of an automatic transmission is connected to the engine crankshaft through a torque converter (fluid coupling) instead of a clutch. To improve fuel economy, reduce emission and enhance driving performance, many new technologies have been introduced in the transmission area in recent years. In the transmission area, Zongxuan and Kumar

(2005) stated that emerging technologies such as continuously variable transmission (CVT), dual clutch transmission (DCT), automated manual transmission (AMT) and electrically variable transmission (EVT) have appeared in the market, which is traditionally dominated by step gear automatic transmission (AT) and manual transmission (MT). Figure 2.5 shows the computer controlled transmission system

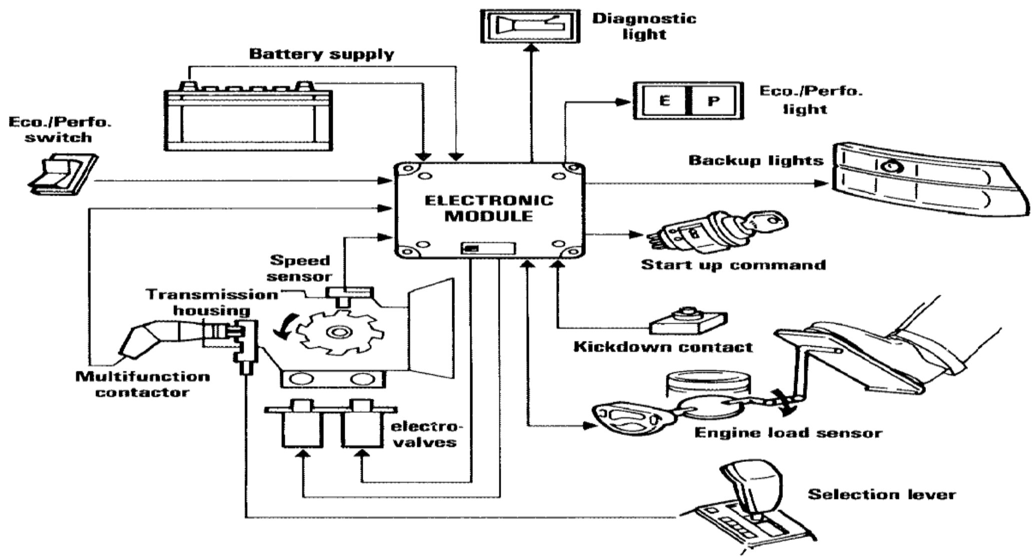

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Figure 2.5 Computer controlled Transmission system

Source: Bonnick (2001).

At the heart of the system is an electronic module. This particular module is a self-contained computer which is also known as a microcontroller. Microcontrollers are available in many sizes, e.g. 4, 8, 16 and 32 bit, which refers to the length of the binary code words that they work on. Today’s automatic transmissions have four to eight forward speeds. Five- and six-speed units are the most common. Seven- and eight-speed units are mostly found in luxury vehicles. Transmissions have at least one overdrive gear to reduce fuel consumption, lower emission levels, and reduce noise while the vehicle is cruising. Today’s transmissions also have a lockup torque converter that eliminates loss of power through the torque converter. The torque converter lockup clutch and shifting of the transmission is computer controlled. Automatic transmissions use a fluid clutch known as a torque converter to transfer engine torque from the engine to the transmission. The torque converter operates through hydraulic force provided by automatic transmission fluid, often simply called transmission oil. The torque converter changes or multiplies the twisting motion of the engine crankshaft and directs it through the transmission. The torque converter automatically engages and disengages power from the engine to the transmission in relation to engine revolution per minute (RPM). With the engine running at the correct idle speed, there is not enough fluid flow for power transfer through the torque converter. As engine speed is increased, the added fluid flow creates sufficient force to transmit engine power through the torque converter assembly to the transmission (Erjavec, 2010).

Automatic transmission problems are commonly caused by poor engine performance, problems in the hydraulic system, abuse resulting in overheating, mechanical malfunctions, electronic failures, and/or improper adjustments. Hence, the transmission system requires regular maintenance intervals if it is to continue to operate without failure. Normal maintenance usually includes fluid checks, scheduled linkage adjustments, and oil and filter changes (Zongxuan & Kumar, 2005). Diagnosis of transmission problems should begin with checking the condition and level of the fluid, conducting a thorough visual inspection, checking the various linkage adjustments, retrieving all Diagnostic Trouble Codes, and checking basic engine operation.

Fluid Level Check

When checking the fluid level, make sure the vehicle is on a level surface. Check the level and condition of the fluid. If the transmission has a dipstick, wipe all dirt off the protective disc and the dipstick handle. The fluid level in the transmission should be inspected by means of the dipstick after the transmission has been warmed up to ordinary operating temperature, approximately 158 degree F to 176 degree F. As a rule of thumb, if the graduated end is too hot to hold, the fluid is at operating temperature. The fluid level is proper if it is in the hot range between hot maximum and hot minimum. In addition, the cool level found on the dip stick should be used as a reference only when the transmission is cold. The correct fluid level can only be found when the fluid is hot. Keeping the fluid at the correct level at all times will ensure proper operation of the automatic transmission. If the fluid is too low, the oil pump will draw in air, causing air to mix with the fluid. Aerated fluid lowers the hydraulic pressure in the hydraulic control system, causing slippage and resulting in damage to clutches and bands. If the fluid level is excessive, planetary gears and other rotating components agitate the fluid, aerating it and causing similar symptoms as too little fluid. In addition, aerated fluid will rise in the case and may leak from the breather plug at the top of the transmission or through the dipstick tube (Toyota Incorporation, 2013).

Inspection and Adjustment of Throttle Cable

To inspect the throttle cable adjustment, the engine should be off. Depress the accelerator pedal completely, and make sure that the throttle valve is at the maximum open position. If the throttle valve is not fully open, adjust as needed. With the throttle fully open, check the throttle cable stopper at the boot end and ensure that there is no more than one millimeter between the end of the stopper and the end of the boot. If adjustment is required, make the adjustment with the throttle depressed. Loosen the locking nuts on the cable housing and reposition the cable housing and boot as needed until the specification is reached.

Inspection and Adjustment of the Shift Cable

To inspect the shift cable, move the gear selector from neutral to each position. The gear selector should move smoothly and accurately to each rear position. Adjust the shift cable if the indicator does not line up with the position indicator while in the proper detent. To adjust, loosen the swivel nut on the shift linkage, push the manual lever at the transmission fully towards the torque converter end of the transmission. Then pull the lever back two notches from park through reverse to the neutral position. Set the selector level to the neutral position and tighten the swivel nut while holding the lever tightly towards the reverse position (Toyota Incorporation, 2013).

Check and Adjustment of Idle Speed

Idle speed according to Toyota Incorporation (2013) is an important aspect for transmission engagement. If set too high, when shifting from neutral to drive or reverse, the engagement will be too abrupt, causing not only driver discomfort but also affecting the components of the transmission as well. If the idle is too low, it may cause the engine to stall or idle roughly. To adjust the idle speed;

i. The engine should be at operating temperature
ii. All accessories should be off.
iii. Set the parking brake.
iv. Place the transmission in park or neutral position.
v. Engine cooling fan should be off (Toyota Incorporation, 2013).

On most automobiles, the ATF level can be checked accurately only when the transmission is at operating temperature, the transmission is in a specific gear, and the engine is running.

Remove the dipstick and wipe it clean with a lint-free white cloth or paper towel. Reinsert the dipstick, remove it again, and note the reading. Markings on a dipstick indicate add levels and on some models indicate full levels for cool, warm, or hot fluid.

2.2.6 Capacity building needs of automotive mechatronics instructors in maintenance of fuel supply system

Fuel injection supply system has proven to be the most precise, reliable, and cost- effective method of delivering fuel to the combustion chambers of today's engines, (Erjavec, 2010). In order to have an efficient-running engine, there must be the correct amount of fuel. To provide this, fuel must be stored, pumped out of storage, piped to the engine, filtered, and delivered to the fuel injectors. The fuel system in modern vehicles is designed to prevent fuel vapors from entering the atmosphere. In Conventional systems, a fuel pump delivered fuel under pressure to the fuel injectors. A pressure regulator at the injectors controlled the fuel pressure by sending excess fuel back to the fuel tank. EFI systems are computer controlled and designed to provide the correct air-fuel ratio for all engine loads, speeds, and temperature conditions. Although fuel injection technology has been around since the 1920s, it was not until the 1980s that manufacturers began to replace carburetors with fuel injection systems. During fuel supply, conventional engines use a fuel injection system which replaced the carburetion system. Multi-Point Injection (MPI) where the fuel is injected to each intake port, is currently one of the most widely used systems. However, even in MPI engines there are limits to the fuel supply response and the combustion control because the fuel mixes with air before entering the cylinder (Denton, 2004).

The process of fuel combustion is controlled by the electronic control unit (ECU). The ECU controls the injection duration in accordance with engine conditions to provide efficient engine operation. The unit is analyzing signals from many sensors, and when the control unit is not able to correct mistakes in fuel combustion, it turn on a warning indicator light and alarming a driver that the emission of polluting gas is too high (Stryjek & Motrycz, 2013). In the opinion of Bonnick (2001), the computer controlled petrol injection is now the normal method of supplying fuel in a combustible mixture form to the engine's combustion chambers. Although it is possible to inject petrol directly into the engine cylinder in a similar way to those in diesel engines, the practical problems are quite difficult to solve and it is still common practice to inject (spray) petrol into the induction manifold. There are, broadly speaking, two ways in which injection into the induction manifold is performed. One way is to use a single injector that sprays fuel into the region of the throttle butterfly and the other way is to use an injector for each cylinder, each injector being placed near to the inlet valve. The two systems are known as single-point injection (throttle body injection), and multi-point injection (Bonnick, 2016).

Single-Point Injection

The single point injection is made up of a single injector. This injector is placed at the throttle body, on the atmospheric side of the throttle valve. The fuel pressure at the injector is controlled by the fuel pressure regulator and the amount of fuel injected is determined by the length of time for which the injector valve is held off its seat. In this particular system, the fuel is injected towards the throttle butterfly where the air velocity helps to mix the fuel spray with the air. The injector valve is designed to weigh as little as possible so that it can be opened and closed rapidly. The magnetic field caused by electric current in the solenoid winding opens the valve and when the current is switched off the injector valve spring returns the valve to its seat. Finely atomized fuel is sprayed into the throttle body, in accordance with controlling actions from the engine computer (EEC, ECM), and this ensures that the correct air–fuel ratio is supplied to the combustion chambers to suit all conditions. In order for the computer to work out (compute) the amount of fuel that is needed for a given set of conditions it is necessary for it to have an accurate measure of the air entering the engine. The speed density method provides this information from the readings taken from the manifold absolute pressure (MAP) sensor, the air charge temperature sensor, and the engine speed sensor. Figure 2.6 shows the single point injection

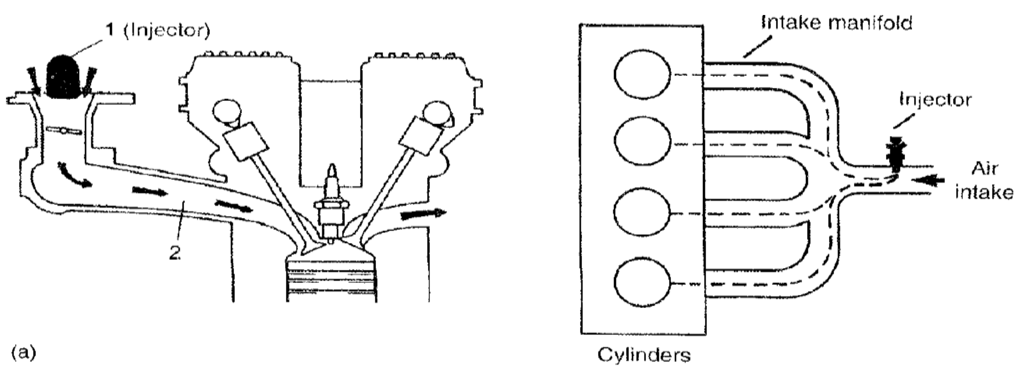

Figure 2.6 Single-Point Injection

Source: Bonnick (2016).

Multi-Point Injection

In these systems, there is an injector for each cylinder. The injectors are normally placed so that they spray fuel into the induction tract, near the inlet valve. Multi-point petrol injection systems normally use a fuel gallery to which the fuel pipes of all the injectors are connected. The pressure in this gallery is controlled by the fuel pressure regulator. This means that the quantity of fuel that each injector supplies is regulated by the period of time for which the control computer holds the injector open. This time varies from approximately 1.5 ms at low engine load, up to approximately 10 ms for full engine load. Naturally, these figures will vary from engine to engine; larger capacity and more powerful engines will require greater amounts of fuel than small capacity and low powered engines. Figure 2.7 shows the multi point injection

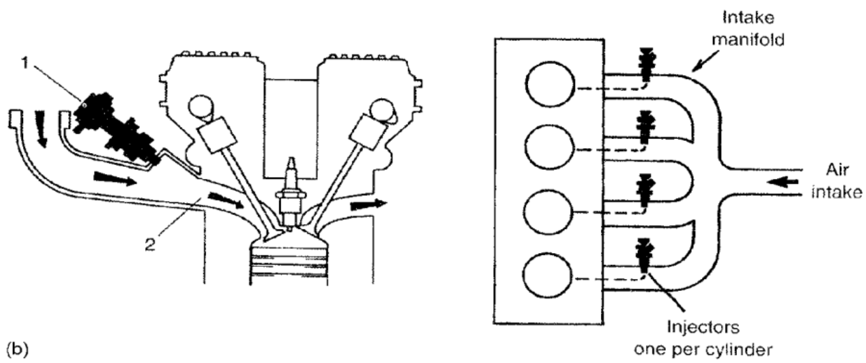

Figure 2.7 Multi-Point Injection

Source: Bonnick (2001)

2.2.6 Capacity building needs of automotive mechatronics instructors in maintenance of suspension system

Automotive suspension systems are dynamic systems which directly affect safety and comfort of the vehicle user as well as of other road traffic participants. The technical condition of this system determines the vehicle behaviour under different driving conditions, being particularly relevant for such parameters as braking distance, grip, acceleration or following a curvilinear track while driving on different road pavements. On account of such an important influence on safety, suspension systems are subject to periodical inspections in the course of the vehicle service**.** Suspension system on the other hand enables vehicle to absorb the bumps and variation in road surface, keeping the vehicle stable. It provides the vehicle a smooth ride in an uneven terrain. A suspension system also helps to improve the fuel efficiency by maintaining continuous contact of the wheels with the road and thereby preventing rolling slip (Julian, 2015).

The various types of suspension system use in modern vehicles in the words of Konrad (2015) includes telescopic fluid filled suspension, leaf spring suspension, torsion spring suspension, hydro-elastic suspension and electro actuated suspension. The electronic damping control (EDC) have electronically controlled suspension systems using air, nitrogen gas and hydraulic oil as suspension agent.; hence there is need capacity building for automotive mechatronics instructors to be competent enough to fully undertake the maintenance and repair of all aspect of modern automotive. The main components of the suspension system as indicated by Konrad (2015) are the springs and the shock absorbers. It could be dependent or independent suspension (or independent front suspension or fully independent suspension system).

The basic components of a suspension system are as follows:

i. Control arm: a movable lever that fastens the steering knuckle to the vehicle frame or body
ii. Control arm Bushing: sleeve, which allows the control arm to move up and down on the frame
iii. Strut Rod: prevents the control arm from swinging to the front or rear of the vehicle)
iv. Ball Joints: a swivel joint that allows the control arm and steering knuckle to move up and down, as well as side to side)
v. Shock Absorber or Strut keeps the suspension from continuing to bounce after

spring compression and extension

vi. Stabilizer Bar: limits body roll of the vehicle during cornering

vii. Spring: supports the weight of the vehicle; permits the control arm and wheel to move up and down

viii. Control Arms and Bushings

The control arm holds the steering knuckle, bearing support, or axle housing in position, as the wheel moves up and down (Cengage Learning , 2014). The outer end of the control arm has a ball joint and the inner end has bushings. Vehicles, having control arms on the rear suspension, may have bushings on both ends. The control arm bushings act as bearings which allow the control arm to move up and down on a shaft bolted to the frame or suspension unit. These bushings may be either pressed or screwed into the openings of the control arm.

Strut Rods

The strut rod are fastens to the outer end of the lower control arm and to the frame. This prevents the control arm from swinging toward the rear or front of the vehicle. The front of the strut rod has rubber bushings that soften the action of the strut rod. These bushings allow a controlled amount of lower control arm movement while allowing full suspension travel.

Ball Joints

The ball joints are connections that allow limited rotation in every direction and support the weight of the vehicle. They are used at the outer ends of the control arms where the arms attach to the steering knuckle. In operation, the swiveling action of the ball joints allows the wheel and steering knuckle to be turned left or right and to move up and down with changes in road surface since the ball joint must be filled with grease, a grease fitting and grease seal are normally placed on the joint. The end of the stud on the ball joint is threaded for a large nut. When the nut is tightened, it force fits the tapered stud in the steering knuckle or bearing support.

Shock Absorbers and Struts

Shock absorbers are necessary because springs do not "settle down" fast enough. After a spring has been compressed and released, it continues to shorten and lengthen for a time. Such spring action on a vehicle would produce a very bumpy and uncomfortable ride. It would also be dangerous because a bouncing wheel makes the vehicle difficult to control; therefore, a dampening device is needed to control the spring oscillations (Lukaz and Rufal, 2017). This device is the shock absorber. The most common type of shock absorber used on modern vehicles is the double-acting, direct-action type, because it allows the use of more flexible springs.

The direct-action shock absorber consists of an inner cylinder filled with special hydraulic oil divided into an upper and lower chamber by a double-acting piston. In operation, the shock absorbers lengthen and shorten, as the wheels meet irregularities in the road. As they do this, the piston inside the shock absorber moves within the cylinder filled with oil; therefore, the fluid is put under high pressure and forced to flow through small openings. The fluid can only pass through the openings slowly. This action slows piston motion and restrains spring action.

During compression and rebound, the piston is moving. The fluid in the shock absorber is being forced through small openings which restrains spring movement. There are small valves in the shock absorber that open when internal pressure becomes excessive. When the valves are open, a slightly faster spring movement occurs; however, restraint is still imposed on the spring. An outer metal cover protects the shock absorber from damage by stones that may be kicked up by the wheels (Lukaz & Rufal, 2017). One end of the shock absorber connects to a suspension component, usually a control arm. The other end fastens to the frame. In this way, the shock absorber piston rod is pulled in and out and resists these movements.

The strut assembly, also called a MacPherson strut, is similar to a conventional shock absorber. However, it is longer and has provisions (brackets and connections) for mounting and holding the steering knuckle (front of vehicle) or bearing support (rear of vehicle) and spring. The strut assembly consists of a shock absorber, coil spring (in most cases), and an upper damper unit. The strut assembly replaces the upper control arm. Only the lower control arm and strut are required to support the front-wheel assembly.

i. Strut Shock Absorber - piston-operated oil-filled cylinder that prevents coil spring oscillations.
ii. Dust Shield - metal shroud or rubber boot that keeps road dirt off the shock absorber.
iii. Lower Spring Seat - lower mount formed around the body of the shock absorber for the coil spring.
iv. Coil Spring - supports the weight of the vehicle and allows for suspension action.
v. Upper Strut Seat - holds the upper end of the coil spring and contacts the strut

bearing.

vi. Strut Bearing - a ball bearing that allows the shock absorber and coil spring assembly to rotate for steering action.

vii. Rubber Bumpers - jounce and rebound bumpers which prevent metal-to-metal contact during extreme suspension compression and extension.

viii. Rubber Isolators - parts of the strut damper which prevents noise from being transmitted into the body structure of the vehicle.

ix. Upper Strut Retainer - mounting that secures the upper end of the strut assembly to the frame or unitized body.

In a MacPherson strut type suspension, only one control arm and a strut is used to support each wheel assembly. A conventional lower control arm attaches to the frame and to the lower ball joint. The ball joint holds the control arm to the steering knuckle or bearing support. The top of the steering knuckle or bearing support is bolted to the strut. The top of the strut is bolted to the frame or reinforced body structure. This type of suspension is the most common type used on late model passenger vehicles. The advantages are a reduced number of parts in the suspension system, lower unsprung weight, and a smoother ride (Cengage Learning, 2014). On some vehicles you may find a Modified Strut Suspension that has the coil springs mounted on the top of the control arm, not around the strut.

Stabilizer Bar

The stabilizer bar also called the sway bar, is used to keep the body of the vehicle from leaning excessively in sharp turns. Made of spring steel, the stabilizer bar fastens to both lower control arms and to the frame. Rubber bushings fit between the stabilizer bar, the control arms, and the frame. When the vehicle rounds a corner, centrifugal force tends to keep the vehicle moving in a straight line. Therefore, the vehicle "leans out" on the turn. This lean out is also called a body roll. With lean out, or body roll, additional weight is thrown on the outer spring. (Lukaz & RufaI, 2017)This puts additional compression on the outer spring, and the control arm pivots upward. As the control arm pivots upward, it carries its end of the stabilizer bar up with it. At the inner wheel on the turn, there is less weight on the spring. Weight has shifted to the outer spring because of centrifugal force. Therefore, the inner spring tends to expand. The expansion of the inner spring tends to pivot the lower control arm downward. As this happens, the lower control arm carries its end of the stabilizer bar downward (Gscheidle, 2016).

The outer end of the stabilizer bar is carried upward by the outer control arm. The inner end is carried downward. This combined action twists the stabilizer bar. This action twists the stabilizer bar and its resistance to this twisting action limits body lean in corners.

Suspension System Springs

The vehicle body or frame supports the weight of the engine, the power train, and the passengers. The body and frame is supported by the springs on each wheel. The weight of the frame, body, and attached components applies an initial compression to the springs. The springs compress further as the wheels of the vehicle hit bumps or expand such as when the wheels drop into a hole in the road. The springs cannot do the complete job of absorbing road shocks (Konrad, 2015). The tires absorb some of the irregularities in the road. The springs in the seats of the vehicle also help absorb shock. However, the passengers feel little shock from road bumps and holes. The ideal spring for an automotive suspension should absorb road shock rapidly and then return to its normal position slowly; however, this action is difficult to attain. An extremely flexible, or soft, spring allows too much movement. A stiff, or hard, spring gives too rough a ride. To attain the action to produce satisfactory riding qualities, use a fairly soft spring with a shock absorber (Gscheidle, 2016).

Spring Terminology

There are three basic types of automotive springs - coil, leaf, and torsion bar. Before discussing these types of springs, you must understand three basic terms - spring rate, sprung weight, and unsprung weight.

i. Spring rate refers to the stiffness or tension of a spring. The rate of a spring is the weight required to deflect it 1 inch. The rate of most automotive springs is almost constant through their operating range, or deflection, in the vehicle. Hooke's law, as applied to coil springs states: that a spring will compress in direct proportion to the weight applied. Therefore, if 600 pounds will compress a spring 3 inches, then 1,200 pounds will compress the spring twice as far, or 6 inches.

ii. Sprung Weight refers to the weight of the parts that are supported by the springs and suspension system. Sprung weight should be kept high in proportion to unsprung weight.

iii. Unsprung Weight refers to the weight of the components that are not supported by the springs. The tires, wheels, wheel bearings, steering knuckles, or axle housing is considered unsprung weight. Unsprung weight should be kept low to improve ride smoothness. Movement of high unsprung weight (heavy wheel and suspension components) will tend to transfer movement into the passenger compartment.

The coil spring is made of round spring steel wound into a coil. Because of their simplicity, they are less costly to manufacture and also have the widest application. This spring is more flexible than the leaf spring, allowing a smoother reaction when passing over irregularities in the road. Coil springs are frictionless and require the use of a shock absorber to dampen vibrations. Their cylindrical shape requires less space to operate in. Pads are sometimes used between the spring and the chassis to eliminate transferring vibrations to the body. Because of its design, the coil spring cannot be used for torque reaction or absorbing side thrust. Therefore, control arms and stabilizers are required to maintain the proper geometry between the body and suspension system. This is the most common type of spring found on modern suspension systems.

Coil spring mountings are quite simple in construction. The hanger and spring seat are shaped to fit the coil ends and hold the spring in place. Cups that fit snugly on each coil end are often used for mounting. The upper cup can be formed within the frame, in the control arms, or part of a support bracket rigidly fixed to the cross member or frame rail. The lower cup is fastened to a control arm hinged to a cross member or frame rail. Rubber bumpers are included on the lower spring support to prevent metal-to-metal contact between the frame and control arm, as the limits of compression are reached (Giri, 2013).

Leaf Spring

The leaf spring acts as a flexible beam on self-propelled vehicles and transmits the driving and breaking forces to the frame from the axle assembly. Leaf springs are semi-elliptical in shape and are made of high quality alloy steel. There are two types of leaf springs - single leaf and multileaf . The single leaf spring, or monoleaf, is a single layer spring that is thick in the center and tapers down at each end. Single leaf springs are used in lighter suspension systems that do not carry great loads. A multileaf spring is made up of a single leaf with additional leaves. The additional leaves make the spring stiffer, allowing it to carry greater loads.

The most common type is the multileaf spring that consists of a single leaf with a number of additional leaves attached to it using spring clips. Spring clips, also known as rebound clips, surround the leaves at intervals along the spring to keep the leaves from separating on the rebound after the spring have been depressed Servason (2014). The clips allow the springs to slide, but prevent them from separating and causing the entire rebound stress to act on the master leaf. The multileaf spring uses an insulator (frictional material) between the leaves to reduce wear and eliminate any squeaks that might develop (Giri, 2013). To keep the leaves equally spaced lengthwise, use a center bolt for the multileaf spring. The center bolt rigidly holds the leaves together in the middle of the spring, preventing the leaves from moving off center. Each end of the largest leaf is rolled into an eye, which serves as a means of attaching the spring to the vehicle. Leaf springs are attached to the vehicle using a spring hanger that is rigidly mounted to the frame in the front and the spring shackle in the rear, which allows the spring to expand and contract without binding as it moves through its arc. Bushings and pins provide the bearing or support points for the vehicle. Spring bushings may be made of bronze or rubber and are pressed into the spring eye. The pins that pass

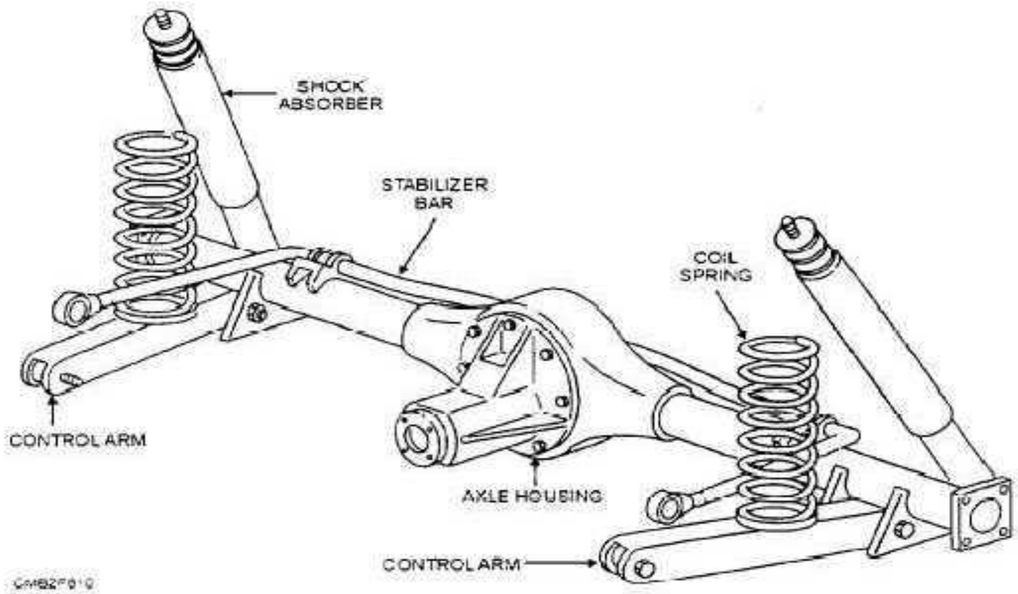

Figure 2.8 Coil springs.

Source: (Melior, 2015)

2.3 Review of Related Empirical Studies

Doka (2007) 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 95 item structured questionnaire and five point likert scales 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 z-test was used to test the null 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 study reviewed is related to the current study in the aspect of skills needs of technical college graduates for self-employment. While the present study is design to identifies capacity building needs of automotive mechatronics instructors in vocational enterprise institution in Abuja and kogi state. The study reviewed focused on technical college graduates of metalwork while the present study focus on automotive mechatronics instructors in vocational enterprise institution in Abuja and Kogi state. Common to both studies is the use of sample and sampling techniques. However, the area of the study is different from the present study.

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 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. The study is related to the present study in that, it investigate the work skills improvement need of graduates of technical colleges in motor vehicle mechanic practice for employment in modern Nigeria, while the present identifies the capacity building needs of automotive mechatronics instructors in VEIs in Abuja and kogi state. The respondents as well as area of the study reviewed are different from the present study. However the use of structured questionnaire in the study reviewed is similar to the present study.

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. 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. The study just reviewed is related to the current study because it investigate the 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 While the present study is design to identify capacity building needs of automotive mechatronics instructors in vocational enterprise institution in Abuja and kogi state. However, the study reviewed focused on competency improvement needs of Teachers in On- Board Diagnostic System for effective teaching of petrol engine maintenance in technical colleges in Nigeria, while the present study is aimed at capacity building needs of automotive mechatronics instructors in vocational enterprise institution in Abuja and Kogi State. Common to both studies is the use of sample and sampling techniques. Through they differ in the area of study and numbers of research questions, research objectives and hypotheses. It was deduced because the respondents of the reviewed stud were from Southeast Nigeria while the present study is conducted in FCT, Abuja and Kogi State in North Central geopolitical zone of Nigeria.

Asogwa *et al.,* (2014) carried out a study on the capacity building needs of lecturers of agricultural education in soil testing (NPK) for effective teaching of students in Colleges of Education in South-easth, Nigeria. Four research questions guided the study. The study adopted descriptive survey research design. The study was conducted in 8 Colleges of Education in South-east, Nigerian offering Agricultural Education programme. The population of the study was 107 lecturers. The entire population was involved in the study. An instrument titled Soil Testing Capacity Building Needs Questionnaire (STCBNQ) was used for data collection. Three experts face validated the questionnaire. Cronbach alpha reliability method was used to determine the internal consistency of the questionnaire items. A reliability coefficient of 0.90 was obtained. Data collected for the study were analyzed using weighted mean, standard deviation and Improvement Need-Performance Index (INPI) to answer the research questions.

The findings of the study revealed that lecturers of Agricultural Education in Colleges of needed capacity building on 12 items in soil sampling, 6 items in testing for soil Nitrogen, 9 items in testing for soil Phosphorus and 9 items in testing for soil Potassium for effective teaching of students in Colleges of Education in South-east, Nigeria. It was recommended that lecturers of Agricultural Education in Colleges of Education should utilize the findings of this study on their capacity building needs to seek for sponsorship from their administrators in order to attend re-training programme for their capacity building in soil testing and analysis among others. The study reviewed is related to the present study because it determine the capacity building needs of lecturers, while the present study is design to identifies the capacity building needs of automotive mechatronics instructors. Geographical area covered in the study is different from the present study. However, method of data analysis in the study is similar to the present study.

Adamu (2015) carried out a study to determine the Capacity Building Needs of Automobile Technology Lecturers in Federal Colleges of Education (Technical) in North-east, Nigeria. The study adopted a survey research design. The population for the study consisted of all the 40 automobile technology lecturers and 20 Instructors from these institutions. Four research questions and four null hypotheses were developed and formulated respectively to guide the study. A structured questionnaire was used for collecting data from the respondents which was duly validated by experts. Cronbach alpha reliability method was used to determine the internal consistency of the questionnaire items. Data collected were analyzed using the mean and improvement needed index to answer the research questions while t- test was used for testing the null hypotheses.

It was found out from the study that automobile technology lecturers need capacity building in 15 skills of modern automotive engine system,15 skills in emerging technologies in transmission, steering, suspension, and braking system,15 skills in Autotronics and 15 skills in operating modern diagnostic tools and equipment. There was no significant difference between the mean responses of lecturers and instructors on the capacity building needs in modern automotive engine system, emerging technologies in transmission, steering, suspension, and braking system, Autotronics technologies and operating modern diagnostic tools and equipment. It was recommended that workshop and seminars should be organized for automobile lecturers in order to build their capacity in modern automotive engine system, emerging technologies in transmission, steering, suspension, and braking system, Autotronics technologies, and operating modern diagnostic tools and equipment. There are close links between the reviewed research work and this research work, both researcher conducted their works on capacity building needs of automotive instructors. Both researcher adopted the use of questionnaire for data collection, both work used descriptive survey researcher design, both uses cronbash alpha for reliability coefficient and weighted mean were used for data analysis

However, there are some areas of difference between the two research work, the reviewed research work is centered on federal colleges of education lectures while the present study centered on automotive mechatronics instructors in VEIs. The research carried out is research in northeast Nigeria. While this research was conducted in FCT, Abuja and kogi state Nigeria, his research was piloted at northeast while this research was piloted in kaduna northwest Nigeria. T-test was used in the reviewed research while z-test was used for testing hypotheses.

Ezeama and Ede (2016) conducted a study on capacity building needs among motor vehicle mechanics trainers in the use of auto scan tools. Three research questions and three null hypotheses guided the study. The study was carried out in three institutions where motor vehicle mechanics trade is offered as automobile technology or automobile education, three centers where auto scan tools are used for vehicle repairs and two technical colleges in Enugu state that offer motor vehicle mechanics (MVM) trade. The population of the study consisted of eighty three (83) MVM trainers, teachers and instructors. The instrument which was structured on two types of response scale (perceived importance and expressed performance) to elicit information on the use of auto scan tool for diagnosing some vehicle systems faults. Data collected were analyzed using the mean and the improvement needed index (INI) to answer the research questions. Then t- test statistic was used to test the null hypotheses at 0.05% level of significance.

The study found out that MVM trainers need capacity building in the use of auto scan tools for vehicle systems diagnosis and repairs. The study recommended that workshop/seminars should be organized by centers like the National center for equipment maintenance and development, the National automotive council and so on to enable MVM trainers acquire the required skills to meet up with the training job facing them. The study just reviewed is related to the present study because it investigated the capacity building needs among motor vehicle mechanics trainers in the use of auto scan tools while the present study is design to identifies the capacity building needs of automotive mechatronics instructors. However, the present study differs from the previous study in term of population and area of study. Common to both studies is there method of data analysis.

Agbo (2018) carried out a study to determine the capacity building needs of principals for effective supervision of instruction in secondary schools in South East Nigeria. The study specifically, identified the competencies required by principals for supervision of instruction and the capacity building needs of principals for supervision of planned, organized, implemented and evaluation of instruction in secondary schools in South East Nigeria. The study adopted descriptive survey research design. Five research questions and four null hypotheses guided the study. The population for the study was 2,603 consisting of 1,305 principals and 1,298 vice principals (academics) from 1,305 secondary schools in five states of South East Nigeria. Stratified simple random sampling technique was adopted in selecting 260 (10% of the population) as sample for the study. Structured questionnaires consisting of 82 items were used for data collection. The items of the questionnaire were assigned four response options of Highly Required/Performed (HR/HP=4), Averagely Required/Performed (AR/AP=3), Slightly Required/Performed (SR/SP=2) and Not

Required/Performed (NR/NP=1). The questionnaires were face validated by three experts. The reliability of the questionnaires was established using Cronbach Alpha and coefficient indices of 0.87 and 0.91 were obtained. Out of the 260 copies of the questionnaire administered 246 copies were retrieved and utilized for analysis representing 97% retrieval rate. Data collected were analyzed using mean and standard deviation to answer the research questions and t-test to test the null hypotheses at 0.05 level of significance.

The findings of the study revealed that the principals underperformed some of the required competencies for the supervision of instruction in secondary schools. It was recommended among others that the state governments in the five states should organize seminars/workshops for principals in order to build their capacity in the identified competencies of need. Principals should make themselves available for the retraining. The study reviewed is related to the present study because it determined the capacity building needs of principals for effective supervision of instruction in secondary schools in South East Nigeria, while the present study is also design to identify the capacity building needs of automotive mechatronics instructors in VEIs in Abuja and kogi state. Geographical area covered in the study reviewed and the subjects are different from the present study. However, the use of descriptive survey research design in the study is similar to the present study.

2.4 Summary of the Literature Reviewed

The literature reviewed revealed that Dreyfus Model of Skill Acquisition is a gradual process that involved being embodied in different ways and developing skills that would make it possible for people to deal with the world. It was further revealed. Learners acquire skill through instruction and experience, it shows that how skills are acquire through formal instruction and practicing. The first model recommends that an understudy goes through five particular stages: beginner, skill, capability, aptitude, and dominance.

It was further revealed that theory of needs on the other hand considered that personality development can be described as a combination of a press and a need. It was further revealed that individual life is characterized by the existence of a need in relation to a particular press, a stimulus- situation that has a potential influence upon the life of the organism. The literature reviewed revealed that need gratification as the basis for the most human behaviours he argue that needs are arrange in hierarchy aesthetic needs, desire to know or understand, self-actualization needs, esteem needs, love and belonging needs, safety needs, physiological needs.

The self-concept theory of career development revealed that the process of career building is essentially that of developing and implementing practical skills in work roles. A relatively stable self-concept emerge in late adolescence to serve as a guide to career development and adjustment, self-concept evolve as person encounters new experience and progress through the developmentally stages. It was further revealed that Career development theory identifies developmentally appropriate tasks and interventions at different educational level and focuses on decision making, self-knowledge, occupational information, planning and problem solving through four intervention methods.

The review of the literature on capacity building and capacity building needs, revealed that capacity building as the process of developing and strengthening the skills, instincts, abilities, processes and resources that individuals, organizations and communities need to survive, adapt and thrive in the fast changing world. The literature reviewed further revealed that capacity building needs is the activities, approaches, strategies and methodologies which help organizations, groups and individual to improve their performance, generate development benefits and achieve their objectives. It further revealed that Capacity building needs refers to the efforts geared towards improving the level of knowledge, skills and attitudes possessed by an individual for proficiency in a given task or job

The literature reviewed on automotive mechatronics programme in VEIs in Nigeria revealed that automotive mechatronic is a vocational trade that prepares individuals for the world of work. It is one of the trades offered in vocational enterprise institution in Nigeria it is aimed at providing solutions to the service maintenance problems of high technology motor vehicles through the production of competent craftsmen and women who will be enterprising and self-reliant. It has been observed that automotive mechatronics instructors needs capacity building in other to achieve the aims of the programme

Furthermore, despite the importance of capacity building needs to automotive mechatronics instructors in VELs in assisting them to provide solution to the service maintenance problems of modern vehicles through the production of competent craftsmen and women who will be enterprising and persistent lack of capacity building by the graduates of automotive mechatronics from VELs in Nigeria to fully undertake the maintenance and repairs of modern mechatronic vehicles. No study known to the researcher have investigated capacity building needs of automotive mechatronics instructors in vocational enterprise institutions in Abuja and Kogi State. Hence, this study is design to identify the capacity building needs of automotive mechatronics instructors in vocational enterprise institutions in Abuja and Kogi State.

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

3.1 Research Design

A descriptive survey research design was adopted for this study. A descriptive survey research design in the view of Anyakaoha (2009) uses questionnaire to determine the opinions, attitudes, preferences and perceptions of the persons. Osuala (2001) stated that descriptive survey is a study of both large and small population by selecting and studying samples chosen from the population to discover the relative incidence, distribution and interrelations of sociological and psychological variables. Descriptive survey research design was adopted for the study because the study involved the use of structure questionnaire to determine the views, responses and opinions of Automotive Mechatronics Instructors in VEIs and Automotive Industrial Technicians in Abuja and Kogi State of Nigeria. Thus descriptive survey research design is considered suitable for the study as it sought to elicit information from the respondents using questionnaire.

3.2 Area of the Study

The study was conducted in three VEIs in Federal Capital Territory and Kogi State. They are Armed Forces Electrical and Mechanical Engineering Mechatronics School, Mogadishu Barracks, Asokoro, Abuja, Industrial Training Fund (ITF) Model Skills Training Centre, Ademola Adetokubo Cresent, Maitama, Federal Capital Territory, Abuja and Nigeria – Korea Friendship Institute of Vocational and Advance Technology, Lokoja, Kogi State. The FCT, Abuja is located in the middle belt region of the country and the administrative headquarters of Nigeria. It is bounded by Niger to the West and North, Kaduna to the North east, Nassarawa to the East and South and Kogi to the West with an approximately landmass of 7,315km^2. Lying between latitude 8.25 and 9.20 North of the equator and longitude 6.45 and 7.39 East of the Greenwich meridian (Michael, 2011); While, Kogi State is also one of the States in the North Central Nigeria with its headquarters in Lokoja.

Kogi State is bounded by the state of Nassarawa to the Northeast, Benue state to the East, Enugu, Anambra and Delta to the South, Ondo, Ekiti and Kwara to the West and Niger to the North with an approximately landmass of 29,833km^2. Lying between latitude 7 and 45.0 North of the Equator and 6 and 45 East of the Greenwich meridian (Michael, 2011); Inability of the graduates of VEIs to effectively undertake the maintenance and repairs of automotive mechatronics vehicles upon graduation, which may likely be attributed to the deficient capacity of automotive mechatronics instructors in VEIs, necessitates the choice of FCT, Abuja and Kogi State as area of study.

3.3 Population

The targeted population for this study was 801 respondents consisting of 763 Automotive Industrial Technicians registered under the Federal Ministry of Commerce and Industry and 38 automotive mechatronics instructors in National Board for Technical Education (NBTE) accredited vocational enterprise institution in Abuja and Kogi State. Figure 3.1 shows the distribution of study population in the area of study

Table 3.1
Distribution of Study Population in the Area of Study

S/N	States	Automotive Industrial Technicians	Automotive Mechatronic Instructor
1	FCT, Abuja	467	22
2	Kogi	296	16
	Total	**763**	**38**

Source: Federal Ministries of Commerce and Industries, State Ministries of Commerce and

Industries and National Board for Technical Education (NBTE)

3.4 Sample and Sampling Technique

A proportional stratified random sampling technique was used to draw 10% of automotive Industrial Technicians from Federal Capital Territory, Abuja and Kogi State respectively. Furthermore, due to the relatively small size of population of automotive mechatronics instructors in the area of study, no sampling technique was employed for them. Therefore the entire population of automotive mechatronics instructors in the area of the study was used for the study. Table 3.2 shows the sample distribution in the area of study.

Table 3.2

Sample Distribution in the Area of Study

S/N	States	Automotive industrial technicians	Automotive mechatronic instructor
1	FCT, Abuja	47	22
2	Kogi	30	16
	Total	**77**	**38**

3.5 Instrument for Data Collection

The instrument used for data collection for the study was a structured questionnaire titled: Automotive Mechatronics Instructors Capacity Building Needs Questionnaire (AMICBNQ) the questionnaire consists of 119 Capacity Building Needs Items, developed after review of available literatures and expert opinion. The instrument was made up of six section (section A-F) section A contains personal data of the respondents. The items have option and blank spaces that will enable the respondents tick (√) or complete as appropriate. Section B contains 21 items on the capacity building needs of automotive mechatronics instructors in maintenance of braking system. Section C has 25 items on the capacity building needs of automotive mechatronics instructors in maintenance of electronic ignition system. Section D consists of 20 items on the capacity building needs of Automotive Mechatronics Instructors in maintenance of transmission system. Section E is made up of 33 items on the capacity building needs of automotive mechatronics instructors in maintenance of fuel supply system. Section F consist of 20 items on the capacity building needs of automotive mechatronics instructors in maintenance of suspension system.

All sections of the questionnaire were assigned two categories of responses scales. These are: the needed scale and performance scale. In the needed category, the respondents expresses their opinion on a four point rating scale of Highly Needed (HN), Needed (ND), Moderately Needed (MN) and Not Needed (NN) and for the Performance category the respondents expresses their opinion on a four point rating scale of Highly Performed (HP), Performed (NP), Moderately Performed (MP) and Not Performed (NP). The numerical values assigned to the various measurements on the needed /performed category were. Table 3.3 shows the four point rating scale of the instrument

Table 3.3

Rating scale

Numerical values assigned to measurements		
1. Highly Needed (HN)/ Highly Performed (HP)	-	4
2. Needed (ND)/ Performed (PD)	-	3
3. Moderately Needed (MN) Moderately Performed (MP)	-	2
4. Not Needed (NN) / Not Performed (NP)	-	1

3.6 Validation of the Instrument

The instrument used for data collection was validated by three experts. One expert from the Department of Industrial and Technology Education, Federal University of Technology, Minna and two Automotive Industrial Supervisors one each from FCT, Abuja and Kogi State respectively. This was done in order to assess the questionnaire items in term of clarity of the instruction to the respondents as well as adequacy and appropriateness of the items in order to address the problem of the Study. Their suggestions, corrections and modification were used to refine the final questionnaire.

3.7 Reliability of the Instrument

The validated instrument used for data collection for the study was trial tested to determine its reliability using split-half reliability method on a randomly sampled size of 6 Automotive Industrial Technicians from Aliu Idris mechanical shop Kaduna Metropolis and four automotive mechatronic instructors of Peugeot Automobile Nigeria (PAN) training institute Kaduna State. The choice of Kaduna State for the trial testing exercise was informed by the fact that Kaduna State did not form part of the study area.

In conducting the trial test, the researcher used one Research Assistant who was conversant with the area for the administration of the questionnaire. The result of the trial testing was used in computing the relevant reliability coefficients. Internal consistency reliability was established for the five clusters of the Automotive Mechatronics Instructor Capacity Building Needs Questionnaire (AMICBNQ) through Cronbach Alpha statistics. The Cronbach Alpha statistics was chosen to determine the reliability of the instrument for this study because the items are non-dichotomously scored.

Statistical Package for Social Science (SPSS) version 23 was used to compute the internal consistency for each of the five clusters. Therefore the internal consistency calculated for each cluster is as follows: A=0.81, B=0.83, C=0.96, D=0.91 and E=0.93, for research questions 1-5 respectively. Overall reliability of the instrument was 0.88 indicating a reliability coefficient of the instrument.

3.8 Administration of the Instrument

Copies of the questionnaire were administered to the respondents with the help of four Research Assistants (RAs). Two RAs each from Abuja and Kogi State making a total of four were appointed by the researcher. Each RA was briefed verbally by the researcher on how to administer the instrument so as to ensure safe handling and return of the instrument. The copies of the questionnaire were distributed and collected back not later than one week; although in some instances the respondents were given an additional interval of one week and questionnaire were returned to the researcher through the RAs. This was done to avoid the loss of questionnaire on the part of the respondents at the same time improves the return rate of the questionnaire.

3.9 Method of Data Analysis

The data collected for the study was analyzed using weighted mean and improvement needed index (INI) to answer all the research questions; while z- test statistics was used to test the null hypotheses formulated for the study all at .05 level of significance. Standard deviation was used to determine the closeness or otherwise of the opinion of the respondents from the mean and from one another. SPSS version 23 was used for the data analysis.

The decision for each research question were based on the resulting mean score interpreted relative to the concept of real lower and upper limit of numbers for both needed and performance category as shown in Tables 3.3. The following steps were used to determine the capacity building needs of automotive mechatronics instructors:

1. The weighted mean of each item under the needed category coded Xn was calculated

2. The weighted mean of each item under the performance category coded Xp was calculated

3. The capacity building (CBN) was determine by finding the difference between Xn and Xp that is Xn – Xp = CBN

4. Where the CBN is positive (+ve) it means capacity building is needed because the rate at which instructors performed is lower than expected. Where CBN is negative (-ve), it means capacity building is not needed because the rate at which instructors performed is greater than the needed. (Agboh, 2011)

The decision on the null hypotheses formulated for the study were based on comparing significant value (P< .05) level of significance, that is where the significant value is less than (P< .05) the null hypotheses was rejected, while equal or greater than (P=>.05) the null hypotheses was upheld. Table 3.4 shows the decision rule for needed and performed category

Table 3.4
Needed and Performed Decision Rule

S/No	Responses options	Rate	Real limit of numbers	Decision
1	Highly Needed /Highly Performed	4	3.50 – 4.00	Highly Needed
2	Needed/ Performed	3	2.50 – 3.49	Needed
3	Moderately Needed/ Moderately Performed	2	1.50 – 2.49	Moderately Needed
4	Not Needed/ Not Performed	1	0.50 – 1.49	Not Needed

CHAPTER FOUR
4.0 RESULTS AND DISCUSSION

This chapter presented the analysis of data for answering the research questions and testing the null hypotheses.

4.1 Research Question 1

What are the Capacity buildings needs of automotive mechatronics instructors in the maintenance of braking system?

Result for answering research question one is presented in Table 4.1

Table 4.1

Capacity building need Analysis of the Mean Responses of Respondents on the Capacity Building Needs of Automotive Mechatronics Instructors in Maintenance of Braking System **N = 115**

S/N	Items	$\bar{X}_n$	$\bar{X}_p$	CBN = ($\bar{X}_n$-$\bar{X}_p$)	Remarks
1.	Perform visual inspection of wheel speed sensor and cables	3.87	3.32	0.55	CBN
2	Identify defective wheel speed sensor	3.51	3.02	0.49	CBN
3	Check wheel speed sensor and the pulse ring	3.88	3.37	0.51	CBN
4.	Carry out speed sensor signal testing	3.91	3.27	0.64	CBN
5.	Check power supply of the wheel speed sensor	3.79	3.07	0.72	CBN
6.	Service the wheel speed sensor	3.80	3.65	0.15	CBN
7.	Visually inspect the wheel speed sensor pulsers for chipped or damaged teeth	3.88	3.37	0.51	CBN
8.	Remove wheel speed sensors	3.91	3.71	0.20	CBN
9	Replace electrical wiring to the wheel speed sensor	3.78	3.01	0.77	CBN
10.	Perform a test drive to check the wheel speed sensor after replacement	4.31	2.89	1.42	CBN
11.	Carryout visual inspection of the wiring and the mechanical components	4.04	2.45	1.59	CBN
12.	Recognize a defective Anti-lock Braking System (ABS) warning light	4.04	2.85	1.19	CBN
13.	Repair braking system for functionality	3.83	2.81	1.02	CBN
14	Test braking system after repair	3.75	2.89	0.86	CBN
15.	Carry out all kinds of mechanical tests on the braking system	4.14	2.92	1.22	CBN
16.	Check the operation of the braking system, adjust and repair according to the manufactures specification	3.55	3.45	0.10	CBN

Table 4.1 continues

17.	Replace faulty or bad braking system with new one	3.65	3.15	0.50	CBN
18.	Select appropriate tools and equipment for the maintenance of automotive braking system	3.90	3.65	0.25	CBN
19.	Service automatic braking system correctly	2.97	2.47	0.50	CBN
20.	Recalibrate the speed sensors	4.50	3.80	0.70	CBN
21.	Use oscilloscope to verify the voltage and signal supply to the braking system	3.65	2.50	1.15	CBN
	GRAND MEAN/CBN	**4.04**	**3.23**	**0.74**	**CBN**

Keys: $\bar{X}_n$= weighted mean for needed category, $\bar{X}_p$ = weighted mean for performance category, performance gap **CBN = ($\bar{X}_n$-$\bar{X}_p$)** CBN = Capacity Building Needed, CBNN = Capacity Building Not Needed

Table 4.1 shows the mean responses of the respondents on the items posed to determine the capacity building needs of automotive mechatronics instructors in the maintenance of braking system with the grand capacity building value of 0.74. This implies that automotive mechatronics instructor's needs capacity building in all the areas of competences in the maintenance of braking system.

4.2 Research Question 2

What are the Capacity buildings needs of automotive mechatronics instructors in maintenance of Ignition system?

Result for answering research question two is presented in Table 4.2

Table 4.2

Capacity building need Analysis of the Mean Responses of Respondents on the Capacity Building Needs of Automotive Mechatronics Instructors in Maintenance of Ignition System N = 115

S/N	Items	$\bar{X}_n$	$\bar{X}_p$	CBN = ($\bar{X}_n$-$\bar{X}_p$)	Remarks
22	Conduct engine performance test using engine analyzer and determine needed repair	3.61	3.20	0.41	CBN
23	Test run the ignition system using the multimeter	4.31	3.15	1.16	CBN

Table 4.2 continues

24	Check the crankshaft (CKP) and camshaft (CMP) sensors and their wiring for damage	4.15	2.66	1.49	CBN
25	Record ignition timing using digital multimeter	3.51	2.91	0.60	CBN
26	Carry out throttle cable inspection and adjustment	4.18	2.50	1.68	CBN
27	Check the crank sensor using diagnostic tool	3.97	2.85	1.12	CBN
28	Perform magnetic sensor testing	4.00	3.82	0.18	CBN
29	Inspect faulty crank position sensor	3.83	3.23	0.60	CBN
30	Test and diagnose defective reluctor sensor	3.65	3.80	0.15	CBN
31.	Use plug wire to check for spark of the plug	3.75	3.60	0.15	CBN
32.	Conduct a careful visual inspection of the wiring and the mechanical components	3.45	3.27	0.17	CBN
33	Check the battery to make sure there is ample voltage to start the engine	3.32	3.00	0.32	CBN
34	Inspect, repair and replace faulty electronic ignition components	3.57	2.60	0.97	CBN
35	Use engine analyzer to conduct engine performance test	3.42	2.52	0.90	CBN
36	Use diagnostic tool to check ignition problem	3.56	3.35	0.21	CBN
37	Interpret ignition diagnostics trouble codes	3.78	2.49	1.29	CBN
38	Inspect faulty electronic ignition components	4.06	3.27	0.79	CBN
39	Repair faulty electronic ignition components	3.87	3.07	0.80	CBN
40	Replace faulty electronic ignition components	4.30	2.85	1.45	CBN
41	Inspect, faulty computerized ignition components	4.18	2.50	1.68	CBN
42	Repair faulty computerized ignition components	3.76	3.27	0.49	CBN
43	Replace faulty computerized ignition components	3.74	2.49	1.25	CBN
44	Inspect faulty transistorized ignition components	3.84	3.27	0.57	CBN
45	Repair faulty transistorized ignition components	4.30	3.07	1.23	CBN
46	Replace faulty transistorized ignition components	3.75	2.85	0.90	CBN
	GRAND MEAN/CBN	**3.83**	**3.02**	**0.82**	**CBN**

Table 4.2 shows the mean responses of the respondents on items posed to determine the capacity building needs of automotive mechatronics instructors in the maintenance of ignition system with the grand capacity building need value of 0.82. This implies that

automotive mechatronics instructors in VEIs in Abuja and Kogi state, needs capacity building in all the areas of competences in the maintenance of ignition system.

4.3 Research Question 3

Capacity building needs of automotive mechatronics instructors in maintenance of transmission system?

Result for answering research question three is presented in Table 4.3

Table 4.3

Capacity building need Analysis of the Mean Responses of Respondents on the Capacity Building Needs of Automotive Mechatronics Instructors in Maintenance of Transmission System N = 115

S/N	Items	$\bar{X}_n$	$\bar{X}_p$	CBN = ($\bar{X}_n$-$\bar{X}_p$)	Remarks
47	Service manual transmission	4.15	2.66	1.49	CBN
48	Carry out road test for proper gear engagement	3.51	2.91	0.60	CBN
49	Retrieve transmission Diagnostic Trouble Codes (DTC's)	4.18	2.50	1.68	CBN
50	Interpret Diagnostic Trouble Codes (DTC's)	3.97	2.85	1.12	CBN
51	Repair auxiliary gear system	4.00	3.82	0.18	CBN
52	Conduct thorough visual inspection on transmission linkage Adjustments	3.83	3.23	0.60	CBN
53	Inspect and adjust the shift cable	3.32	3.00	0.32	CBN
54	Examine fluid level for leakage from the transmission vent	3.57	2.60	0.97	CBN
55	Check transmission fluid and filters for oxidation or Contamination	3.42	2.52	0.90	CBN
56	Check drive train for looseness or leaks	3.56	3.35	0.21	CBN
57	Remove new gasket to correct fluid leakage	3.45	1.47	1.97	CBN
58	Reinstall new gasket to correct fluid leakage	3.56	3.35	0.21	CBN
59	Check torque converter for leaks	4.40	3.90	0.50	CBN
60	Replace leaking or damaged torque converter	3.47	3.37	0.01	CBN
61	Check transmission vent for blockage	4.10	3.67	0.42	CBN
62	Replacement of O-ring and gears	3.32	2.62	0.70	CBN

Table 4.3 continues

63	Inspect entire transmission wiring harness for tears and other Damages	3.97	3.02	0.95	CBN
64	Replace damaged fluid lines and fittings	3.97	3.35	0.62	CBN
65	Carefully inspect a disassembled transmission to diagnose noise and vibration problems	4.10	3.67	0.42	CBN
66	Repair All-wheel drive system	3.97	3.57	0.40	CBN
	GRAND/MEAN/CBN	**3.79**	**3.07**	**0.71**	**CBN**

Table 4.3 shows the mean responses of the respondents on the items posed to determine the capacity building needs of automotive mechatronics instructors in the maintenance of transmission system with the grand capacity building need value of 0.71. This implies that automotive mechatronics instructor's needs capacity building in all the areas of competences in the maintenance of transmission system.

4.4 Research Question 4

Capacity building needs of automotive mechatronics instructors in maintenance of fuel supply system?

Result for answering research question four is presented in Table 4.4

Table 4.4

Capacity building need Analysis of the Mean Responses of Respondents on the Capacity building needs of automotive mechatronics instructors in maintenance of fuel supply system **N = 115**

S/N	Items	$\bar{X}_n$	$\bar{X}_p$	CBN = ($\bar{X}_n$-$\bar{X}_p$)	Remarks
67	Check fuel injection malfunction using vehicle communication kit	3.78	2.49	1.29	CBN
68	Test the fuel pressure by controlling the activity of the pump with a scan tool	4.06	3.27	0.79	CBN
69	Record vehicle fuel consumption using calibration machine	3.87	3.07	0.80	CBN
70	Check the fuel injector and pump control with multimeter	4.30	2.85	1.45	CBN
71	Check fuel system circuits	3.56	3.35	0.21	CBN

Table 4.4 continues

72	Test the manifold absolute pressure sensor using multimeter	3.76	3.27	0.49	CBN
73	Inspect oxygen (lambda) sensor	3.95	2.45	1.50	CBN
74	Replace oxygen (lambda) sensor	3.98	3.32	0.66	CBN
75	Check fuel pump pressure	3.72	3.57	0.15	CBN
76	Inspect electronics defective injectors	3.95	3.18	0.77	CBN
77	Remove electronics defective injectors	3.74	2.49	1.25	CBN
78	Replace electronics defective injectors	3.84	3.27	0.57	CBN
79	Carry out proper injector cleaning	4.30	3.07	1.23	CBN
80	Remove fuel injection fuel rail	3.75	2.85	0.90	CBN
81	Refit fuel injection fuel rail	3.56	3.35	0.21	CBN
82	Remove pressure regulator	4.75	3.27	1.48	CBN
83	Refit pressure regulator	4.38	3.10	1.28	CBN
84	Remove fuel injectors	3.79	3.00	0.79	CBN
85	install fuel injectors	4.17	3.81	0.36	CBN
86	Install new O-rings onto the new injector	3.58	2.69	0.89	CBN
87	Check for fuel leaks at the rail and be sure the engine operation is normal	3.56	3.35	0.21	CBN
88	Carryout throttle actuator inspection	3.71	2.92	0.79	CBN
89	Check the fuel pump and its electrical circuits	3.76	2.66	1.10	CBN
90	Check pressure sensor and power control module (PCM)	3.75	2.69	1.06	CBN
91	Test the petrol engine for sensors that are in good condition	3.64	2.86	0.78	CBN
92	Test the petrol engine for actuators that are in good Condition.	4.34	3.50	0.84	CBN
93	Check the wiring and connectors to the oxygen (lambda) sensors for damage and evidence of unwanted resistance	3.65	2.5	1.15	CBN
94	Check for intake and exhaust system leaks	4.12	3.67	0.45	CBN
95	Inspect all under hood wiring	3.90	2.70	1.20	CBN
96	Check the malfunction Indication Lamp	3.42	2.97	0.45	CBN
97	Check and adjust Idle Speed	3.45	3.25	0.20	CBN
98	Carry out visual inspection of the air mass sensor	4.02	3.65	0.37	CBN
99	Inspect the ductwork and hoses of the air induction system	4.00	3.45	0.55	CBN
	GRAND WEIGHTED MEAN/CBN	**3.88**	**3.09**	**0.79**	**CBN**

Table 4.4 shows the mean responses of the respondents on the items posed to determine the capacity building needs of automotive mechatronics instructors in the maintenance of fuel

supply system with the grand capacity building need value of 0.79. This implies that automotive mechatronics instructor's needs capacity building in all the areas of competences in the maintenance of fuel Supply system.

4.5 Research Question 5

What are the Capacity buildings needs of automotive mechatronics instructors in maintenance of suspension system?

Result for answering research question five is presented in Table 4.5

Table 4.5

Capacity building need Analysis of the Mean Responses of Respondents on the Capacity building needs of automotive mechatronics instructors in maintenance of suspension system N=115

S/N	Items	$\bar{X}_n$	$\bar{X}_p$	CBN = ($\bar{X}_n$-$\bar{X}_p$)	Remarks
100	Inspect struts bearing to determine their faults	3.55	3.45	0.10	CBN
102	replace struts bearings where if necessary	3.65	3.15	0.50	CBN
103	check shock absorbers or struts for bouncy or over bumps	3.90	3.65	0.25	CBN
104	Check and inspect ball joints	2.97	2.47	0.50	CBN
105	Maintain Active Suspension system	4.50	3.89	0.70	CBN
106	repair Active Suspension system	3.65	2.59	1.15	CBN
107	Maintain and repair air suspension system	4.12	3.67	0.45	CBN
108	Check and inspect telescopic shock absorbers	3.90	3.70	0.20	CBN
109	Inspect suspension for squeaking noises due to bushing and other connections failing	3.42	2.97	0.45	CBN
110	Inspect strut rods for their faults	3.45	3.25	0.20	CBN
111	Replace strut rods where necessary	4.02	3.65	0.37	CBN
112	Inspect leaf springs as needed				
113	Repair leaf springs as needed	4.00	3.45	0.55	CBN
114	Replace leaf spring as needed	3.95	2.45	1.50	CBN
115	Check control arms and bushing	3.98	3.32	0.66	CBN
116	Check and inspect Stability Control System	3.72	3.57	0.15	CBN
117	Check out for leaks on the air suspension system	3.78	2.49	1.29	CBN
118	Service the air compressor for replenishing the air	4.06	3.27	0.79	CBN
119	Detect active suspension system actuator faults	3.87	3.07	0.80	CBN
	GRAND WEIGHTED MEAN /CBN	**3.64**	**3.05**	**0.60**	**CBN**

Table 4.5 shows the mean responses of the respondents on the items posed to determine the capacity building needs of automotive mechatronics instructors in the maintenance of suspension system with the grand capacity building need value of 0.60. This implies that automotive mechatronics instructor's needs capacity building in all the areas of competences in the maintenance of suspension system

4.6 Testing of Hypotheses

Hypothesis 1

There is no significant difference in the mean responses of the automotive industrial technicians and automotive mechatronics instructors on the capacity building needs of automotive mechatronics instructors in maintenance of braking system.

Result of testing null hypothesis one are presented in Table 4.6.

Table 4.6

Z-test Analysis of the Mean Responses of Automotive Industrial Technicians and Automotive Mechatronics Instructors on the Capacity Building Needs of Automotive Mechatronics Instructors in Maintenance of Braking System

Motor vehicle mechanics	N	Mean	S.D	df	P – value	Alpha level	Decision
Automotive industrial technicians	77	4.04	0.77	114	0.60	0.05	Accepted
Automotive mechatronics instructors	38	3.23	0.65				

Key: df = degree of freedom**,** p- value = probability value calculated by the computer, S.D = Standard deviation

The analysis of the results presented in Table 4.6 revealed that since p-value 0.60 is greater than 0.05 this implies that there is no significant difference in the mean responses of both groups of respondents. Therefore, the null hypothesis of no significant difference between the mean responses of automotive industrial technicians and automotive mechatronics instructors on the capacity building needs of automotive mechatronics instructors in maintenance of braking system was upheld.

Hypothesis 2

There is no significant difference in the responses of the automotive industrial technicians and automotive mechatronics instructors on the capacity building needs of automotive mechatronics instructors in maintenance of ignition system.

Result of testing null hypothesis two is presented in Table 4.7.

Table 4.7

Z-test Analysis of the Mean Responses of Automotive Industrial Technicians and Automotive Mechatronics Instructors on the Capacity Building Needs of Automotive Mechatronics Instructors in Maintenance of Ignition System

Motor vehicle mechanics	N	Mean	S.D	df	P – value	Alpha level	Decision
Automotive industrial technicians	77	3.82	0.77	114	0.96	0.05	Accepted
Automotive mechatronics instructors	38	3.02	0.65				

The analysis of the results presented in Table 4.7 revealed that since p-value 0.96 is greater than 0.05 this implies that there is no significant difference in the mean responses of both groups of respondents. Therefore, the null hypothesis of no significant difference between the mean responses of automotive industrial technicians and automotive mechatronics instructors on the capacity building needs of automotive mechatronics instructors in maintenance of ignition system was upheld.

Hypothesis 3

There is no significant difference in the responses of the automotive industrial technicians and automotive mechatronics instructors on the capacity building needs of automotive mechatronics instructors in maintenance of transmission system.

Result of testing null hypothesis three are presented in Table 4.8

Table 4.8

z-test Analysis of the Mean Responses of Automotive Industrial Technicians and Automotive Mechatronics Instructors on the Capacity Building Needs of Automotive Mechatronics Instructors in Maintenance of Transmission System

Motor vehicle mechanics	N	Mean	S.D	df	P – value	Alpha level	Decision
Automotive industrial technicians	77	3.79	0.77	114	0.69	0.05	Accepted
Automotive mechatronics instructors	38	3.07	0.65				

The analysis of the results presented in Table 4.6 revealed that since p-value 0.69 is greater than 0.05 this implies that there is no significant difference in the mean responses of both groups of respondents. Therefore, the null hypothesis of no significant difference between the mean responses of automotive industrial technicians and automotive mechatronics instructors on the capacity building needs of automotive mechatronics instructors in maintenance of transmission system was upheld

Hypothesis 4

There is no significant difference in the responses of the automotive industrial technicians and automotive mechatronics instructors on the capacity building needs of automotive mechatronics instructors in maintenance of fuel supply system.

Result for testing null hypothesis four are presented in Table 4.9

Table 4. 9
z-test Analysis of the Mean Responses of Automotive Industrial Technicians and Automotive Mechatronics Instructors on the Capacity Building Needs of Automotive Mechatronics Instructors in Maintenance of Fuel Supply System

Motor vehicle mechanics	N	Mean	S.D	df	P – value	Alpha level	Decision
Automotive industrial technicians	77	3.88	0.77	114	0.74	0.05	Accepted
Automotive mechatronics instructors	38	3.09	0.65				

The analysis of the results presented in Table 4.9 revealed that since p-value 0.74 is greater than 0.05 this implies that there is no significant difference in the mean responses of both groups of respondents. Therefore, the null hypothesis of no significant difference between the mean responses of automotive industrial technicians and automotive mechatronics instructors as regard the capacity building needs of automotive mechatronics instructors in maintenance of fuel supply system was upheld

Hypothesis 5

There is no significant difference in the responses of the automotive industrial technicians and automotive mechatronics instructors as regard the capacity building needs of automotive mechatronics instructors in maintenance of suspension system.

Result of testing null hypothesis five are presented in Table 4.1

Table 4.10
Z-test Analysis of the Mean Responses of Automotive Industrial Technicians and Automotive Mechatronics Instructors on the Capacity Building Needs of Automotive Mechatronics Instructors in Maintenance of Suspension System

Motor vehicle mechanics	N	Mean	S.D	Df	P – value	Alpha level	Decision
Automotive industrial technicians	77	3.64	0.77	114	0.64	0.05	Accepted
Automotive mechatronics instructors	38	3.05	0.65				

The analysis of the results presented in Table 4.10 revealed that since p-value 0.64 is greater than 0.05 this implies that there is no significance difference in the mean responses of both groups of respondents. Therefore, the null hypothesis of no significant difference between the mean responses of automotive industrial technicians and automotive mechatronics instructors on the capacity building needs of automotive mechatronics instructors in maintenance of suspension system was upheld.

4.11 Findings of the Study

The following findings emerged from the study based on the research questions and hypotheses:

A. Automotive mechatronics instructors need capacity building in the following area in the maintenance of braking systems

1. Recognize a defective Anti-lock Braking System (ABS) warning light
2. Repair braking system for functionality
3. Identify defective wheel speed sensor

B. Automotive mechatronics instructors need capacity building in the following area in the maintenance of ignition systems

4. Replace faulty electronic ignition components
5. Use plug wire to check for spark of the plug

C. Automotive mechatronics instructors need capacity building in the following area in the maintenance of transmission systems

6. Examine fluid level for leakage from the transmission vent
7. Check torque converter for leaks
8. Check transmission fluid and filters for oxidation or Contamination
9. Replace leaking or damaged torque converter

D. Automotive mechatronics instructors need capacity building in the following area in the maintenance of fuel supply systems

10. Check fuel injection malfunction using vehicle communication kit
11. Remove fuel injection fuel rail
12. Refit fuel injection fuel rail

E. Automotive mechatronics instructors need capacity building in the following area in the maintenance of suspension systems

13. Maintain Active Suspension system
14. Repair Active Suspension system
15. Check and inspect stability control system

Findings relating to hypothesis one revealed that:

H_{o1} There was no significant difference between the mean responses of automotive industrial technicians and automotive mechatronics instructors on the capacity building needs of automotive mechatronics instructors in maintenance of braking system

Findings relating to hypothesis two revealed that:

H$_{o2}$There was no significant difference between the mean responses of automotive industrial technicians and automotive mechatronics instructors on the capacity building needs of automotive mechatronics instructors in maintenance of ignition system

Findings relating to hypothesis three revealed that:

H$_{o3}$ There was no significant difference between the mean responses of automotive industrial technicians and automotive mechatronics instructors on the capacity building needs of automotive mechatronics instructors in maintenance of transmission system

Findings relating to hypothesis four revealed that:

H$_{o4}$There was no significant difference between the mean responses of automotive industrial technicians and automotive mechatronics instructors on the capacity building needs of automotive mechatronics instructors in maintenance of fuel supply system

Findings relating to hypothesis five revealed that:

H$_{o5}$There was no significant difference between the mean responses of automotive industrial technicians and automotive mechatronics instructors on the capacity building needs of automotive mechatronics instructors in maintenance of suspension system

4.12 Discussion of the Findings

The findings in Table 4.1 relating to research question 1 showed that automotive mechatronics instructors in Vocational Enterprise Institutions in Abuja and Kogi State, Nigeria needs capacity building in all twenty one areas of competencies in the maintenance of braking system. The findings revealed that automotive mechatronics instructor's needs capacity building in recognizing a defective Anti-lock Braking System (ABS) warning light. This is line with the view of Erjavec (2010) who pointed out that automobile instructors possessed average competency in operating ABS scan tools and testers that are used to monitor and trigger input and output signals in the ABS, which allow technicians to confirm the presence of a suspected problem with an input, switch, or output solenoid in the system. Buttressing this finding, Bosch (2013) opined that 76 percent of all new vehicles were equipped with ABS and it has become standard equipment for passenger vehicle in the European Union (EU), United States of America (USA) and Japan. However, automobile instructors possessed average competency in the maintenance ABS. Affirming this assertion Ofria, (2015) reported that anti-lock braking system originally developed for aircraft braking system is now been applied in modern motor vehicles.

The finding also revealed that automotive mechatronics instructors needs capacity building in repairing braking system for functionality. This is in agreement with the findings of Kerr (2014) who maintained that automobile instructors possessed average competency in the maintenance electronic brake force distribution (EBFD) which is a computer controlled solenoid that is part of the anti-lock brake system that varies brake pressure to the rear wheel based on the vehicle deceleration rates, steering angle and possibly even lateral acceleration of the vehicle. This is also in conformity with the views of Erjavec (2010), who asserted that braking system converts the momentum of the vehicle into heat by slowing and stopping the vehicle wheel, this is done by causing friction at the wheel. The finding also revealed that automotive mechatronics instructors needs capacity building in carrying out preventive maintenance in the braking system. This finding conform to the findings of Li (2010) who asserted that, 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. Bonnick (2016) argued that ABS control computer that was incorporated into the ABS modulator and, with the aid of sensor inputs required high maintenance to keep the system working effectively. Measures to keep education and training in tune with the knowledge and skills needed in the world of work, school courses and curricula must be reviewed, enriched and updated regularly in line with changes that are taking place in the industries. Thus, it was imperative to ascertain the new technological innovations in braking system with the view to identifying those that posed new challenges to the instructors in VEIs to retrain them through organizing seminars and workshops for capacity building.

The findings in Table 4.2 relating to research question 2 showed that automotive mechatronics instructors in Vocational Enterprise Institutions in Abuja and Kogi State, Nigeria needs capacity building in all twenty five areas of competencies in the maintenance of ignition system. The findings revealed that automotive mechatronics instructors needs capacity building in replace faulty electronic ignition components, The finding is in line with the assertion of Melior (2015) who held that the designs of vehicles have advanced to a very sophisticated level, and unlike the old mechanically operated vehicle systems, the modern vehicles are being operated and controlled by computerised electronic sensors. For example, latest vehicles' ignition systems are electronically controlled without employing the old use of manually reset contact breaker. This finding agreed with the findings of Julian (2015) which asserted that, an ignition system is needed on gasoline engines to ignite the air-fuel mixture. It produces an extremely high voltage surge, which operates the spark plugs. A very hot electric arc jumps across the tip of each spark plug at the correct time. This causes the air-fuel mixture to burn, expand, and produce power.

The findings further revealed that automotive mechatronics instructors needs capacity building in using wire to check for spark of the plug. This finding is in consonant with the views of Melior (2015) which pointed out that, ignition system have several ignition coils, one for each spark plug or pair spark plugs, when a coil is activated by the electronic control module, high voltage is sent through a spark plug unit. Buttressing this, Bonnick (2016) revealed that without a good quality spark, in the right place at the right time the engine performance will be affected as well as the operation of emission control system. The gaps created between the curriculum and the new technological innovations have made the needed skills imperative for effective teaching of these new breed of automotive mechatronics students. Therefore automotive mechatronics instructors need capacity building on these skills in order to teach their students effectively.

The findings in Table 4.3 relating to research question 3 showed that automotive mechatronics instructors in Vocational Enterprise Institutions in Abuja and Kogi State, Nigeria needs capacity building in all twenty areas of competencies in the maintenance of transmission system. The findings revealed that automotive mechatronics instructors needs capacity building in examining the fluid level for leakage from the transmission vent. This is in line with the views of Zongxuan and Kumar (2005) which pointed out that, diagnosis of transmission problems should being with checking transmission fluid and filters for oxidation or Contamination, Check drive train for looseness or leaks, This finding was further supported by the work of Toyota incorporation (2013) who maintained that the fluid level in the transmission should be inspected by the means of dipstick after the transmission has been warmed up to ordinary operating temperature.

The findings of the study further revealed that automotive mechatronic instructors needs capacity building in checking torque converter for leaks. This finding is in agreement with the findings of Roberson (2013), which pointed out that the torque converter mechanism facilities gear changing by dispensing with the need to press a clutch pedal at same time as changing gears. It uses electronic sensors, pneumatics, processors and actuators to execute gear shift on input from the driver or by a computer. Supporting this assertion Gold (2015) maintained that this remove the need for a clutch pedal which the driver otherwise need to depress before making a gear change. This finding was further supported by the work of Mohammed *et al.,* (2019) who maintained that one of the recent developments in the automobile transmission is the introduction of a continuously variable transmission type of transmission which provides more useable power, better fuel economy and smoother driving experience. The knowledge of automotive mechatronics which combines the inclusion of electronic circuits in automobile has now posed a challenge to instructors in such field of study to meet up with the demands of modern technologies in automobile technologies therefore, capacity building is imperative to improve their skills, and knowledge for teaching effectively.

The findings in Table 4.4 relating to research question 4 showed that automotive mechatronics instructors in Vocational Enterprise Institutions in Abuja and Kogi State, Nigeria needs capacity building in all thirty three areas of competencies in the maintenance of fuel supply system. The findings revealed that automotive mechatronics instructors needs capacity building in checking fuel injection malfunction using vehicle communication kit and Test the fuel pressure by controlling the activity of the pump with a scan tool. The finding is in line with the assertion of Jayne (2012) that modern automobile technicians should troubleshoot problems in vehicles by checking components and systems; this can be done by using a diagnostic computer, test drives or digital tools to diagnose problems in vehicles, as well as how to repair the computerized systems present in many automobiles. This finding is also in agreement with assertion of Erjavec (2010) who pointed out that, EFI systems are computer controlled and designed to provide the correct air-fuel ratio for all engine loads, speeds and temperature condition.

Furthermore, the findings also revealed that automotive mechatronics instructors needs capacity building in Removing fuel injection fuel rail and Refit fuel injection fuel rail. In justifying the respondents opinion Bonnick (2016), asserted that the computer controlled petrol injection is now the normal method of supplying fuel in a combustible mixture form to the engine combustion chambers. In support of this Stryjek and Motrycz (2013) revealed that the fuel pressure at the injectors is controlled by the fuel pressure regulator and the amount of fuel injected is determined by the length of time for which the injector valve is held off its seat, Denton (2004), further stressed that, it important to remove fuel injectors and clean it and install fuel injectors back so that a finely atomized fuel is sprayed into the throttle body, in accordance with controlling actions from the engine computer. The finding of the study also revealed that automotive mechatronic instructors need capacity building in checking pressure sensor and power control module (PCM).

This finding conform to the findings of Udogu (2015) who asserted that, That the use of electronic circuit and advent of computer have changed the operating systems of fuel supply system in modern vehicles. Stryjek and Motrycz (2013) buttress that, the knowledge of Autotronics, which combines the inclusion of electronic circuits in automobile, has now posed a challenge to teachers in such field of study to meet up with the demands of modern technologies in automobile technologies therefore, capacity building is imperative to improve their competencies, and knowledge for teaching effectively. However, automotive mechatronics instructors need to acquire servicing skills such as Check fuel injection malfunction using vehicle communication kit, Remove fuel injection fuel rail, Refit fuel injection fuel rail in order to effectively teach automotive mechatronics trainee servicing of modern automobiles.

The findings in Table 4.5 relating to research question 5 showed that automotive mechatronics instructors in Vocational Enterprise Institutions in Abuja and Kogi State, Nigeria needs capacity building in all twenty areas of competencies in the maintenance of suspension system. The findings revealed that automotive mechatronics instructors needs capacity building in maintaining active suspension system. This finding is in line with the words of Konrad (2015) who maintained that active suspension usually used passive parts such as extra springs, and dampers in parallel or in series with their actuators, to enhance the suspension system performance and insure system reliability even when the actuators are having faults or not working. Gsecheidle (2016) maintained that as a result of the mechatronic integration of actuators, they involved sensors and electronic units, enable process suspension system identification and fault detection and diagnosis for the whole system. The finding also revealed that automotive mechatronics instructors needs capacity building in Detecting active suspension system actuator faults. This finding is in line with the findings of Cengage learning (2014) which pointed out that, modern suspension system uses advanced electronics and computer systems to make real-time changes to steering and suspension systems to provide increase handling and safety.in support of this Servason (2014) in a study on suspension system technology revealed that the most popular suspension system systems for passenger car today are the double wishbone suspension system with actuators and the Macpherson strut suspension system. Servason, maintained that while it is more usual to see the double wishbone system at rear end of the car, Macphersons strut suspension system normally find s its place at the front end of the car. The finding also revealed that automotive mechatronic instructors need checking and inspecting stability control system. This is in consonant with Lukaz & RufaI (2017) who asserted that at stability bar keep the body of the vehicle from leaning excessively in sharp turns. Therefore automotive mechatronics instructors highly need the ability to repair and maintain stability control systems.

The findings in Table 4.6 relating to hypothesis 1 showed that there was no significant difference between the mean responses of automotive industrial technicians and automotive mechatronics instructors on the capacity building needs of automotive mechatronics instructors in maintenance of braking system. This means that the automotive industrial technician and automotive mechatronic instructors had similar perceptions on the competencies in the maintenance of braking system. This finding is in line with the views of Usman, (2017) who revealed that the orthodox skills of auto technicians have been rendered valueless by emergence of computer technology in modern automobiles, and auto technicians lack knowledge and capacity building are needed to repair modern automobiles. Ugwoke *et al* (2016) emphasis that there must be synergy between institution and industry to stimulate and enhance the capacity building needs of instructors in TVET institutions, as well as the demand for competent graduates for employment and economic development.

The findings in Table 4.7 relating to hypothesis 2 showed that there was no significant difference between the mean responses of automotive industrial technicians and automotive mechatronics instructors on the capacity building needs of automotive mechatronics instructors in maintenance of ignition system. This means that the automotive industrial technician and automotive mechatronic instructors had similar perceptions on the competencies in the maintenance of ignition system. The finding agreed with Abah (2011) who outlined that, lecturers in tertiary institutions in Northern states of Nigeria possessed average competencies in practical's, workshop cum classroom management and theories of automobile technology. He recommended that seminars and workshops should be organized by industries for lecturers and instructors of automobile technology on methods of teaching practical, effective classroom cum workshop management. To buttress this fact Ojimba (2013) emphasized the need for school and industry to partner to reform the programme and help instructors acquire skill and suitable work habit for the 21st century.

The findings in Table 4.8 relating to hypothesis 3 showed that there was no significant difference between the mean responses of automotive industrial technicians and automotive mechatronics instructors on the capacity building needs of automotive mechatronics instructors in maintenance of transmission system. This means that the automotive industrial technician and automotive mechatronic instructors had similar perceptions on the competencies in the maintenance of transmission system. That is, they have the same opinions on most of the area of competences in the maintenance of transmission system. Triki (2013) affirmed that TVET partnership with industry is essential for curriculum development, access to modern equipment, improve skill acquisition by students and enhanced the capacity building needs of instructors.

The findings in Table 4.9 relating to hypothesis 4 showed that there was no significant difference between the mean responses of automotive industrial technicians and automotive mechatronics instructors on the capacity building needs of automotive mechatronics instructors in maintenance of braking system. That is, they have the same opinions on most of the area of competences in the maintenance of fuel supply system. The is in consonant with the words of Ezenwafor and Okoli (2014) who posited that in order to bridge the gap between quantity and quality of lecturers and instructors for effective implement of TVET programme in Nigeria their training and retraining should be a focal area. To support this fact Amechi (2013) suggested the following as strategies for repositioning TVET in Nigeria: regular capacity building and training workshops for teachers and instructors,

The findings in Table 4.10 relating to hypothesis 5 showed that there was no significant difference between the mean responses of automotive industrial technicians and automotive mechatronics instructors on the capacity building needs of automotive mechatronics instructors in maintenance of suspension system. This means that the automotive industrial technician and automotive mechatronic instructors had similar perceptions on the competencies in the maintenance of suspension system. This finding is in agreement with the works of Ayonmike and Chinyere (2016) who revealed that industries should synchronize with institutions on the areas of capacity building needs and the relevant skills needed by TVET instructors and the training materials and method that should be employed to enhance effective implementation of the programme.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

1.1 Conclusion

This study was designed to determined capacity building needs of automotive mechatronics instructors in vocational enterprise institution Abuja and Kogi State, Nigeria. The findings of the study serve as the basis for making the following conclusion: that automotive mechatronics instructors needs capacity building in all the area of competences identified in the maintenance of braking system such as perform visual inspection of wheel speed sensor and cable, check power supply of the wheel sensor, replace electrical wiring to the wheel speed sensor. It was also concluded that automotive mechatronics instructors needs capacity building in all the area of competences in the maintenance of ignition system such as inspect, adjust or replace faulty crank position sensor, test and diagnose defective reluctor sensor, use plug wire to check for spark of the plug, conduct a careful visual inspection of the wiring and the mechanical components, check the battery to make sure there is ample voltage to start the engine. It was further concluded that automotive mechatronics instructor’s needs capacity building in all the area of competences in the maintenance of transmission, fuel supply and suspension systems. Therefore, the trainees in VEIs at all levels can only acquire skills for employments or self-reliant under competent instructors. The inclusion of these identified areas of competences in the training manual of automotive mechatronic instructors will in no doubt help the instructors in effective teaching of automotive mechatronics courses.

5.2 Recommendations

1. Management of VEIs should sent automotive mechatronics instructors for further

training in automotive mechatronics courses in order to update their knowledge/competencies.

2. Workshop and seminars should be organized by National Automotive Council of Nigeria for automotive mechatronics instructors in order to build their capacity in braking, ignition, transmission, fuel supply and suspension system.
3. NBTE as the governing body that oversee the affairs of VEIs should organize capacity building training from time to time and regular seminars and conferences for automotive mechatronics instructors in VEIs in Abuja and Kogi State and indeed automotive mechatronics instructors in other parts of Nigeria
4. Modern automotive industrial employers should from time to time visit Vocational Enterprise Institution to inform them about the new development and the required skill development that goes with it in order to keep these schools abreast with the ongoing developments
5. The findings of the study should be made available to policy makers like the automobile council of Nigeria, educational institutions and other cooperate bodies/agencies of education to enable tem effect necessary changes in the automotive mechatronics programme with respect to its theories and practical's.

5.3 Suggestion for Further Research

The following are suggested for further research

1. Capacity building needs of automotive mechatronics instructors in vocational enterprise institution in other states of the federation
2. Competency improvement needs of lecturers of automobile technology in NCE programmes of Polytechnics and Colleges of Education in North central, Nigeria.

3. Capacity building needs of automotive mechatronics instructors in vocational enterprise institution in the maintenance of electric vehicles
4. Capacity building needs of automotive mechatronics instructors in vocational enterprise institutions in the maintenance of compression ignition engine.

5.4 Contribution to Knowledge

The study established capacity building needs for automotive mechatronics instructors in Vocational Enterprise Institution in the maintenance of braking, ignition, transmission, fuel supply and suspension systems with Grand Performance Gap values of 0.74, 0.82, 0.71, 0.79 and 0.60 respectively.

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Appendix A

QUESTIONNAIRE

AUTOMOTIVE MECHATRONICS INSTRUCTOR CAPACITY BUILDING NEEDS QUESTIONNAIRE (AMICBNQ)

PART 1
SECTION I: PERSONAL DATA

Read the following statements carefully and write down your responses in the blank spaces provided. Where there are alternatives, put a tick (√) against the responses that is best applicable to you. Please tick (√) as appropriate in the boxes provided or otherwise specify.

Position/Status:

- Automotive Industrial Technician ( )
- Automotive mechatronics instructor ( )

SECTION II: Options

Instruction: Please indicate the degree to which each item on the Capacity Building Needs of Automotive Mechatronics Instructors in Vocational Enterprise Institutions required.

5. Highly Needed (HN)/ Highly Performed (HP) - 4
6. Needed (ND)/ Performed (PD) - 3
7. Moderately Needed (MN) Moderately Performed (MP) - 2
8. Not Needed (NN) / Not Performed (NP) - 1

PART II: SECTION B

What are the capacity building needs of automotive mechatronics instructors in maintenance of braking system?

		Needed category				Performance category			
S/N	**Items**	**HN 4**	**ND 3**	**MN 2**	**NN 1**	**HP 4**	**PD 3**	**MP 2**	**NP 1**
1.	Perform visual inspection of wheel speed sensor and cables								
2	Identify defective wheel speed sensor								
3.	Check wheel speed sensor and the pulse ring								
4.	Carry out speed sensor signal testing								
5.	Check power supply of the wheel speed sensor								
6.	Service the wheel speed sensor								
7.	Visually inspect the wheel speed sensor pulsers for chipped or damaged teeth								
8.	Remove, adjust and replace wheel speed sensors								
9.	Replace electrical wiring to the wheel speed sensor								
10.	Perform a test drive to check the wheel speed sensor after replacement								
11.	Carryout visual inspection of the wiring and the mechanical components								
12.	Recognize a defective Anti-lock Braking System (ABS) warning light								
13.	Repair braking system for functionality								
14	Test braking system after repair								
15.	Carry out all kinds of mechanical tests on the braking system								
16.	Check the operation of the braking system, adjust and repair according to the manufactures specification								
17.	Replace faulty or bad braking system with new one								
18.	Select appropriate tools and equipment for the maintenance of automotive braking system								
19.	Service automatic braking system correctly								
20.	Recalibrate the speed sensors								
21.	Use oscilloscope to verify the voltage and signal supply to the braking system								
22.	Carry out preventive maintenance in the braking system								

SECTION C

What are the capacity building needs of automotive mechatronics instructors in maintenance of Ignition system?

		Needed category				Performance category			
S/N	**ITEMS**	**HN 4**	**ND 3**	**MN 2**	**NN 1**	**HP 4**	**PD 3**	**MP 2**	**NP 1**
23	Conduct engine performance test using engine analyzer and determine needed repair								
24	Test run the ignition system using the multimeter								
25	Check the crankshaft (CKP) and camshaft (CMP) sensors and their wiring for damage								
26	Record ignition timing using digital multimeter								
27	Carry out throttle cable inspection and adjustment								
28	Check the crank sensor using diagnostic tool								
29	Perform magnetic sensor testing								
30	Inspect, adjust or replace faulty crank position sensor								
31	Test and diagnose defective reluctor sensor								
32.	Use plug wire to check for spark of the plug								
33.	Conduct a careful visual inspection of the wiring and the mechanical components								
34	Check the battery to make sure there is ample voltage to start the engine								
35	Inspect, repair and replace faulty electronic ignition components								
36	Use engine analyzer to conduct engine performance test								
37	Use diagnostic tool to check ignition problem								
38	Interpret ignition diagnostics trouble codes								
39	Inspect faulty electronic ignition components								
40	Repair faulty electronic ignition components								

41	Replace faulty electronic ignition components								
42	Inspect, faulty computerized ignition components								
43	Repair faulty computerized ignition components								
44	Replace faulty computerized ignition components								
45	Inspect faulty transistorized ignition components								
46	Repair faulty transistorized ignition components								
47	Replace faulty transistorized ignition components								

SECTION D

What are the capacity building needs of automotive mechatronics instructors in maintenance of Transmission system?

		Needed category				**Performance category**			
S/N	**ITEMS**	**HN 4**	**ND 3**	**MN 2**	**NN 1**	**HP 4**	**PD 3**	**MP 2**	**NP 1**
48	Service manual transmission								
49	Carry out road test for proper gear engagement								
50	Retrieve transmission Diagnostic Trouble Codes (DTC's)								
51	Interpret Diagnostic Trouble Codes (DTC's)								
52	Repair auxiliary gear system								
53	Conduct thorough visual inspection on transmission linkage Adjustments								
54	Inspect and adjust the shift cable								
55	Examine fluid level for leakage from the transmission vent								
56	Check transmission fluid and filters for oxidation or Contamination								
57	Check drive train for looseness or leaks								

58.	Remove new gasket to correct fluid leakage								
59	Reinstall new gasket to correct fluid leakage								
60	Check torque converter for leaks								
61	Replace leaking or damaged torque converter								
62	Check transmission vent for blockage								
63	Replacement of O-ring and gears								
64	Inspect entire transmission wiring harness for tears and other Damages								
65	Replace damaged fluid lines and fittings								
66	Carefully inspect a disassembled transmission to diagnose noise and vibration problems								
67	Repair All-wheel drive system								

SECTION E

What are the capacity building needs of automotive mechatronics instructors in maintenance of fuel supply system?

		Needed category				**Performance category**			
S/N	**ITEMS**	**HN 4**	**ND 3**	**MN 2**	**NN 1**	**HP 4**	**PD 3**	**MP 2**	**NP 1**
68	Check fuel injection malfunction using								
69	Test the fuel pressure by controlling the activity of the pump with a scan tool								
70	Record vehicle fuel consumption using calibration machine								
71	Check the fuel injector and pump control with multimeter								
72	Check fuel system circuits								
73	Test the manifold absolute pressure sensor using multimeter								
74	Inspect oxygen (lambda) sensor								
75	Replace oxygen (lambda) sensor								
76	Check fuel pump pressure								
77	Inspect electronics defective injectors								
78	Remove electronics defective injectors								

79	Replace electronics defective injectors								
80	Carry out proper injector cleaning								
81	Remove fuel injection fuel rail								
82	Refit fuel injection fuel rail								
83	Remove pressure regulator								
84	Refit pressure regulator								
85	Remove fuel injectors								
86	install fuel injectors								
87	Install new O-rings onto the new injector								
88	Check for fuel leaks at the rail and be sure the engine operation is normal								
89	Carryout throttle actuator inspection								
90	Check the fuel pump and its electrical circuits								
91	Check pressure sensor and power control module (PCM)								
92	Test the petrol engine for sensors that are in good condition								
93	Test the petrol engine for actuators that are in good condition.								
94	Check the wiring and connectors to the oxygen (lambda) sensors for damage and evidence of unwanted resistance								
95	Check for intake and exhaust system leaks								
96	Inspect all under hood wiring								
97	Check the malfunction Indication Lamp								
98	Check and adjust Idle Speed								
99	Carry out visual inspection of the air mass sensor								
100	Inspect the ductwork and hoses of the air induction system								

SECTION F

What are the capacity building needs of automotive mechatronics instructors in maintenance of suspension system?

S/N	ITEMS	Needed category HN 4	ND 3	MN 2	NN 1	Performance category HP 4	PD 3	MP 2	NP 1
101	Inspect struts bearing to determine their faults								
102	replace struts bearings where if necessary								
103	check shock absorbers or struts for bouncy or over bumps								
104	Check and inspect ball joints								
105	Maintain Active Suspension system								
106	repair Active Suspension system								
107	Maintain and repair air suspension system								
108	Check and inspect telescopic shock absorbers								
109	Inspect suspension for squeaking noises due to bushing and other connections failing								
110	Inspect strut rods for their faults								
111	Replace strut rods where necessary								
112	Inspect leaf springs as needed								
113	Repair leaf springs as needed								
114	Replace leaf spring as needed								
115	Check control arms and bushing								
116	Check and inspect Stability Control System								
117	Check out for leaks on the air suspension system								
118	Service the air compressor for replenishing the air								
119	Detect active suspension system actuator faults								

APPENDIX B

VALIDATION LETTER

Department of Industrial Technology Education,

Federal University of Technology Minna,

Niger State, Nigeria.

Date: --------------------------------

Federal University of Technology Minna

Department of Industrial Technology Education

Sir,

REQUEST FOR RESEARCH INSTRUMENT VALIDATION

Your kind gesture is needed to ascertain the credibility and suitability of this instrument on the **Capacity building needs of automotive mechatronics instructor in vocational enterprise institutions in Abuja and Kogi state.**

I therefore request that you validate the attached instruments (questionnaire).

You are obliged to remove or add item (s) necessary for the actualization of the set goal. The proficiency of the project is based on the accuracy of this instrument, and as such, your kind opinions on the the above subject matter are highly valuable.

Thank you

Yours faithfully,

Ayoko Samson Oladeji
MTECH/SSTE/2018/7886
08106172642

APPENDIX C

VALIDATION CERTIFICATE

VALIDATION CERTIFICATE

This is to certify that the instrument on the research work titled: **Capacity building needs of automotive mechatronics instructor in vocational enterprise institutions in Abuja and Kogi state**. Was validated by me:

Name of first validates': DR. AUDU RUFAI

Institution: FEDERAL UNIVERSITY OF TECHNOLOGY MINNA

Department: INDUSTRIAL AND TECHNOLOGY EDUCATION

Signature and Date: 21/04/2021

Name of second validates': ABDULAZEEZ MURTALA O.

Organization: PREMIERNET AUTOCARE SERVICES LIMITED, FCT

Position/Status: WORKSHOP SUPERVISOR

Signature and Date: 15 — 04 — 2021

PREMIERNET AUTOCARE SERVICES LIMITED SIGN DATE 15/4/21

Name of third validates': Engr Yakubu Su[illegible]

Organization: Sumala mechanic workshop, Lokoja, Kogi

Position/Status: Automotive Service Advisor (1)

Signature and Date: 13-04-2021

Name of Researcher Student: Ayoko Samson Oladeji

Matriculation Number: MTech/SSTE/2018/7886

Programme of Study: MTech Industrial and Technology Education (Automobile Technology)

APPENDIX D
Determination of Reliability of the Instrument

Section B

```
RELIABILITY
  /VARIABLES=ITEM1 ITEM2 ITEM3 ITEM4 ITEM5
ITEM6 ITEM7 ITEM8 ITEM9 ITEM10 ITEM11 ITEM12
ITEM13 ITEM14 ITEM15 ITEM16 ITEM17 ITEM18
ITEM14 ITEM19 ITEM20 ITEM21
  /SCALE('ALL VARIABLES') ALL
  /MODEL=ALPHA.
```

Scale: ALL VARIABLES

Case Processing Summary

		N	%
Cases	Valid	10	100.0
	Excluded[a]	0	.0
	Total	10	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.810	21

Section C

```
RELIABILITY
  /VARIABLES= ITEM1 ITEM2 ITEM3 ITEM4 ITEM5
ITEM6 ITEM7 ITEM8 ITEM9 ITEM10 ITEM11 ITEM12
ITEM13 ITEM14 ITEM15 ITEM16 ITEM17 ITEM18
ITEM14 ITEM19 ITEM20 ITEM21 ITEM22 ITEM23
ITEM24 ITEM25
  /SCALE('ALL VARIABLES') ALL
  /MODEL=ALPHA.
```

Scale: ALL VARIABLES

Case Processing Summary

		N	%
Cases	Valid	10	100.0
	Excluded[a]	0	.0

	Total	10	100.0

. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.832	25

Section D

```
RELIABILITY
  /VARIABLES= ITEM1 ITEM2 ITEM3 ITEM4 ITEM5
ITEM6 ITEM7 ITEM8 ITEM9 ITEM10 ITEM11 ITEM12
ITEM13 ITEM14 ITEM15 ITEM16 ITEM17 ITEM18
ITEM14 ITEM19 ITEM20
  /SCALE('ALL VARIABLES') ALL
  /MODEL=ALPHA.
```

Scale: ALL VARIABLES

Case Processing Summary

		N	%
Cases	Valid	10	100.0
	Excluded[a]	0	.0
	Total	10	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.963	32

Section E

```
RELIABILITY
  /VARIABLES= ITEM1 ITEM2 ITEM3 ITEM4 ITEM5
ITEM6 ITEM7 ITEM8 ITEM9 ITEM10 ITEM11 ITEM12
ITEM13 ITEM14 ITEM15 ITEM16 ITEM17 ITEM18
ITEM14 ITEM19 ITEM20 ITEM21 ITEM22 ITEM23
ITEM24 ITEM25 ITEM26 ITEM27 ITEM28 ITEM29
ITEM30 ITEM31 ITEM32 ITEM33
  /SCALE('ALL VARIABLES') ALL
```

```
  /MODEL=ALPHA.
```

Scale: ALL VARIABLES

Case Processing Summary

		N	%
Cases	Valid	10	100.0
	Excluded[a]	0	.0
	Total	10	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.909	33

Section F

```
RELIABILITY
  /VARIABLES= ITEM1 ITEM2 ITEM3 ITEM4 ITEM5
ITEM6 ITEM7 ITEM8 ITEM9 ITEM10 ITEM11 ITEM12
ITEM13 ITEM14 ITEM15 ITEM16 ITEM17 ITEM18
ITEM14 ITEM19 ITEM20
  /SCALE('ALL VARIABLES') ALL
  /MODEL=ALPHA.
```

Scale: ALL VARIABLES

Case Processing Summary

		N	%
Cases	Valid	10	100.0
	Excluded[a]	0	.0
	Total	10	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.926	20

Overall Reliability for Sections B-F

```
RELIABILITY
  /VARIABLES= ITEM1 ITEM2 ITEM3 ITEM4 ITEM5
ITEM6 ITEM7 ITEM8 ITEM9 ITEM10 ITEM11 ITEM12
ITEM13 ITEM14 ITEM15 ITEM16 ITEM17 ITEM18
ITEM14 ITEM19 ITEM20 ITEM21
ITEM1 ITEM2 ITEM3 ITEM4 ITEM5 ITEM6 ITEM7
ITEM8 ITEM9 ITEM10 ITEM11 ITEM12 ITEM13
ITEM14 ITEM15 ITEM16 ITEM17 ITEM18 ITEM14
ITEM19 ITEM20 ITEM21 ITEM22 ITEM23 ITEM24
ITEM25
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ITEM8 ITEM9 ITEM10 ITEM11 ITEM12 ITEM13
ITEM14 ITEM15 ITEM16 ITEM17 ITEM18 ITEM14
ITEM19 ITEM20
ITEM1 ITEM2 ITEM3 ITEM4 ITEM5 ITEM6 ITEM7
ITEM8 ITEM9 ITEM10 ITEM11 ITEM12 ITEM13
ITEM14 ITEM15 ITEM16 ITEM17 ITEM18 ITEM14
ITEM19 ITEM20 ITEM21 ITEM22 ITEM23 ITEM24
ITEM25 ITEM26 ITEM27 ITEM28 ITEM29  ITEM30
ITEM31  ITEM32 ITEM33
ITEM1 ITEM2 ITEM3 ITEM4 ITEM5 ITEM6 ITEM7
ITEM8 ITEM9 ITEM10 ITEM11 ITEM12 ITEM13
ITEM14 ITEM15 ITEM16 ITEM17 ITEM18 ITEM14
ITEM19 ITEM20
  /SCALE('ALL VARIABLES') ALL
  /MODEL=ALPHA.
```

Scale: ALL VARIABLES

Case Processing Summary

		N	%
Cases	Valid	10	100.0
	Excluded[a]	0	.0
	Total	10	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.876	119

APPENDIX E

Analysis of Mean, Standard Deviation and Z-test

Research Question One

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
ITEM1	115	1.00	4.00	3.7982	.53513
ITEM2	115	1.00	4.00	3.5263	.61271
ITEM3	115	1.00	4.00	3.4649	.71865
ITEM4	115	2.00	4.00	3.5965	.57560
ITEM5	115	1.00	4.00	3.2982	.67745
ITEM6	115	1.00	4.00	3.5614	.76465
ITEM7	115	1.00	4.00	3.2719	.61378
ITEM8	115	1.00	4.00	3.4474	.79925
ITEM9	115	1.00	4.00	3.4649	.65419
ITEM10	115	1.00	4.00	3.7544	.67262
ITEM11	115	1.00	4.00	3.4737	.69398
ITEM12	115	1.00	4.00	3.4386	.63851
ITEM13	115	1.00	4.00	3.2982	.79745
ITEM14	115	1.00	4.00	3.1053	.74511
ITEM15	115	1.00	4.00	2.4211	.0107
ITEM16	115	1.00	4.00	2.5532	.0532
ITEM17	115	1.00	4.00	3.6543	.0253
ITEM18	115	1.00	4.00	3.9812	.0576
ITEM19	115	1.00	4.00	2.9871	.0768
ITEM20	115	1.00	4.00	4.5230	.1154
ITEM21	115	1.00	4.00	3.6521	.0446
Valid N (listwise)	115				

Research Question Two

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
ITEM1	115	1.00	4.00	3.7632	.59945
ITEM2	115	1.00	4.00	3.6053	.64655
ITEM3	115	1.00	4.00	3.6140	.69777
ITEM4	115	1.00	4.00	3.3947	.64655
ITEM5	115	1.00	4.00	3.5439	.70573
ITEM6	115	1.00	4.00	3.6140	.79276
ITEM7	115	1.00	4.00	3.0789	.76592
ITEM8	115	1.00	4.00	3.1754	.97077

ITEM9	115	1.00	4.00	3.5965	.73736
ITEM10	115	1.00	4.00	3.4649	.71865
ITEM11	115	1.00	4.00	3.4825	.68139
ITEM12	115	1.00	4.00	3.4035	.71296
ITEM13	115	1.00	4.00	3.7456	.56147
ITEM14	115	1.00	4.00	3.1228	.76587
ITEM15	115	1.00	4.00	3.4386	.65223
ITEM16	115	1.00	4.00	3.5351	.71865
ITEM17	115	1.00	4.00	3.6579	.64942
ITEM18	115	1.00	4.00	3.4474	.75366
ITEM19	115	1.00	4.00	3.2807	.83622
ITEM20	115	1.00	4.00	4.3078	.16823
ITEM21	115	1.00	4.00	3.6543	.04976
ITEM22	115	1.00	4.00	3.8432	.12543
ITEM23	115	1.00	4.00	4.3054	..05732
ITEM24	115	1.00	4.00	3.7541	.12345
ITEM25	115	1.00	4.00	3.765	.09023
Valid N (listwise)	115				

Research Question Three

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
ITEM1	115	1.00	4.00	3.7368	.67905
ITEM2	115	1.00	4.00	3.4912	.80095
ITEM3	115	1.00	4.00	3.4825	.83329
ITEM4	115	1.00	4.00	3.5526	.89336
ITEM5	115	1.00	4.00	3.6140	.80385
ITEM6	115	1.00	4.00	3.4825	.82261
ITEM7	115	1.00	4.00	3.5965	.82783
ITEM8	115	1.00	4.00	3.2807	.71034
ITEM9	115	1.00	4.00	3.5351	.70623
ITEM10	115	1.00	4.00	3.4211	.75134
ITEM11	115	1.00	4.00	3.3246	.69760
ITEM12	115	1.00	4.00	3.0702	.59077
ITEM13	115	1.00	4.00	3.3509	.71621
ITEM14	115	1.00	4.00	3.4298	.75222
ITEM15	115	1.00	4.00	3.5877	.77358
ITEM16	115	1.00	4.00	3.2105	.94517
ITEM17	115	1.00	4.00	3.2456	.90780
ITEM18	115	1.00	4.00	3.3947	.68638

ITEM19	115	1.00	4.00	3.4298	.78672
ITEM20	115	1.00	4.00	3.5000	.73171
ITEM21	115	1.00	4.00	3.4737	.91410
ITEM22	115	1.00	4.00	3.2193	.77298
ITEM23	115	1.00	4.00	3.3684	.79002
ITEM24	115	1.00	4.00	3.3158	.86542
ITEM25	115	1.00	4.00	3.6667	.68701
ITEM26	115	1.00	4.00	3.4474	.67956
ITEM27	115	1.00	4.00	3.6140	.71034
ITEM28	115	1.00	4.00	3.5965	.78390
ITEM29	115	1.00	4.00	3.3860	.81478
ITEM30	115	1.00	4.00	3.1491	.93347
ITEM31	115	1.00	4.00	3.0789	.75428
Valid N (listwise)	114				

Research Question Four

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
ITEM1	115	2.00	4.00	3.8421	.43271
ITEM2	115	1.00	4.00	3.7193	.57235
ITEM3	115	1.00	4.00	3.7544	.58840
ITEM4	115	1.00	4.00	3.2632	.63876
ITEM5	115	1.00	4.00	3.5702	.71605
ITEM6	115	1.00	4.00	3.5965	.82783
ITEM7	115	1.00	4.00	3.4386	.82048
ITEM8	115	1.00	4.00	3.7456	.52901
ITEM9	115	1.00	4.00	3.6579	.62157
ITEM10	115	1.00	4.00	3.6228	.65703
ITEM11	115	1.00	4.00	3.5614	.58043
ITEM12	115	1.00	4.00	3.4211	.71513
ITEM13	115	1.00	4.00	3.4298	.70358
ITEM14	115	1.00	4.00	3.4298	.69089
ITEM15	115	1.00	4.00	3.3246	.74662
ITEM16	115	1.00	4.00	3.3070	.71800
ITEM17	115	1.00	4.00	3.5965	.70043
ITEM18	115	1.00	4.00	3.5965	.72526
ITEM19	115	1.00	4.00	3.1667	.79730
ITEM20	115	1.00	4.00	3.6053	.79399
ITEM21	115	1.00	4.00	3.6579	.62157

ITEM22	115	1.00	4.00	3.6228	.65703
ITEM23	115	1.00	4.00	3.5614	.58043
ITEM24	115	1.00	4.00	3.4211	.71513
ITEM25	115	1.00	4.00	3.4298	.70358
Valid N (listwise)	115				

Research Question Five

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
ITEM1	115	1.00	4.00	3.6930	.70557
ITEM2	115	1.00	4.00	3.6754	.69760
ITEM3	115	1.00	4.00	3.7105	.72532
ITEM4	115	1.00	4.00	3.7193	.69777
ITEM5	115	1.00	4.00	3.7719	.66566
ITEM6	115	1.00	4.00	3.6842	.62847
ITEM7	115	1.00	4.00	3.6491	.60940
ITEM8	115	1.00	4.00	3.6316	.62772
ITEM9	115	1.00	4.00	3.5439	.81077
ITEM10	115	1.00	4.00	3.4912	.77854
ITEM11	115	1.00	4.00	3.4474	.82109
ITEM12	115	1.00	4.00	3.5263	.78943
ITEM13	115	1.00	4.00	3.5526	.71757
ITEM14	115	1.00	4.00	3.6053	.86851
ITEM15	115	1.00	4.00	3.4386	.84178
ITEM16	115	1.00	4.00	3.5175	.84385
ITEM17	115	1.00	4.00	3.7193	.67192
ITEM18	115	1.00	4.00	3.6316	.69465
ITEM19	115	1.00	4.00	3.6140	.75854
ITEM20	115	1.00	4.00	3.5000	.82279
Valid N (listwise)	115				

Descriptive Statistics

Hypothesis One

One-Sample Test

	Test Value = 0					
					95% Confidence Interval of the Difference	
	t	Df	Sig. (2-tailed)	Mean Difference	Lower	Upper

Automotiveindustrialtechnicans	3.225	76	.060	3.80000	2.2357	3.3643
Automotivemechatronicinstructors	2.510	37	.060	2.60000	1.9089	3.2911

independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
ITEM1	Equal variances assumed	7.029	.060	-1.181	76	.240	-.21905	.18554	-.58668	.14858
ITEM2	Equal variances not assumed			-4.049	37.000	.000	-.21905	.05410	-.32633	-.11176
ITEM3	Equal variances assumed	38.634	.000	-2.471	76	.015	-.51429	.20816	-.92673	-.10185
ITEM4	Equal variances not assumed			-8.473	37.000	.000	-.51429	.06070	-.63465	-.39392
ITEM5	Equal variances assumed	23.392	.000	-2.375	76	.019	-.58095	.24463	-1.06566	-.09624
ITEM6	Equal variances not assumed			-8.144	37.000	.000	-.58095	.07133	-.72240	-.43950
ITEM7	Equal variances assumed	.078	.781	.221	76	.825	.04444	.20077	-.35335	.44224
ITEM8	Equal variances not assumed			.241	37.000	.815	.04444	.18463	-.36837	.45726
ITEM9	Equal variances assumed	6.593	.012	-2.807	76	.006	-.64127	.22844	-1.09390	-.18864
ITEM10	Equal variances not assumed			-4.962	37.000	.000	-.64127	.12923	-.91755	-.36499
ITEM11	Equal variances assumed	2.826	.096	-.884	76	.379	-.23492	.26584	-.76165	.29181
ITEM12	Equal variances not assumed			-1.417	37.000	.180	-.23492	.16574	-.59338	.12354
ITEM13	Equal variances assumed	.073	.788	-2.038	76	.044	-.42857	.21027	-.84519	-.01195
ITEM14	Equal variances not assumed			-2.420	37.000	.036	-.42857	.17707	-.82217	-.03498
ITEM15	Equal variances assumed	9.565	.003	-1.742	76	.084	-.47937	.27513	-1.02450	.06577
ITEM16	Equal variances not assumed			-3.505	37.000	.003	-.47937	.13675	-.76668	-.19205
ITEM17	Equal variances assumed	1.518	.221	-.964	76	.337	-.21905	.22729	-.66939	.23129
ITEM18	Equal variances not assumed			-1.225	37.000	.247	-.21905	.17885	-.61456	.17647
ITEM19	Equal variances assumed	1.722	.192	-.623	76	.534	-.14603	.23425	-.61017	.31811
ITEM20	Equal variances not assumed			-1.122	14.886	.279	-.14603	.13011	-.42355	.13149

Hypothesis Two

Group Statistics

One-Sample Test

	Test Value = 0					
					95% Confidence Interval of the Difference	
	t	Df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Automotiveindustrialtechnicans	3.425	76	.960	2.80000	2.2357	3.3643
Automotivemechatronicinstructors	2.810	37	.960	2.60000	1.9089	3.2911

ependent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
ITEM1	Equal variances assumed	7.688	.960	-1.238	76	.218	-.25714	.20771	-.66870	.15442
ITEM2	Equal variances not assumed			-4.246	37.000	.000	-.25714	.06057	-.37725	-.13704
ITEM3	Equal variances assumed	.728	.395	-.296	76	.768	-.06667	.22548	-.51342	.38008
ITEM4	Equal variances not assumed			-.373	37.000	.716	-.06667	.17865	-.46197	.32863
ITEM5	Equal variances assumed	2.176	.143	-.732	76	.466	-.17778	.24285	-.65896	.30340
ITEM6	Equal variances not assumed			-1.093	37.000	.296	-.17778	.16272	-.53241	.17686
ITEM7	Equal variances assumed	4.515	.036	-1.872	76	.064	-.41587	.22211	-.85596	.02422
ITEM8	Equal variances not assumed			-2.596	37.000	.024	-.41587	.16018	-.76746	-.06428
ITEM9	Equal variances assumed	3.486	.065	-1.036	76	.302	-.25397	.24504	-.73948	.23154
	Equal variances not assumed			-1.558	76	.145	-.25397	.16300	-.60895	.10101
ITEM21	Equal variances assumed	.657	.419	-.207	37.000	.837	-.05714	.27652	-.60503	.49075
	Equal variances not assumed			-.309		.762	-.05714	.18465	-.45944	.34516
ITEM22	Equal variances assumed	.040	.842	-1.039	76	.301	-.27619	.26593	-.80310	.25072
	Equal variances not assumed			-1.116		.291	-.27619	.24739	-.82972	.27734
ITEM23	Equal variances assumed	1.257	.265	-.150	37.000	.881	-.05079	.33864	-.72177	.62018
	Equal variances not assumed			-.173		.866	-.05079	.29394	-.70556	.60397
ITEM24	Equal variances assumed	2.380	.126	-.767	76	.445	-.19683	.25657	-.70519	.31154
	Equal variances not assumed			-1.197		.254	-.19683	.16450	-.55369	.16004

		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
ITEM25	Equal variances assumed	4.428	.038	-1.366	37.000	.175	-.33968	.24865	-.83236	.15299
	Equal variances not assumed			-2.078		.059	-.33968	.16346	-.69524	.01587

Hypothesis Three

Group Statistics

One-Sample Test

	Test Value = 0					
					95% Confidence Interval of the Difference	
	t	Df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Automotiveindustrialtechnicans	3.225	76	.069	2.80000	2.2357	3.3643
Automotivemechatronicinstructors	2.510	37.00	.069	2.60000	1.9089	3.2911

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
ITEM1	Equal variances assumed	6.769	.011	-1.142	76	.256	-.17143	.15009	-.46881	.12595
	Equal variances not assumed			-3.917	37.000	.000	-.17143	.04376	-.25821	-.08464
ITEM2	Equal variances assumed	.542	.463	-.318	76	.751	-.06349	.19959	-.45895	.33197
	Equal variances not assumed			-.403	37.000	.695	-.06349	.15764	-.41220	.28522
ITEM3	Equal variances assumed	8.704	.004	-1.309	76	.193	-.26667	.20373	-.67032	.13699
	Equal variances not assumed			-4.489	37.000	.000	-.26667	.05940	-.38446	-.14887
ITEM4	Equal variances assumed	.171	.680	-2.001	76	.048	-.43810	.21897	-.87195	-.00424
	Equal variances not assumed			-2.462	37.000	.033	-.43810	.17796	-.83264	-.04355
ITEM5	Equal variances assumed	3.075	.082	-.906	76	.367	-.22540	.24890	-.71856	.26777
	Equal variances not assumed			-1.379	37.000	.193	-.22540	.16349	-.58099	.13020
ITEM6	Equal variances assumed	2.197	.141	-.683	76	.496	-.19683	.28821	-.76787	.37422
	Equal variances not assumed			-1.165	37.000	.264	-.19683	.16889	-.55947	.16582
ITEM7	Equal variances assumed	2.606	.109	-.868	76	.387	-.24762	.28529	-.81287	.31764
	Equal variances not assumed			-1.333	37.000	.207	-.24762	.18578	-.65132	.15609
ITEM8	Equal variances assumed	.214	.645	-.189	76	.850	-.03492	.18453	-.40054	.33069

	Equal variances not assumed			-.224	37.000	.827	-.03492	.15607	-.38194	.31210
ITEM9	Equal variances assumed	6.438	.013	-1.164	76	.247	-.25079	.21555	-.67788	.17629
	Equal variances not assumed			-1.970	37.000	.069	-.25079	.12734	-.52447	.02288
ITEM10	Equal variances assumed	6.437	.013	-1.269	76	.207	-.28889	.22759	-.73983	.16205
	Equal variances not assumed			-2.238	37.000	.041	-.28889	.12910	-.56499	-.01279
ITEM11	Equal variances assumed	4.620	.034	-1.167	76	.246	-.23492	.20128	-.63373	.16388
	Equal variances not assumed			-1.489	37.000	.166	-.23492	.15782	-.58383	.11399
ITEM12	Equal variances assumed	4.296	.041	-1.569	76	.119	-.38730	.24679	-.87629	.10168
	Equal variances not assumed			-2.373	37.000	.035	-.38730	.16322	-.74256	-.03204
ITEM13	Equal variances assumed	2.096	.150	-1.053	76	.295	-.25714	.24426	-.74110	.22682
	Equal variances not assumed			-1.423	37.000	.182	-.25714	.18074	-.65478	.14050
ITEM14	Equal variances assumed	4.772	.031	-1.585	76	.116	-.37778	.23838	-.85009	.09453
	Equal variances not assumed			-2.330	37.000	.038	-.37778	.16215	-.73172	-.02383
ITEM15	Equal variances assumed	2.252	.136	-1.439	76	.153	-.37143	.25810	-.88282	.13996
	Equal variances not assumed			-2.037	76	.066	-.37143	.18237	-.77097	.02811
ITEM16	Equal variances assumed	1.117	.293	-1.576	37.000	.118	-.39048	.24776	-.88138	.10043
	Equal variances not assumed			-2.156		.054	-.39048	.18115	-.78858	.00763
ITEM17	Equal variances assumed	2.835	.095	-.808	76	.421	-.19683	.24365	-.67959	.28594
	Equal variances not assumed			-1.209		.250	-.19683	.16282	-.55159	.15793
ITEM18	Equal variances assumed	1.685	.197	-.780	37.000	.437	-.19683	.25234	-.69680	.30315
	Equal variances not assumed			-.843		.419	-.19683	.23339	-.71885	.32520
ITEM19	Equal variances assumed	.216	.643	-1.986	76	.050	-.54286	.27339	-1.08454	-.00118
	Equal variances not assumed			-2.188		.054	-.54286	.24808	-1.09708	.01136

Hypothesis Four

One-Sample Test

	Test Value = 0					
					95% Confidence Interval of the Difference	
	t	Df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Automotiveindustrialtechnicans	3.225	76	.0740	2.80000	2.2357	3.3643
Automotivemechatronicinstructors	2.320	37.00	.0740	2.60000	1.9089	3.2911

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	T	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
ITEM1	Equal variances assumed	7.154	.009	-1.214	112	.227	-.28571	.23536	-.75205	.18062
	Equal variances not assumed			-4.163	104.000	.000	-.28571	.06863	-.42180	-.14963
ITEM2	Equal variances assumed	9.027	.003	-1.562	112	.121	-.43175	.27643	-.97946	.11597
	Equal variances not assumed			-3.152	18.099	.005	-.43175	.13697	-.71940	-.14409
ITEM3	Equal variances assumed	8.019	.005	-1.534	112	.128	-.44127	.28771	-1.01133	.12879
	Equal variances not assumed			-3.176	19.089	.005	-.44127	.13893	-.73196	-.15058
ITEM4	Equal variances assumed	12.639	.001	-1.576	112	.118	-.48571	.30827	-1.09651	.12508
	Equal variances not assumed			-5.404	104.000	.000	-.48571	.08989	-.66396	-.30747
ITEM5	Equal variances assumed	14.024	.000	-1.509	112	.134	-.41905	.27763	-.96914	.13104
	Equal variances not assumed			-5.176	104.000	.000	-.41905	.08095	-.57958	-.25852
ITEM6	Equal variances assumed	9.605	.002	-1.554	112	.123	-.44127	.28394	-1.00386	.12132
	Equal variances not assumed			-3.191	18.752	.005	-.44127	.13827	-.73093	-.15161
ITEM7	Equal variances assumed	5.317	.023	-1.105	112	.271	-.31746	.28724	-.88660	.25168
	Equal variances not assumed			-2.286	19.047	.034	-.31746	.13885	-.60803	-.02689
ITEM8	Equal variances assumed	.180	.673	-.719	112	.474	-.17778	.24725	-.66767	.31211
	Equal variances not assumed			-.939	10.777	.368	-.17778	.18936	-.59562	.24006
ITEM9	Equal variances assumed	24.257	.000	-2.088	112	.039	-.50476	.24172	-.98370	-.02582
	Equal variances not assumed			-7.162	104.000	.000	-.50476	.07048	-.64453	-.36499
ITEM10	Equal variances assumed	.144	.705	-.097	112	.923	-.02540	.26211	-.54473	.49394
	Equal variances not assumed			-.100	9.551	.922	-.02540	.25317	-.59312	.54232
ITEM11	Equal variances assumed	.441	.508	-1.035	112	.303	-.25079	.24222	-.73072	.22913
	Equal variances not assumed			-1.328	10.653	.212	-.25079	.18881	-.66802	.16643
ITEM12	Equal variances assumed	3.305	.072	-2.007	112	.047	-.40635	.20250	-.80757	-.00513
	Equal variances not assumed			-1.635	8.866	.137	-.40635	.24848	-.96974	.15704
ITEM13	Equal variances assumed	1.436	.233	-1.384	112	.169	-.34286	.24776	-.83376	.14804
	Equal variances not assumed			-1.893	11.135	.085	-.34286	.18115	-.74096	.05525
ITEM14	Equal variances assumed	1.945	.166	-.984	112	.327	-.25714	.26130	-.77488	.26059
	Equal variances not assumed			-1.407	11.530	.186	-.25714	.18276	-.65714	.14286
ITEM15	Equal variances assumed	7.329	.008	-1.220	112	.225	-.32698	.26811	-.85821	.20424
	Equal variances not assumed			-2.412	17.404	.027	-.32698	.13556	-.61248	-.04149

ITEM16	Equal variances assumed	2.675	.105	-1.517	112	.132	-.49524	.32641	-1.14197	.15149
	Equal variances not assumed			-1.954	10.679	.077	-.49524	.25347	-1.05518	.06470
ITEM17	Equal variances assumed	3.281	.073	-1.457	112	.148	-.45714	.31375	-1.07879	.16450
	Equal variances not assumed			-1.813	10.454	.099	-.45714	.25211	-1.01558	.10130
ITEM18	Equal variances assumed	1.684	.197	-1.241	112	.217	-.29524	.23783	-.76647	.17599
	Equal variances not assumed			-1.640	10.863	.130	-.29524	.18001	-.69205	.10157
ITEM19	Equal variances assumed	12.081	.001	-1.843	112	.068	-.49841	.27039	-1.03416	.03734
	Equal variances not assumed			-3.666	17.592	.002	-.49841	.13594	-.78449	-.21233
ITEM20	Equal variances assumed	3.740	.056	-1.189	112	.237	-.30159	.25368	-.80422	.20104
	Equal variances not assumed			-1.838	12.375	.090	-.30159	.16412	-.65796	.05479
ITEM21	Equal variances assumed	16.117	.000	-1.818	112	.072	-.57143	.31430	-1.19418	.05132
	Equal variances not assumed			-6.235	104.000	.000	-.57143	.09164	-.75316	-.38969
ITEM22	Equal variances assumed	.578	.449	-1.365	112	.175	-.36508	.26746	-.89501	.16485
	Equal variances not assumed			-1.905	11.306	.083	-.36508	.19168	-.78558	.05542
ITEM23	Equal variances assumed	10.134	.002	-2.090	112	.039	-.56508	.27039	-1.10083	-.02933
	Equal variances not assumed			-4.157	17.592	.001	-.56508	.13594	-.85116	-.27900
ITEM24	Equal variances assumed	4.652	.033	-1.682	112	.095	-.50159	.29818	-1.09239	.08921
	Equal variances not assumed			-2.944	14.306	.010	-.50159	.17036	-.86624	-.13694
ITEM25	Equal variances assumed	4.473	.037	-1.011	112	.314	-.24127	.23859	-.71401	.23147
	Equal variances not assumed			-1.845	15.182	.085	-.24127	.13078	-.51974	.03720
ITEM26	Equal variances assumed	4.693	.032	-1.529	112	.129	-.35873	.23465	-.82365	.10619
	Equal variances not assumed			-2.219	11.675	.047	-.35873	.16169	-.71211	-.00535
ITEM27	Equal variances assumed	1.981	.162	-.719	112	.474	-.17778	.24725	-.66767	.31211
	Equal variances not assumed			-1.089	12.130	.297	-.17778	.16328	-.53311	.17755
ITEM28	Equal variances assumed	1.595	.209	-.721	112	.472	-.19683	.27285	-.73744	.34379
	Equal variances not assumed			-.836	10.052	.422	-.19683	.23534	-.72084	.32718
ITEM29	Equal variances assumed	2.594	.110	-1.078	112	.283	-.30476	.28279	-.86508	.25556
	Equal variances not assumed			-1.643	12.211	.126	-.30476	.18546	-.70806	.09854
ITEM30	Equal variances assumed	1.653	.201	-.615	112	.540	-.20000	.32511	-.84417	.44417
	Equal variances not assumed			-.789	10.656	.447	-.20000	.25333	-.75978	.35978
ITEM32	Equal variances assumed	.149	.700	-1.055	112	.294	-.27619	.26185	-.79501	.24263
	Equal variances not assumed			-1.118	9.644	.291	-.27619	.24702	-.82935	.27697
ITEM33	Equal variances assumed	5.583	.020	-1.270	112	.207	-.43810	.34501	-1.12170	.24551
	Equal variances not assumed			-1.714	11.030	.114	-.43810	.25556	-1.00039	.12420

Hypothesis Five

Group Statistics

One-Sample Test

	Test Value = 0					
					95% Confidence Interval of the Difference	
	T	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Automotiveindustrialtechnicans	3.234	76	.643	2.80000	2.2357	3.3643
Automotivemechatronicinstructors	3.546	37.00	.643	2.60000	1.9089	3.2911

independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
ITEM1	Equal variances assumed	6.769	.011	-1.142	76	.256	-.17143	.15009	-.46881	.12595
	Equal variances not assumed			-3.917	37.000	.000	-.17143	.04376	-.25821	-.08464
ITEM2	Equal variances assumed	.542	.463	-.318	76	.751	-.06349	.19959	-.45895	.33197
	Equal variances not assumed			-.403	37.000	.695	-.06349	.15764	-.41220	.28522
ITEM3	Equal variances assumed	8.704	.004	-1.309	76	.193	-.26667	.20373	-.67032	.13699
	Equal variances not assumed			-4.489	37.000	.000	-.26667	.05940	-.38446	-.14887
ITEM4	Equal variances assumed	.171	.680	-2.001	76	.048	-.43810	.21897	-.87195	-.00424
	Equal variances not assumed			-2.462	37.000	.033	-.43810	.17796	-.83264	-.04355
ITEM5	Equal variances assumed	3.075	.082	-.906	76	.367	-.22540	.24890	-.71856	.26777
	Equal variances not assumed			-1.379	37.000	.193	-.22540	.16349	-.58099	.13020
ITEM6	Equal variances assumed	2.197	.141	-.683	76	.496	-.19683	.28821	-.76787	.37422
	Equal variances not assumed			-1.165	37.000	.264	-.19683	.16889	-.55947	.16582
ITEM7	Equal variances assumed	2.606	.109	-.868	76	.387	-.24762	.28529	-.81287	.31764
	Equal variances not assumed			-1.333	37.000	.207	-.24762	.18578	-.65132	.15609
ITEM8	Equal variances assumed	.214	.645	-.189	76	.850	-.03492	.18453	-.40054	.33069
	Equal variances not assumed			-.224	37.000	.827	-.03492	.15607	-.38194	.31210
ITEM9	Equal variances assumed	6.438	.013	-1.164	76	.247	-.25079	.21555	-.67788	.17629
	Equal variances not assumed			-1.970	37.000	.069	-.25079	.12734	-.52447	.02288
ITEM10	Equal variances assumed	6.437	.013	-1.269	76	.207	-.28889	.22759	-.73983	.16205

	Equal variances not assumed			-2.238	37.000	.041	-.28889	.12910	-.56499	-.01279
ITEM11	Equal variances assumed	4.620	.034	-1.167	76	.246	-.23492	.20128	-.63373	.16388
	Equal variances not assumed			-1.489	37.000	.166	-.23492	.15782	-.58383	.11399
ITEM12	Equal variances assumed	4.296	.041	-1.569	76	.119	-.38730	.24679	-.87629	.10168
	Equal variances not assumed			-2.373	37.000	.035	-.38730	.16322	-.74256	-.03204
ITEM13	Equal variances assumed	2.096	.150	-1.053	76	.295	-.25714	.24426	-.74110	.22682
	Equal variances not assumed			-1.423	37.000	.182	-.25714	.18074	-.65478	.14050
ITEM14	Equal variances assumed	4.772	.031	-1.585	76	.116	-.37778	.23838	-.85009	.09453
	Equal variances not assumed			-2.330	37.000	.038	-.37778	.16215	-.73172	-.02383
ITEM15	Equal variances assumed	2.252	.136	-1.439	76	.153	-.37143	.25810	-.88282	.13996
	Equal variances not assumed			-2.037	76	.066	-.37143	.18237	-.77097	.02811
ITEM16	Equal variances assumed	1.117	.293	-1.576	37.000	.118	-.39048	.24776	-.88138	.10043
	Equal variances not assumed			-2.156		.054	-.39048	.18115	-.78858	.00763
ITEM17	Equal variances assumed	2.835	.095	-.808	76	.421	-.19683	.24365	-.67959	.28594
	Equal variances not assumed			-1.209		.250	-.19683	.16282	-.55159	.15793
ITEM18	Equal variances assumed	1.685	.197	-.780	37.000	.437	-.19683	.25234	-.69680	.30315
	Equal variances not assumed			-.843		.419	-.19683	.23339	-.71885	.32520
ITEM19	Equal variances assumed	.216	.643	-1.986	76	.050	-.54286	.27339	-1.08454	-.00118
	Equal variances not assumed			-2.188		.054	-.54286	.24808	-1.09708	.01136
ITEM20	Equal variances assumed	.258	.612	-.241	37.000	.810	-.06667	.27693	-.61536	.48203
	Equal variances not assumed			-.268		.794	-.06667	.24841	-.62123	.48789