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Distributed Cognition Learning Theories on Trainers Capacity Building in Use of Autotronic Tools for Skill Acquisition in Nigeria Tertiary Institutions

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Abstract: The major aim of this study was to investigate the effects of Distributed Cognition Learning Theories on Trainers Capacity Building in the use of Autotronic tools for Skill acquisition in Nigeria Tertiary Institutions. In the study which was experimental with pre-test and post-test control groups of 84 (having n=44 as experimental and n=40 as control) participants made up of automobile/autotronic engineering trainers in Nigeria tertiary institutions. Instruments used for data collection was: Autotronic Simulator Interest Inventory (ASII), Autotronic Demonstrator Perception Inventory (ADPI) and Auto Diagnostic Competence Test (ADCT) to determine trainers capacity building needs using Improvement Needed Index (INI). In describing the instruments used for data collection, ASII, ADPI and ADCT were designed to seek information concerning application of Distributed Cognition Learning Theories (DCLT) approaches of physical prototypes, design analysis tools and computer-aided design models. The ASII and ADPI have 24 items while ADCT has 12 items and were analysed appling mean and standard deviation. Also, the score guide sheet was based on a four-point rating scale used by ratters. The Pearson Product Moment Coefficient of the test instrument was used to determine the reliability coefficient of 0.79. The data collected was in line with the research questions and hypotheses which were analysed. In taking decisions for items on interest, perception and competence, any mean of 3.50 and above are regarded as highly important and high performance, 2.50 - 3.49 mean are moderately important and moderate performance while mean of less than 1.50 are regarded as not important and very low performance. Analysis of variance (ANOVA) was applied to test the null hypothesis at 0.05 level of significance and with the use of MATLAB for the graphical representations of the mean ratings that was used to answer the research questions. DCLT and Autotronic tools showed changes in the interest, perception and competence of Trainers was found in the process. The following recommendations are made: Review of curriculum to incorporate activities that reflect DCLT for imparting autotronic engineering with modern skill; trainers to be periodically encouraged to embark on capacity building training as the government is expected to equip the departments with the latest autotronic technology facilities.

Keywords: Tertiary Institutions, Autotronic Technology, Simulators, Demonstrators, Auto Diagnostic Tools, Skill Acquisition, Capacity Building, Distributed Cognition Learning Theories

1. Introduction

Tertiary Institutions in Nigeria are post-secondary institutions which include Universities, Polytechnics and Colleges of Education, preparing students for the word of work leading to award of diplomas or degrees upon satisfactory completion of programme on graduation. In Nigeria, an appraisal according to Solesi et al. [19] revealed that efforts of individuals, corporate organizations and the Federal Government in establishing skills acquisition centers, it is undesirable that skill level is still low and unemployment prevalent in Nigeria. There was presidential initiative in 2005 to revitalize and improve the study of science, technology, engineering and mathematics (STEM) subjects in schools at all levels in Nigeria and the National Universities Commission (NUC), the National Board for Technical Education (NBTE), embarked on series of activities aimed at addressing the observed problems in STEM, with TETFund intervention involving educational training laboratories and workshop/equipment supplied by SKILL “G” to 73 Nigerian public universities, 6 federal polytechnics, 961 sets of secondary micro science kits to selected colleges of education, technical colleges and secondary schools in all the states of the federations and conducted training on the use of the kits for teachers in the six geopolitical zones [18]. Teachers, lecturers and technologists of various tertiary institutions supplied with the SKILL “G” equipment were also trained. Automobile engineering / automobile engineering technology is the course in tertiary institutions where teachers use autotronic technology tools (simulators, demonstrators and auto diagnostic tools) for training students to acquire skills.

Autotronic technology (AT) is characterized by the presence of the Industrial 4.0 noticeable by artificial intelligence, robotics, IoT, autonomous vehicles, 3-D printing, nanotechnology, biotechnology, materials science, energy storage, and quantum computing [16]. According to Wagiran and Yudha Ari Purnama [22] cars on the road are being equipped with danger-warning applications, traffic information services, and host of infotainment features and increased safety features as well resulting from AT applications. The AT concern of this study is on the use of simulators, demonstrators and auto diagnostic tools for students autotronic skill acquisition. Autotronic was described by Haruna, et al. [7] as an artificial word that combines automotive sector and electronics content which is at the heart of every meaningful automobile industrial breakthrough recorded in the last two centuries and continually transforming maintenance operations with endless discovery of new techniques. Also, there is an innovative, blended learning approach, which combines multimedia with sophisticated classroom training in order to meet the standards and challenges of modern automotive technologies worldwide.

Autotronic is a modern automotive technology field of automobile engineering having many applications in the motor vehicle technology and keeping to basic traditional science and technology principles. It is an aspect of automobile engineering that presents the basics, advantages, layout and components and functional operation of various computer-controlled motor vehicle systems [7]. Autotronic deals with computer-controlled motor vehicle systems like: engine management, anti-brake skid (ABS), traction control (TCS), stability control (SCS), self-diagnosis and fault codes [7]. The computer-controlled motor vehicle system like: engine management, anti-brake skid (ABS), traction control (TCS), stability control (SCS), self-diagnosis and fault codes has a simulating and demonstrating platform for student’s practical learning. Autotronics trainers (simulators and demonstrators) are used as a computer assisted instructional package for learning in an autotronic laboratory that allows the theoretical and practical learning of the problems related to the field of electrical and electronic technology applied to automotive technology. The laboratory consists of the following: a set of modules for the study of basic electricity and main electric circuits, a set of simulation panels for electric and electronic systems in modern automobiles, complete with dedicated software for demonstration of the relevant theory and introduction of simulated faults, a set of panels with real components for demonstration and a set of sectioned components [4].

Simulation is used as a technique for providing training to the students. Such types of instructional activities provide powerful learning tools to them [17]. Autotronic simulators are automotive devices used for simulation. Autotronics Simulators and students’ interest in autotronic technology skill acquisition has to do with faults troubleshooting of automotive systems using electronic control equipment to perform constant monitoring of sensors and all the other electronic components, in order to immediately locate errors or faults. These faults are registered in the control module memory and can be read while using the diagnostic device and complete separation exists between the input and output components of the computerized systems [18]. There was presidential initiative to revitalize science, engineering, technology education and training (SET) in Nigeria and the national universities commission (NUC) embarked on series of activities aimed at addressing the observed problems in SET with TETFund intervention involving educational training laboratories and workshop/equipment supplied by SKILL G can increase students’ interest in the learning of autotronic technology using autotronic simulators. The troubleshooting is done according to SKILL” G” NIGERIA Ltd, by performing the following tests: Does the non-responsive consumer (lamp, motor or solenoid) receive voltage for its operation? If yes, the fault is in the consumer; Does the input component provide the required signal? If not, the fault is in the input component; Does the control unit receive the signal from the input component and does not output the required signal to the output components? If yes, the fault is in the control unit.

Various faults can be simulated in the ABS 4 Channel

Brake System - TPS-3547. Instead of accumulating these faults and transmitting them to the diagnostic device on demand, a fault lamp is turned "ON" on the panel. Next to each lamp a short text is written, describing the fault type.

The autotronic simulation system instructional manual stipulations for higher educational institution (HEI) and technical vocational educational training (TVET), compiled by SKILL "G" Nigeria limited, experiment has to be applied in this study to determine students' interest when the troubleshooting and fault simulation of ABS 4 Channel Brake System - TPS-3547 is used for autotronic skill acquisition.

Autotronics Demonstrators and teachers' perception in autotronic technology skill acquisition has to do with carrying out principles of operation procedures of faults and troubleshooting of automotive systems as trainer model with computer communication interface based on electronic components such as sensors, actuators, and electronics circuits controlled by control units. With the presidential initiative to revitalize science, engineering, technology education and training (SET) in Nigeria and the national universities commission (NUC) embarked on series of activities aimed at addressing the observed problems in SET with TETFund intervention involving educational training laboratories and workshop/equipment supplied by SKILL G can increase students' perception in the learning of autotronic technology using autotronic demonstrators. The demonstrator's trainers according to SKILL" G" NIGERIA Ltd, comprise of real time controller which simulates the real automotive controller such as the ECU (the engine ELECTRONIC Control Unit), the ABS controller and so on, where each demonstrator can be used as a standalone system without PC or with a PC, has the following STATE display and keys: Power ON switch; 2 channel digital oscilloscope; LCD graphical display for displaying the scope signals and the measured and the simulating values; 12 key monitor keyboards; RPM display; Fault insertion module with display and keys; Simulating switches and potentiometers; PC communication interface; CAN-BUS communication interface.

The autotronic demonstrator system instructional manual stipulations for higher educational institutions (HEI) and technical vocational educational training (TVET), compiled by SKILL "G" Nigeria limited, experiments have to be applied in this study to determine students' perception when: 1. Lightning and signaling demonstration – TPS-3541; 2. Electronic ignition demonstration – TPS-3545; 3. Multi point injection systems – TPS-3546; are used for autotronic skill acquisition.

Auto diagnostic tools are used to diagnose automotive systems operations which are systematically coded and translate the vehicular troubleshooting and faults dictation via interface with the tool, vehicle and internet for component required remedies like removal, repairs, refurbish, replacement, service or maintenance to be accomplished. Those components required remedies/jobs (removal, repairs, refurbish, replacement, service or maintenance) are some of the functions auto mechanics need to accomplish if auto diagnostic tool usage skill is acquired. Using an onboard diagnostic (OBD-II) scan tool will give you an extra way to find and fix problems while feeling like a professional mechanic at the same time [2]. So, if you want to get the most out of the diagnostic tool, you need to know when to use it. To get the most out of the OBD and when and how to use it well, Austin [2] stated as follows: 1. When the Check Engine light is on: Remember the light that is seemingly always on, even when the engine is not dropping out? That simple little light represents a number of different problems that can occur somewhere in your engine, transmission, or exhaust systems. If you want to make sense of this light instead of just ignoring it, the diagnostic tool will get the job done. 2. Record vehicle performance/statistics: Some higher-end car diagnostic tools can do more than just read engine codes. More advanced tools can take live data measurements of the car's systems to help you fine-tune the setup. Students competence will be assured in the learning of autotronic technology using auto diagnostic tools to skills through practical hands-to-tool processes. The auto diagnostic tools (Launch code reader creader professional 123; second generation on board diagnostic OBD 2; Bio-directional auto scan tool) usage and application in learning of autotronic technology as stated in Ezeama et al. [5] to enhance students competence by following indicated process: 1. How to locate access point; 2. Connect the tool using appropriate connectors; 3. Turn "ON" vehicle ignition; 4. Turn "ON" the tool; 5. Run the tool diagnostic program; 6. Navigate through the vehicle system to access diagnostic code from the vehicle electronic control module; 7. Record findings; 8. Check what the system code meant and see if the try fault indicated by the trouble code needs to be corrected before you clean the code; 9. Carry out the system repairs; 10. Select the delete code option to clear fault code; 11. Repeat items 3-6 to recheck and reactivate the fault code; 12. Turn "OFF" the tool and disconnect from the access point.

Skill acquisition will be best understood if one comprehends the meaning of skill. According to Cranmer [3] skill is an ability and capability acquired through deliberate, systematic and sustained effort to smoothly and adaptively carry out complex activities or job functions involving ideas (cognitive) things (technical skills) and/or people (interpersonal skills). Autotronic skill is a technical skill that has complex activities on autotronic technology that deals with automotive systems simulation, demonstration, diagnosis, maintenance and repairs. To acquire is to attain, so skill acquisition is one's possession of ability to accomplish an identified job, function or operation in a required systematic manner. There are six stages of skill acquisition according to Rousse, [14]: 1. Novice stage; 2. Advanced beginner stage; 3. Competence stage; 4. Proficiency stage; 5. Expertise stage; 6. Mastery stage. Skill acquisition refers to a form of prolonged learning about a family of events [6]. The scientific roots of skill acquisition theory can be found in different branches of psychology, which ranges from behaviorism to cognitivism and connectionism [11]. Skill acquisition is the systematic process of imbibing new ideas and knowledge of executing accurately professional function through repetitive practice that enables individuals to acquire the knowhow of a variety of skills that is related to a particular trade [10]. It is therefore important that the theories, models and practice of skill must be fully integrated into a pedagogical process of teachers for the purpose of effectiveness and worthwhile results [10]. Skill acquisition, according to Speelman and Krisner [20], is a specific form of learning. Learning can be adequately defined as the representation of information in memory about some environmental or cognitive occurrence.

Capacity building is the process of systematic method of training/learning to improve/advance in a specific way of particular professional job demands. Effective modern automotive technology (MAT) professional development incorporates motor vehicle mechanics (MVM) trainers' own aspirations, skills, knowledge, and understanding into the learning context [5]. Even though it seems a complex venture it needs to be surmounted because the traditional methods were put in a modern method. Thus, the gap between traditional automotive technology (TAT) and MAT can be easily closed through skill improvement and professional MVM teacher development. The capacity building needs of MVM trainers has changed significantly from TAT to MAT because of technological developments in the automotive industries [5]. Though, the need to give emphasis on MVM trainers and learners capacity building and skills development respectively, especially for the less privileged, educated, poor and school drop-out has been neglected for some time now throughout the African region [1]. The capacity building needs of MVM teachers on MAT do handle basically areas of maintenance, services and repair of automotive systems using auto diagnostic tools. The end result will be that MVM teachers will be industry-certified and current in their field or area of knowledge as it regards MAT. The automotive council of Nigeria in its bold effort at capacity building in the repairs and maintenance of new generation vehicles had, in collaboration with other stakeholders carried out the following: Developed and launched a curriculum for teaching automotive mechatronics in the informal sector; Held a critique workshop on the curriculum of automotive mechatronics; Concluded arrangement for the printing of the curriculum and subsequent launching; The acquisition of mechatronics diagnostic equipment and tools for training Nigerian auto technicians is ongoing; and held a meeting with the Hon Minister, Federal Ministry of Labour and productivity on the establishment of specialized centers for teaching of automotive mechatronics [9].

Distributed cognitive learning theory generalizes the information processing theory framework to include the physical environment around the learner, including interactions with other problem-solvers, external tools to share the cognitive load [15]. There are examples to buttress Schunn and Silk [15] explanation of the distributed cognitive learning theories as follows:

A pilot uses dials to help remember the state the plane is in, uses the co-pilot to help run through check-lists before take-off, and even uses simple perceptual features of dials and indicators to compute simple computations about whether to change the plane's speed thereby distributing tightly coupled tasks across individuals as group-work and with tools;

Engineers and technologists use thinking tools which are called models (tools or formalisms that represent aspects of some external situations for a purpose) that distributes thinking in another way and this requires an additional strand for learning. Examples of such models in engineering and technology education (ETE) include, a. graphs, b. equations, c. physical prototypes, d. computer-aided design models, e, design analysis tools. In this study the simulators, demonstrators and auto diagnostic tools as representational tools as physical prototypes, computer-aided design model and design analysis tools that can be computer interfaced to distribute and proffer solutions to problems concerning autotronic technology;

The ability to formulate, represent and solve complex science, technology, engineering and mathematics (STEM) problems. Student are usually given models as a skill rather than being allowed to modify and strategically select models, thereby undercutting the development of strategic competence;

Model-eliciting activities (MEA_S) development are a form of problem-based learning in ETE where students are to produce conceptual tools for constructing, describing, or explaining meaningful situations. For example, students are provided with the case of a robotics team that programs synchronized dancing Lego robots, and the problem is to program these various dance routines in a way that differ in sized robots and develop a script that the fictional team can use to program robots for these arbitrary scripts quickly and accurately. Students might think of a model refinement process to improve their mathematical concept of proportionality or their robotics concept of proportional control.

1.1. Statement of the Problem

Autotronic/automobile engineering teachers in tertiary institutions are to equip students with necessary theoretical knowledge and practical skills that will enable the graduates to be competent and can set up their own workshops, be self-employed and even employ others. In Nigeria, an appraisal according to Solesi et al., [19] revealed that efforts of individuals, faith-based organizations and the Federal Government in establishing skills acquisition centers, it is undesirable that skill level is still low and unemployment prevalent in Nigeria. There was presidential initiative in 2005 to revitalize and improve the study of science, technology, engineering and mathematics (STEM) subjects in schools at all levels in Nigeria and the National Universities Commission (NUC), the National Board for Technical Education (NBTE), embarked on series of activities aimed at addressing the observed problems in STEM, with TETFund intervention involving educational training laboratories and workshop/equipment supplied by SKILL "G" to 73 Nigerian public universities. The question would be to what extent were supplied equipment used for proper skill acquisition that will lead to technological advancement? Again, are autotronic engineering trainers well trained on how to use the equipment for students' learning? Challenges confronting optimum productivity in institutions supplied with SKILL G equipment are non-availability of state-of-art hands-on equipment; inadequate training and capacity building for lecturers and technicians; non-conducive infrastructure for training; lack of research structure and research activities among scholars [18]. Clearly, mass unemployment is still a feature of the Nigerian economy, such that reducing it is one of the prime concerns of the Government at all levels. According to Central Intelligence Agency (CIA) World Factbook Demographic Statistics (2011), cited in Solesi, et al., [19] about 55.9% of Nigerians between the ages 15-64 (most vibrant and active population) are jobless. Similarly, the National Bureau of Statistics (2012) reports that the national unemployment rate increased to 23.4% in 2012 compared to 21.1% in 2010 and 19.7% in 2009 which is the concern to many analysts and economists as the figures increasingly suggest dwindling utilisation of human resources at the nation's disposal. Even though the place of skills acquisition for self-reliance and sound productivity in the society cannot be overemphasized, it is important to note that participation in a skill acquisition programme, graduating and getting a paper certificate is not all that matters [19]. Then of importance, is the value of the training and its production, trainers' capacity building, the skill acquisition process, infrastructure, equipment and trainees' interest [19]. Autotronic technology skill acquisition were not notable, fully mounted and functional training equipment in the tertiary institutions so that competent trainers will be made available for technical education level institutions. Most simulators, demonstrators and auto diagnostic tools provided for the institutions seem to be highly underutilized because of the present value of training and its production as noted in Solesi et al. [19] report. The need for this study is to highlight proper use of autotronic technology tools by trainers for skill acquisition in tertiary institutions for employment generation, wealth creation and poverty eradication in Nigeria. It also brings to forefront such issues as to whether the trainers need capacity building in autotronic technology in the institutions. Thus, answers to some of the problems raised are to be provided and solutions proffered. Few researchers have addressed the issue of the use, application and implementation of autotronic technology for trainer's skill acquisition. Relevance and competence are keywords for the implementation of vocational and technical education, but unfortunately, mismatch is still a major problem as stated in the Statistics Indonesia [21]; Puspitasari [13]; MacKenzie and Polvere [8], as seen in the autotronics field of expertise. This is possibly complexly aggravated by the lack of research conducted to investigate the relevance of learning in vocational and technical schools with the needs for competencies in the researched field [22]. The competency units (CUs) formulated in the field of autotronics engineering, based on the synthesis of the Indonesian National Work Competency Standards (SKKNI), National Qualification Framework (KKNI), and Vocational Schools Basic-Core Competencies (KI- KD), are classified into five main clusters or key functions, namely (1) Basics of Autotronic Systems; (2) Engine Management System (EMS); (3) Chassis Management System (CMS); (4) Comfort, Safety, and Information Technology (CSIT); and (5) Vehicle Control System (VCS). Furthermore, these five main clusters are divided into 47 main functions and later developed into 101 basic functions further elaborated into several CUs [22]. However, motor vehicle mechanic graduates find it difficult to maintain and repair modern automobile vehicles competently due to new electronics technology such as computer systems and microprocessors in the form of electromechanical systems in automobile vehicles [10]. The basic question here is, if there are competent autotronic technology trainers/teachers in the institutions and are there required facilities to train students to face the demands of the global world of work? Thus, the need to determine the effect of Distributed Cognition Learning Theories in the use of autotronic technology tools for skill acquisition in Nigeria tertiary institutions.

1.2. Purpose of the Study

The major purpose of this study is to determine the effect of Distributed cognition learning theories in the use of autotronic tools for skill acquisition in Nigeria tertiary institutions. Specifically, the study seeks to find out the effect of using; 1. Distributed cognition learning theories in application of simulators for trainers' interest in students learning. 2. Distributed cognition learning theories in application of demonstrator for trainers' perception in students learning. 3. Distributed cognition learning theories in application of auto diagnostic tools for trainers' competence in students learning.

1.3. Hypotheses

The following hypothesis was formulated to guide the study and was tested at 0.05 level of significance. H_{01}. There is no significant difference between the mean interest scores of trainers' capacity building applying Distributed cognition learning theories using simulators with those trained without simulator application for students learning. H_{02}. There is no significant difference between the mean perception scores of trainers' capacity building applying Distributed cognition learning theories using demonstrator with those trained without demonstrator application for students learning. H_{03}. There is no significant difference between the mean competence scores of trainers' capacity building applying Distributed cognition learning theories using auto diagnostic tools with those trained without auto diagnostic tool application for students learning.

2. Methodology

The study was experimental with pre-test and post-test control groups of 84 (having n=44 as experimental and n=40 as control) participants made up of automobile/autotronic engineering trainers in Nigeria tertiary institutions. Instruments used for data collection was: Autotronic Simulator Interest Inventory (ASII), Autotronic Demonstrator Perception Inventory (ADPI) and Auto Diagnostic Competence Test (ADCT) to determine trainers capacity building needs using Improvement Needed Index (INI) to answer the research questions. The materials used and their sources were enumerated above as supplied to the institutions by [18]. In describing the instruments used for data collection, ASII, ADPI and ADCT were designed to seek information concerning application of Distributed Cognition Learning Theories (DCLT) approaches of physical prototypes (machine-person interaction as in a group-work), design analysis tools (external tools for problem solving) and computer-aided design model (cognitive load sharing). Capacity Building Need (CBN) was verified as follows: the mean (XI) of the important (that is the needed) category was determined for each item; the mean (XP) of the performance category was checked for each item; the performance gap (PG) was determined by finding the difference between the two means (that is subtracting XP from XI to get PG). If PG is zero, it means that skill improvement is not needed for that item because the level at which the trainers perform the skill is equal to the level at which the skill is needed. If PG is negative (-), it means skill improvement is not needed for that item because the level at which the teachers perform the skill is higher than the level at which it is needed. If PG is positive (+), it means skill improvement is needed because the level at which the teachers perform the skill is lower than the level at which it is needed [12]. Autotronic Simulator Interest Inventory (ASII), Autotronic Demonstrator Perception Inventory (ADPI) have 24 items and Auto Diagnostic Competence Test (ADCT) has 12 items. Also the score guide sheet was based on a four-point rating scale used by ratters. The instruments were face and content validated by three experts. Two lecturers from the Department of Industrial Technical Education, University of Nigeria, Nsukka, one from Department of Vocational Technology Ebonyi State University Abakaliki. The Pearson Product Moment Coefficient of the test instrument was used to determine the reliability coefficient of 0.79, which indicates that the instrument was reliable for the study. The data collected was analysed in line with the research questions and hypotheses. The inventories showing interests and perception and tests indicating competence will be analysed using mean and standard deviation. In taking decisions for interest and perception, any item with mean of 3.50 and above was considered as highly important, 2.50 - 3.49 was moderately important while any item with mean of less than 1.50 was considered as not important. In taking decisions for competence, any item with mean of 3.50 and above was considered as high performance, 2.50 - 3.49 was moderate performance while any item with mean of less than 1.50 was considered as very low performance. A mean of 3.50 and above will be considered interested, below that will be considered not interested. Analysis of variance (ANOVA) will be used to test the null hypothesis at 0.05 level of significance with the use of MATLAB for the graphical representations.

3. Presentation of Data and Analysis

3.1. Research Question 1

What is the effect of Distributed cognition learning theories (DCLT) in the application of simulators for trainers' interest in students learning with the autotronic tool?

Table 1. *Mean Ratings of autotronic trainers' capacity building needs interest in the use of a Distributed Cognition Learning Theories and Simulator for student learning.*

S/N	ITEMS	$\overline{XI}$	SDI	PG	$\overline{XP}$	SDP	REMARKS
1	If the non-responsive consumer (lamp, motor or solenoid) received voltage for its operation, the fault is in the consumer	4.00	1.00	0.80	3.20	1.66	CBN
2	Does the input component provide the required signal? If not, the fault is in the input component	4.13	1.09	0.21	3.92	1.28	CBN
3	Turn on the Simulator components	4.61	0.70	0.65	3.96	1.54	CBN
4	Does the control unit receive the signal from the input component and does not output the required signal to the output components? If yes, the fault is in the control unit	4.32	0.76	1.57	2.75	1.34	CBN
5	Run the Simulator system program	2.75	1.35	-2.25	5.00	0.50	CBNN
6	Various faults can be simulated in the ABS 4 Channel Brake System - TPS-3547	3.93	1.54	-0.82	4.75	0.55	CBNN
7	Record and note your findings	4.23	1.09	0.70	3.53	1.26	CBN
8	Instead of accumulating these faults and transmit them to the diagnostic device on demand, will a fault lamp be turned "ON" on the panel	4.03	0.95	-0.72	4.75	0.55	CBNN
9	Next to each lamp will a short text be written, describing the fault type	3.66	0.90	-1.34	5.00	0.50	CBNN
10	Select the delete code option on the Simulator to clear fault code.	4.02	0.96	-0.98	5.00	0.50	CBNN
11	Repeat items 3-6 to recheck and reactivate the fault code.	3.32	1.48	-1.68	5.00	0.50	CBNN
12	Turn off the Simulator and disconnect from the access point all components.	3.98	1.25	-0.20	4.18	0.50	CBNN
	Section (cluster) average mean, PG and SD	3.91	1.08	0.33	4.20	0.93	

Keys: XI=mean of important (needed) category, XP=mean of performance category, PG=performance gap, CBN=capacity building needed, CBNN=capacity building not needed, SDI=standard deviation of important category, and SDP=standard deviation of performance category.

The data presented in Table 1 showed that 5 out of 12 items had a performance gap tailored between 0.21 to 0.80

and were positive indicating that the trainers need capacity building to reveal more interest in five items only. Seven out of 12 items in the section or cluster have negative and zero performance gaps indicating that trainers capacity building is not needed on those items. Generally, the trainers need skill improvement in all the items having the cluster average XI and XP as 3.91 and 4.20 respectively but less emphasis on the 7 items with negative and zero performance gap values.

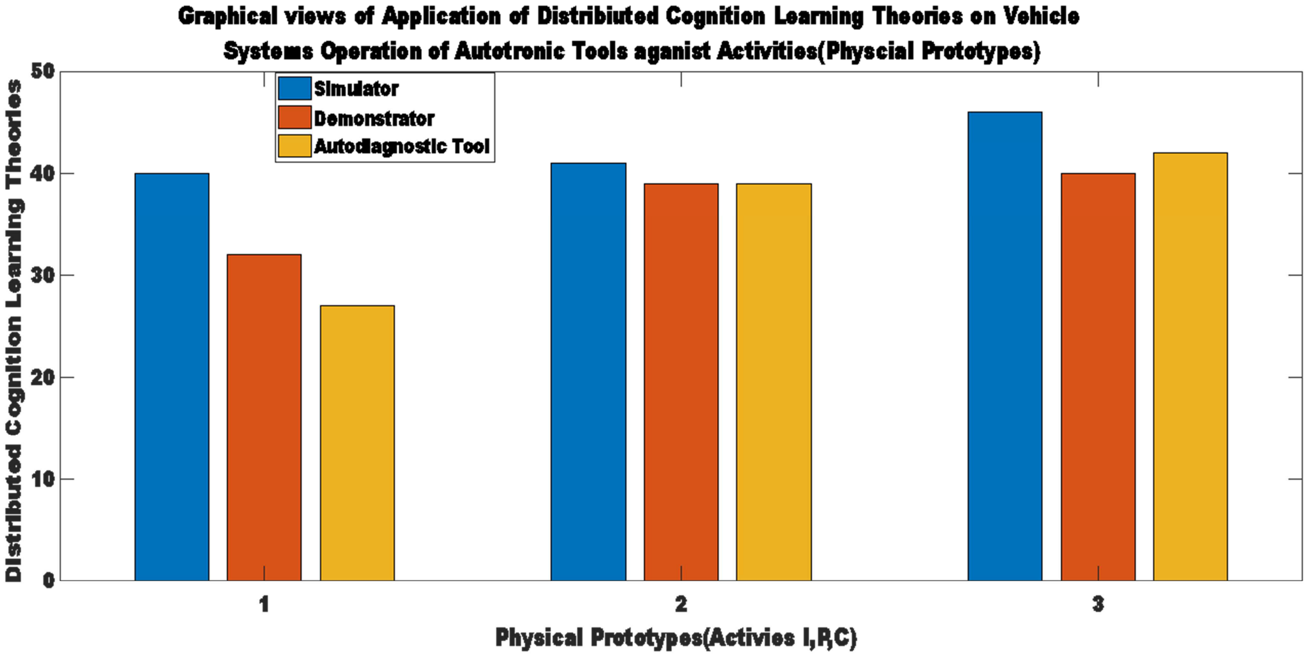

Figure 1. *Graphical Views of Application of Distributed Cognition Learning Theories on Vehicle Systems Operations of Autotronic Tools against Activities (Physical Prototypes).*

3.2. Research Question 2

What is the effect of Distributed cognition learning theories (DCLT) in the application of demonstrator for trainers' perception in students learning with the autotronic tool?

Table 2. *Mean Ratings of autotronic trainers' capacity building needs perception in the use of a Distributed Cognition Learning Theories and Demonstrator for student learning.*

S/N	ITEMS	$\overline{XI}$	SDI	PG	$\overline{XP}$	SDP	REMARKS
13	The demonstrator simulates the real automotive controller such as the engine ELECTRONIC Control Unit (ECU)	4.32	0.73	1.41	2.91	0.15	CBN
14	Automatic brake system (ABS) controller where each demonstrator can be used as a standalone system without Personal computer (PC) or with a PC	3.45	1.28	2.38	1.07	0.31	CBN
15	Turn on the demonstrator	4.26	0.98	2.88	1.38	0.62	CBN
16	Lightning and signaling demonstration – TPS-3541 has electronic link to the Alarm system, Immobilizer, Fuel system safety after accident, Measurements in a computerized system and Troubleshooting	4.18	1.07	-0.78	4.96	0.14	CBNN
17	Electronic ignition demonstration – TPS-3545 has tasks linked to the Fuel injection engine control, Principles/functions of motion/position sensors, Distributor less ignition system, Electromagnetic injector, Temperature/mass air flow sensors, Principles/function of the pressure sensors and Troubleshooting	4.71	0.76	3.64	1.07	0.31	CBN
18	Multi point injection system – TPS-3546 activities/programme include: Fuel injection engine control, Principles/function of motion/position sensors	4.53	0.70	3.46	1.07	0.31	CBN
19	Demonstrator will equally with the Distributor less ignition system, Electromagnetic injector, Temperature/mass air flow sensors, Principles/function of the pressure sensors, Idle air control, Fuel pump safety system and Troubleshooting control injection	4.48	0.51	-0.48	4.96	0.14	CBNN
20	Record/note your findings on the demonstrator	5.00	0.50	2.09	2.91	0.15	CBN
21	Diagnose and carry out the repair of the system control	4.22	1.08	3.13	1.09	0.30	CBN
22	Select the delete code option on the demonstrator to clear fault code.	4.50	0.05	-0.40	4.90	0.30	CBNN
23	Repeat items 3-6 to recheck and reactivate the fault code.	3.95	1.55	2.61	1.34	0.65	CBN
24	Turn off the demonstrator and disconnect from the access point.	4.13	1.22	-0.83	4.96	0.14	CBNN
	Section (cluster) average mean, PG and SD	4.31	0.90	1.59	2.71	0.29	

The data presented in Table 2 showed that 8 out of 12 items had a performance gap tailored between 1.14 to 3.64 and were positive indicating that the trainers need capacity building showing their good perception in eight items only. Four out of 12 items in the section or cluster have negative and zero performance gaps indicating that trainers' capacity building is not needed on those items. Generally, the trainers need skill improvement in all the items having the cluster average XI and XP as 4.31 and 2.71 respectively but less emphasis on the 4 items with negative and zero performance gap values.

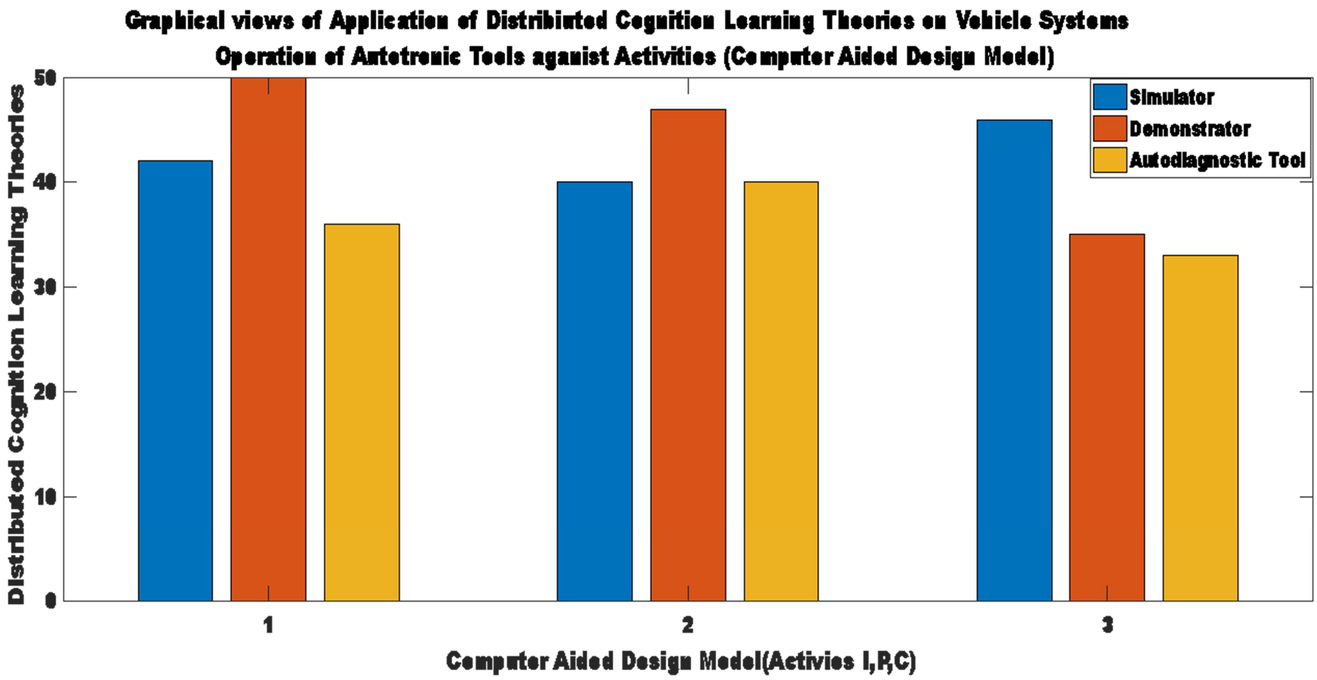

Figure 2. *Graphical Views of Application of Distributed Cognition Learning Theories on Vehicle Systems Operations of Autotronic Tools against Activities (Computer Aided Design Model).*

3.3. Research Question 3

What is the effect of Distributed cognition learning theories (DCLT) in the application of an auto diagnostic tool for trainers' competence in students learning with the autotronic tool?

Table 3. *Mean Ratings of autotronic trainers' capacity building needs competence in the use of a Distributed Cognition Learning Theories and Auto diagnostic tool for student learning.*

S/N	ITEMS	$\overline{XI}$	SDI	PG	$\overline{XP}$	SDP	REMARKS
25	Locate the bi-directional auto scan tool access point	3.93	1.27	0.03	3.90	0.46	CBN
26	Connect the bi-directional auto scan tool using the appropriate connector for the vehicle	3.45	1.25	-1.51	4.96	0.14	CBNN
27	Turn on the vehicle ignition	4.05	1.18	-0.85	4.90	0.30	CBNN
28	Turn on the bi-directional auto scan tool	4.02	0.93	1.12	2.90	0.14	CBN
29	Run the bi-directional auto scan tool diagnostic program	4.33	0.81	3.26	1.07	0.31	CBN
30	Navigate through the vehicle brake system to access the diagnostic trouble codes from the vehicle electronic control module.	3.97	0.93	2.59	1.38	0.63	CBN
31	Record your findings for the brake system	3.66	1.08	-1.30	4.96	0.14	CBNN
32	Check what the brake system code means and see if the try fault indicated by the trouble codes need to be corrected before you clear the code.	3.67	1.63	2.60	1.07	0.31	CBN
33	Perform the repair of the brake system	4.22	1.07	-0.74	4.96	0.14	CBNN
34	Select the delete code option on the bi-directional auto scan tool to clear fault code.	4.03	1.14	-0.93	4.96	0.14	CBNN
35	Repeat items 3-6 to recheck and reactivate the fault code.	2.41	1.62	-2.49	4.90	0.30	CBNN
36	Turn off the bi-directional auto scan tool and disconnect from the access point.	3.96	1.36	-1.00	4.96	0.14	CBNN
	Section (cluster) average mean, PG and SD	3.80	1.18	0.78	3.74	0.26	

The data presented in Table 3 showed that 5 out of 12 items had a performance gap tailored between 0.03 to 3.26 and were positive indicating that the trainers need skill improvement in five items only. Seven out of 12 items in the section or cluster have negative and zero performance gaps indicating that trainers skill improvement is not needed on those items. Generally, the trainers need skill improvement in all the items having the cluster average XI and XP as 3.80 and 3.74 respectively but less emphasizes on the 7 items with negative because competence was lacking and zero performance gap values.

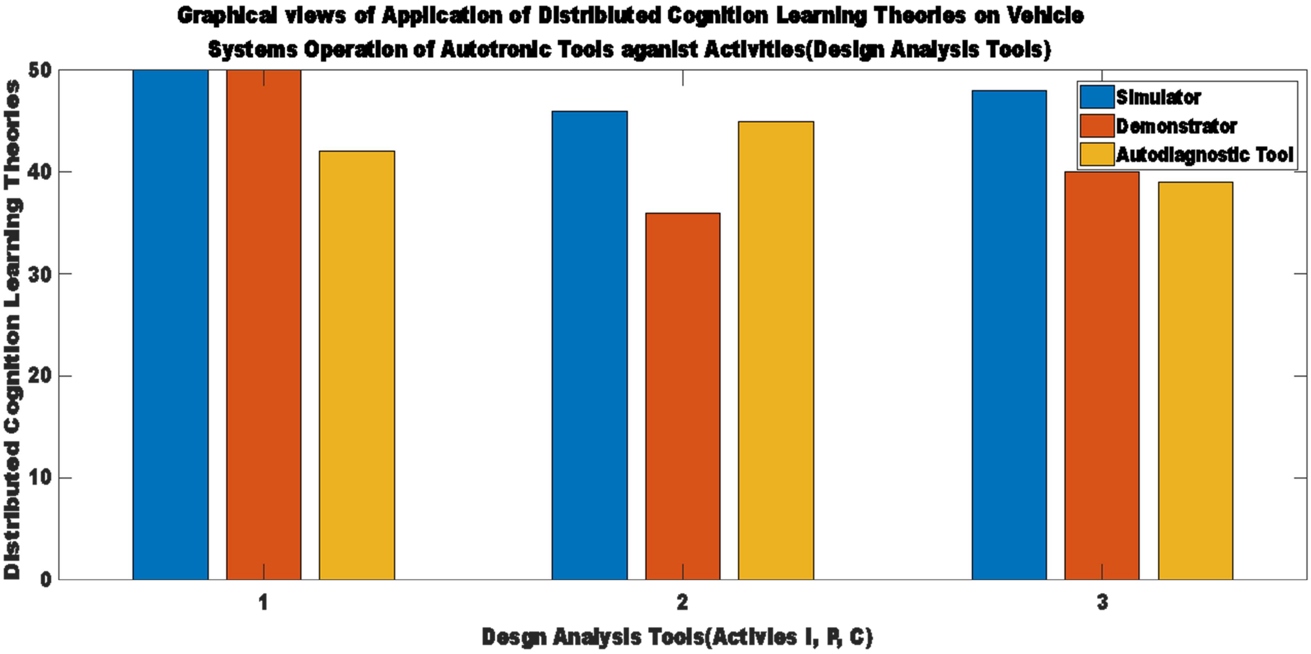

Figure 3. *Graphical Views of Application of Distributed Cognition Learning Theories on Vehicle Systems Operations of Autotronic Tools against Activities (Design Analysis Tools).*

H_{01}. There is no significant difference between the mean interest scores of trainers' capacity building applying Distributed cognition learning theories using simulators with those trained without simulator application for students learning. Data for testing the hypotheses is presented in Table 4.

Table 4. *Summary of ANOVA for testing significance differences of the effect of Distributed Cognition Learning Theories (DCLT) and Simulator with respect to their Mean Interest Scores of Autotronic Trainers on the capacity building skill improvement needs.*

Trainers	$\underline{X}$	SD	N	DF	T-calculated	T-critical	Decision
DCLT	3.91	1.08	22	27	0.69	±2.05	Accept
Simulator	4.20	0.93	7				

The data in Table 4 shows that trainers' test applying DCLT had a mean score of 3.91 and Standard deviation of 1.08. Trainers test applying Simulator had a mean score of 4.20 and Standard deviation of 0.93. With these results, both DCLT and Simulator are effective in capacity building needs of trainers' interest in autotronic tools application for students learning. Therefore, the null hypothesis is accepted. The t-calculated is less than t- critical therefore there is no significant difference between the mean responses in the use of DCLT and Simulator for trainers' interest in autotronic tools application for students learning.

H_{02}. There is no significant difference between the mean perception scores of trainers' capacity building applying Distributed cognition learning theories using demonstrator with those trained without demonstrator application for students learning. Data for testing the hypotheses is presented in Table 5.

Table 5. *Summary of ANOVA for testing significance differences of the effect of Distributed Cognition Learning Theories (DCLT) and Demonstrator with respect to their Mean Perception Scores of Autotronic Trainers on the capacity building skill improvement needs.*

Trainers	$\underline{X}$	SD	N	DF	T-calculated	T-critical	Decision
DCLT	4.31	0.90	22	27	7.30	±2.05	Reject
Demonstrator	2.71	0.29	7				

The data in Table 5 shows that trainers' test applying DCLT had a mean score of 4.31 and Standard deviation of 0.90. Trainers test applying Demonstrator had a mean score of 2.71 and Standard deviation of 0.29. With these results, both DCLT and Demonstrator are not effective in capacity building needs of trainers' perception in autotronic tools application for students learning. Therefore, contrary to expectations, the null hypothesis is rejected. The t- calculated is not less than t- critical therefore there is significant difference between the mean responses in the use of DCLT and Demonstrator for trainers' perception in autotronic tools application for students learning.

H_{03}. There is no significant difference between the mean competence scores of trainers' capacity building applying Distributed cognition learning theories using auto diagnostic tools with those trained without auto diagnostic tool application for students learning. Data for testing the hypotheses is presented in Table 6.

Table 6. *Summary of ANOVA for testing significance differences of the effect of Distributed Cognition Learning Theories (DCLT) and Auto diagnostic tool with respect to their Mean Competence Scores of Autotronic Trainers on the capacity building skill improvement needs.*

Trainers	$\underline{X}$	SD	N	DF	T-calculated	T-critical	Decision
DCLT	3.80	1.18	22	27	0.26	±2.05	Accept
Auto diagnostic tool	3.74	0.26	7				

The data in Table 6 shows that trainers' test applying DCLT had a mean score of 3.80 and Standard deviation of 1.18. The Trainer's test applying Auto diagnostic tool had a mean score of 3.74 and Standard deviation of 0.26. With these results, both DCLT and Auto diagnostic tools are effective in capacity building needs of trainers' competence in autotronic tools application for students learning. Therefore, the null hypothesis is accepted. The t- calculated is less than t- critical therefore there is no significant difference between the mean responses in the use of DCLT and Auto diagnostic tool for trainers' competence in autotronic tools application for students learning.

4. Conclusion

In this study, the effect of using Distributed Cognition Learning Theories and Autotronic tools on the Trainers Capacity building for skill acquisition was examined. At the end of the study, it was found that the application of Autotronic tools including Simulators, Demonstrators and Auto diagnostic tools showed changes in the interest, perception and competence respectively with respect to adopting Distributed Cognition Learning Theories in the process. The Distributed Cognition Learning is more effective in improving trainers' interest, perception and competence in Autotronic tools application in relation to employing Distributed Cognition Learning Theories in Skill Acquisition in Tertiary Institutions. Distributed Cognition Learning Theories is practically the same as it generalizes the information processing theory framework which comprise the physical environment around the learner, including interaction with other problem-solvers sharing the cognitive load using mainly external tools. Our work has led us to conclude that Distributed Cognition Learning Theories give Trainers the opportunity to engage the students in the learning process using tools especially autotronic tools which is a modern automobile engineering advancement tool that needs capacity building for better students skill acquisition. The application of Distributed Cognition Learning Theories in the use of Autotronic tools will increase Trainers skill, confidence, competence, proficiency, interest, preparedness and passion to impart the modern technology in the learning of automobile engineering. Distributed Cognition Learning Theories should be used in developing problem-solving purposes using representational tools like autotronic tools as a combination of models for engineering learning.

5. Recommendations

Based on the result of the study, the following recommendations were made:

Automobile engineering and engineering technology departments should be well equipped with modern automobile technology facilities and competent teachers employed to man the facilities in order to enhance teaching and learning.

National Universities Commission (NUC) and National Board for Technical Education (NBTE) should consider the review of curriculum for Automobile engineering and engineering technology to incorporate activities that reflect Distributed Cognition Learning Theories to enable trainers/teachers to be more effective in imparting Autotronic engineering.

The findings of the study should be made available to policy makers like the automobile council of Nigeria, educational institutions and other corporate bodies/agencies of education to enable them effect necessary changes in the Automobile engineering with respect to its theories and practical's.

Government should sponsor trainers to be periodically funded and encourage them to embark on capacity building training on the latest autotronic technology facilities.

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