Learning Automobile Petrol Engine from a Computer Simulation Compared with Direct Experience of the Engine

by

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Abstract

The main purpose of the study is to determine the effect of psychomotor performance scores of students of Motor Vehicle Mechanics' Work taught automobile petrol engine using computer simulation teaching technique and conventional teaching method respectively. Section 8 of the 2013 Nigerian National Policy on Education recommended the establishment of Education Resource Centers and Information Technology (IT) facilities to support the educational system and for the capacity building of teachers. This paper is one of the material resources necessitated by the capacity building of the teachers using IT facility. This paper compared two groups of four technical college classes studying automobile petrol engine. The study adopted a pretest, posttest, control group, quasi-experimental research design. Psychomotor performance test, in form of rating scale, was used to obtain data. The Psychomotor performance test used in the study is Automobile Engine Rating Scale (AERS). Pearson Product Moment Correlation was computed to establish a correlation coefficient of 0.82 after test-retest of the AERS, which means that the instrument is reliable. The instrument was validated by five experts. Reliability of the instrument was carried out using the test re-test method and reliability coefficient of the cognitive achievement test was 0.82. The area of the study is Enugu State of Nigeria. 526 NTC 1 (average of 16-17 years old) students of Motor Vehicle Mechanics' Work formed the population of the study; while 106 (49 in experimental group and 57 in the control group), students were purposively sampled from 4 schools out of the 22 schools managed by Science Technical and Vocational Schools Management Board (STVSMB), Enugu. Arithmetic mean was utilized to answer the research question, while the hypothesis was tested using Analysis of Covariance (ANCOVA) tested at .05 level of significance. The findings of the study revealed that real object experience group performed better than that using computer simulation teaching technique. It was also found that the difference was not significant. Based on the findings, one of the recommendations made is that computer simulation teaching technique should be incorporated in the teaching of Motor Vehicle Mechanics' Work.

Keywords: Computer simulation teaching technique, Psychomotor performance, Automobile petrol engine

Introduction

Some of the specific goals of education in Nigeria as affirmed in the National Policy of Education, (FRN, 2013) include; to ensure periodic review, effectiveness and relevance of the curriculum at all levels to meet the needs of society and the world of work; promote information technology capability at all levels; educational activities shall be learner centered for maximum self-development and self-fulfillment and teaching shall be practical, activity-based, experiential and Information Technology supported. Computer simulation teaching technique is one of the information technologies (IT) that satisfied the attainment of the specific goals. Computer simulation teaching technique in automobile deals on the psychomotor performance procedures of automobile technology. The practical aspects of automobile are shown in computer simulation. Fishwick (2015) defines computer simulation as the discipline of designing a model of a studied object, executing the model on a digital computer, and analyzing the execution output. Computer simulation in automobile technology is basically the virtual practical aspect of automobile

technology. The more students feel ‘‘present’’ in a computer-created environment, believing that they are in the simulated world and not the real world, the more they learn (Winn, Windschitl, Fruland & Lee, 2012). Computer simulation as a teaching technique can be used in teaching different types of automobile engines such as automobile petrol engine.

Automobile petrol engine is also known as a gasoline engine. Walter (2019) defined automobile petrol engine as an automobile internal combustion engine with spark-ignition, designed to run on petrol and similar volatile fuels. Automobile petrol engine is any of a class of automobile internal-combustion engines that generate power by burning a volatile liquid fuel (gasoline or a gasoline mixture such as ethanol) with ignition initiated by an electric spark (Charles and Orville, 2019). Walter (2019) explained that in most petrol engines, the fuel and air are usually pre-mixed before compression (although some modern petrol engines now use cylinder-direct petrol injection). The pre-mixing was formerly done in a carburetor, but now it is done by electronically controlled fuel injection, except in small engines where the cost/complication of electronics does not justify the added engine efficiency. A spark plug ignites the pre-mixing, which Giri (2015) termed charge, in the combustion chamber near the end of the compression stroke. The spark, produced across the spark plug electrodes at the correct time, must have sufficient energy to raise the gas temperature between the electrodes at a point so that the charge burning becomes self-sustaining. From this point, a flame front moves smoothly across the combustion. Charles and Orville (2019) explained that the process differs from a diesel engine in the method of mixing the fuel and air, and in using spark plug to initiate the combustion process. In a diesel engine, only air is compressed (and therefore heated), and the fuel is injected into very hot air at the end of the compression stroke, and self-ignites. The maintenance of automobile engine requires adequate skill in psychomotor performance.

Psychomotor performance of the students used in this study is derived from the rating scale. The rating scale, which was developed by the researcher, is a 19 item performance ability which is required to adjust a valve in an automobile petrol engine. Psychomotor performance tests are used to assess the achievement of objectives in the psychomotor domain. The psychomotor domain of educational objectives is concerned with the practical or motor skills possessed by students. Performance tests involve the use of tools and equipment in a direct assessment of the amount of practical or psychomotor skills possessed by students (Okoro, 2002). Psychomotor learning is the relationship between cognitive functions and physical movement. Psychomotor learning is demonstrated by physical skills such as movement, coordination, manipulation, dexterity, grace, strength, speed; actions which demonstrate the fine motor skills such as use of precision instruments or tools. In psychomotor learning research, attention is given to the learning of coordinated activity involving the arms, hands, fingers, and feet, while verbal processes are not emphasized (Clyde, 2014).Two methods were used to impart this relationship between cognitive function and physical movement. One is using computer simulation and the other is using engine parts model.

There is a dearth of automobile engine models in the teaching of Motor Vehicle Mechanics Work in Nigeria (Igwe, (2017) and (Anaele, Adelakun, Olumoko & Judith, 2014). Cengiz (2010) opined that using alternative method of teaching students practical lessons which involves psychomotor activities came as a result of dearth of materials, models and machines. This dearth of different physical automobile models restricts the Motor Vehicle Mechanics’ Works’ (MVMW) teachers to using fewer multimedia in teaching the students. Mayer (2011) refers multimedia instruction as learning environments that contain both words and pictures with the intention to promote learning. The words may be printed (as in a magazine article) or spoken (as in a narration); and the pictures may be static (such as diagrams, illustrations, or photos in PowerPoint slides) or dynamic/motion (such as an animation or video in an online lesson or computer simulation). The promise of multimedia

instruction is that people can learn better from words and pictures than from words alone (Mayer, 2009). Mayer, Heiser & Lonn (2001) posits that although adding pictures to words can improve learning, not all graphics are equally effective and some are even detrimental. The challenge of multimedia instruction is to figure out how to design effective lessons using words and pictures. Where some lessons are presented using static pictures, others are presented using dynamic pictures. The conventional method therefore used by teachers for teaching Motor Vehicle Mechanics' Work in Enugu State Technical Colleges is by the use of static pictures and few automobile physical models (Igwe 2017). This was compared to the lesson presentation using dynamic pictures in form of computer simulation. Computer simulation teaching technique is taken here to refer to classes using computer simulation as a replacement to conventional classroom instruction. Conventional teaching method on the other hand is taken here to refer to classes using traditional methods of instruction, such as using charts and physical model to teach for psychomotor performance.

The basic replacement in this study is in the learning resources, that is teaching materials. Kootenay Columbia School District (2018) defined learning resources as any person(s) or any material with instructional content or function that is used for formal or informal teaching/learning purposes. Aberdeen College (2012) excluded human resources and buildings in defining learning resources, when they define learning resources as all those resources which contribute directly or indirectly to successful learning and teaching. This is taken to include the various learning environments, though not the buildings which contain them or human resources (although, of course, the skills, knowledge and attitudes of staff will impact on the effectiveness of other learning resources). Multimedia is used, as learning resources, in both methods in order to achieve the objectives of the study.

When the study's finding shows that computer simulation teaching technique is better than the conventional method or if the hypothesis shows no significant differences between the computer simulation teaching technique and conventional method; then it means that computer simulation teaching technique can be used alongside the conventional method or can also be used when the physical automobile engine, which is presently used in teaching students of Motor Vehicle Mechanics' Work in Technical College in Nigeria, is not available. Where the physical automobile models are available, they are impossible to use to teach combustion and stroke, for instance, as processes in petrol engine. Envisaging this, Federal Republic of Nigeria (NBTE, 2009) recommended that there should be a sub-section of Diagnosis/Computer/Simulator in automobile section. This section is where simulators, such as computer simulations, should be used to instruct Motor Vehicle Mechanics' Work students in Nigeria. Computer simulation makes it possible for the student to visualize the dynamic processes in a running engine. Observation by the researcher revealed that there is currently no school in Enugu State technical colleges that has sub-section of Diagnosis/Computer/Simulator in their automobile section. The experiment in this study therefore sought to find out if there would be positive effects in using computer simulation to teach automobile engines as against the conventional method of using physical models as been practiced till date in Technical Colleges in Enugu State.

Research Question

1. What are the psychomotor performance mean scores of students of Motor Vehicle Mechanics' Work taught automobile petrol engine using computer simulation teaching technique and students taught using the conventional teaching method?

Hypothesis

1 There is no significant difference between the psychomotor post-test mean scores of students taught automobile petrol engine using computer simulation teaching technique and those taught using conventional teaching method.

Methods

In this study, a quasi-experimental research design of pre and posttest, experimental-control-group model was used. 526 NTC 1 (average of 16-17 years old) students of Motor Vehicle Mechanics' Work formed the population of the study; while 106 (49 in experimental group and 57 in the control group), students were purposively sampled from 4 schools out of the 22 schools managed by Science Technical and Vocational Schools Management Board (STVSMB), Enugu. This study was carried out in second term of 2018/2019 academic session. The study involved two groups of subjects. They are the experimental and control groups. The experimental groups are those who were taught automobile petrol engine using computer simulation teaching technique and the control groups were also taught automobile petrol engine using conventional method of teaching. Only the scores of students who participated in pretest, treatment, and posttest were taken to analyze the data; therefore the experimental group consists of 34 students and that of the control group were 40 students. The study was conducted in Enugu State, Nigeria. Psychomotor rating scale was used to rate the students based on the performance test used in the study.

The study was conducted during the normal school lesson hours. It followed the classes' time table for Motor Vehicle Mechanics' Work. The regular school Motor Vehicle Mechanics' Work teachers were used in the study. Pretest of performance skill, as contained in the 19 item rating scale, was administered to both groups before the commencement of the lessons. The items are: selection of appropriate tools, observation of safety precautions, cleaning of the surface of workbench, making proper use of parts tray, care of the components not to mix-up, checking the method of operation, spreading a rag on the working table, skillful pushing of the hinge pin out of the carburetor, skillful removal of inlet needle valve, skillful removal of fuel bowl gasket. Others are; skillful removal of idle mixture screw alongside the spring, skillful removal of the throttle plate screws and the throttle plate, skillful removal of the throttle plate shaft and foam seal, skillful removal of the choke plate, choke shaft and foam washer, skillful removal of the Welch plugs, skillful removal of the main jet, skillful removal of the emulsion tube, skillful arrangement of the parts in row for easy reassembling and correct re-assembling of the carburetor.

During the lessons, the experimental group used computer simulation teaching technique lesson plan to learn, while the control group used conventional teaching method lesson plan. Experimental group used only computer simulation and white board; while the control group received the lesson in a conventional classroom situation where charts, physical models of automobile engines and white board were used as the only learning resources. The regular Motor Vehicle Mechanics' Work teachers who were involved in the experimental group were trained on how to teach the selected topics using computer simulation. This was done before the pretests. After the training and pretests, then the treatment (that is actual teaching) commenced. Each lesson lasted for a period of 45 minutes, two periods in a week and the lessons were a period of three weeks. A total of six lesson periods were therefore involved in the study. At the end of the lessons, posttest of the same instrument, were administered to both groups. The data collected from the pretest and posttest was used for further analysis. The analysis determined if there are significant differences in the psychomotor performance between the two groups. The instrument was validated by five experts, three from the Department of Industrial Technical Education, one from the Department of Computer and Robotics Education and one from Measurement and Evaluation unit of the Department of Science Education, University of Nigeria, Nsukka. The Reliability of the instrument was carried out using the test re-test method and reliability coefficient of the cognitive achievement test was 0.82.

Results

The results are presented according to the research question and hypothesis that guided the study.

Table 1: Mean Scores of Pre-test and Post-test Psychomotor Performance Scores of Motor Vehicle Mechanics' Work Students taught automobile petrol engine using Computer Simulation Teaching Technique and those taught using Conventional Teaching Method

Techniques	N	Pre-test	Post-test	Mean
		$\overline{X}$	$\overline{X}$	
Conventional	40	28.91	45.62	16.71
CST	34	28.39	42.25	13.86

Table 1 shows mean scores of 28.39 in the pre-test of psychomotor performance and a mean psychomotor performance score of 42.25 in the post-test of CST; making a pre-test, post-test mean gain in the CST technique to be 13.86. The conventional group taught MVMW had a mean psychomotor performance score of 28.91 in the pre-test and mean post-test psychomotor performance score of 45.62. This gives a mean gain of 16.71 in the conventional method. With these results, the effect of conventional teaching method on students' Psychomotor Performance in MVMW is higher than the effect of CST.

Table 2
Summary of Analysis of Covariance (ANCOVA) for Test of Significance between the Mean Scores of Experimental and Control Groups in the Psychomotor Performance Test

Source of Variation	Type III Sum of Squares	Df	Mean Squares	F	Significance of F
Corrected Model	208.905[a]	1	208.905	2.767	.101
Intercept	105767.723	1	105767.723	1400.772	.000
Group	208.905	1	208.905	2.767	.101
Error	5436.486	72	75.507		
Total	112881.728	74			
Corrected Total	5645.390	73			

a. R Squared = .037 (Adjusted R Squared = .024)

The data presented in Table 2 shows that F calculated value for group is 2.767 with significance of F at .101 which is greater than 0.05. Therefore, the null hypothesis of no significant difference between the effect of experimental and control groups of students, in the psychomotor performance in MVMW is accepted at 0.05 level of significance. Hence, there was no significant difference between experimental and control groups of students in respect to their mean scores on the MVMW Psychomotor Performance Test.

Discussion of Findings

The findings as presented in Table 1 showed that the group taught Motor Vehicle Mechanics' Work using conventional method had a mean gain of 2.85, in psychomotor performance score over the group taught using computer simulation teaching technique. With this result, the conventional method is more effective in psychomotor performance of the students of Motor Vehicle Mechanics' Work than computer simulation teaching technique. This result agreed to the study of William, et al (2015), who found a better result in conventional teaching method over computer simulation teaching technique in psychomotor performance where real objects were used.

Analysis of covariance explained the null hypothesis in table 2. It revealed that F-calculated value of mean psychomotor performance of students taught using computer simulation teaching technique and those taught using conventional method is 2.767 with a significance of F at .101 which is greater than 0.05. This result implies that there was no significant difference between the mean psychomotor performance scores of MVMW students taught using computer simulation teaching technique and those taught using conventional method. The hypothesis agree with the statement of Aleksandrov & Nancheva (2007) and Martínez, Perez, Suero & Pardo (2012)which opined that the practices carried out in virtual environments, such as in computer simulation, are useful as an educational complement, but cannot replace the real laboratory.

In order to enhance students' learning, it is important to integrate computer simulation teaching technique as complementary methods added to those used in traditional teaching. Kolb, Boyatzis, & Mainemelis (2001) provide a useful framework within which to think about how students learn with computer simulation compared with real-world experiences. Kolb's theory describes four successive learning stages in an iterative cycle, which are concrete experiences (sensing and feeling), reflective observations (reflecting), conceptualizations (abstracting), and active experimentation (doing). The theory stresses the importance of direct interaction with the environment for both the acquisition and application of experience. It also stresses the intermediate need to develop more abstract conceptions from experience and to reflect on them. Kolb's four-stage ''cycle'' therefore encompasses concrete experiences and observations of them, and the distillation of these into more abstract concepts, whose implications guide subsequent actions that help create new experiences. It was expected that the simulation of petrol engine processes would be most effective in the second and third (''reflecting'' and "abstracting") stages of Kolb's cycle. By contrast, doing exercises on a research vessel would provide the direct sensory experiences that a computer simulation cannot, and would be more effective for the first and fourth (''data-gathering'' and ''experimentation'' that is sensing, feeling and doing) stages of the cycle. Many schools that perform practical lessons involving only physical data gathering and experimentation of recent automobile finds it difficult to obtain the sufficient recent physical automobiles and their engines.

Conclusion

Based on the analysis of data, it is concluded that conventional teaching method is better than computer simulation teaching technique in psychomotor assessment. The study also revealed no significant difference in psychomotor performance between computer simulation teaching technique and conventional teaching method. Therefore, computer simulation can complement teaching where real objects are used as teaching resources.

Recommendations

Based on the findings of this study, the following recommendations were made:

1. Government should provide facilities and necessary infrastructure for the promotion of Information Technology (IT) at all levels of education, as enshrined in the national policy on education.
2. Nigerian Educational Research and Development Council (NERDC) should work with research centres, such as higher

institutions, to acquire resource materials such as this paper.

3. National Board for Technical Education (NBTE) should consider incorporating computer simulation teaching technique into the teaching of Motor Vehicle Mechanics' Work.
4. Workshops, seminars and conferences and in-service training should be organized by the government and professional bodies like the National Board for Technical Education (NBTE) and the Nigerian Association of Teachers of Technology (NATT) on the use of computer simulation teaching technique for improving students' performance in Motor Vehicle Mechanics' Work.
5. Teachers training tertiary institutions, where Information and communication Technology (ICT) has not been introduced, should include ICT in their curricula and impact the use of computer simulation instruction strategy to the student teachers.

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