EFFECT OF VIRTUAL LABORATORY ON STUDENTS LEARNING OUTCOMES IN AUTOMOBILE TECHNOLOGY

Fakorede, S. O. A. Ph.D.
Department of Science and Technology Education, Faculty of Education,
University of Lagos, Akaka, Nigeria.
sfakorede@unilag.edu.ng

Abstract
The study investigated the effect of virtual laboratory on students' learning outcomes in Automobile Technology. The study is a quasi-experimental research. The sample of the study comprised of 104 senior secondary class two (SS2) students of public secondary schools in Ondo West Local Government Area of Ondo State. Participants were randomly assigned into experimental and control groups of 26 students in each school. The experimental groups were taught using virtual laboratories, where experimental activities were conducted through Automobile Technology reactions simulation software while control group were taught through traditional lecture method. Both groups were pre and post-tested. The instruments are Automobile Technology Achievement Test and Automobile Technology Attitude Inventory Test. Data was analyzed using Mean to answer the research questions while ANCOVA was used to test the hypotheses formulated. The result showed that students taught using virtual Automobile Technology laboratory performed better than those taught using the traditional teaching method (9.32 > 8.88). The mean gain in attitude in Automobile Technology for the group taught using virtual Automobile Technology laboratory was significantly higher than those taught using traditional lecture method (32.71>4.70). The study concluded that students performed better and also had a positive attitude towards virtual laboratory as a mode of instruction. The study recommended among others that Automobile Technology teachers should be creative, resourceful in planning, selecting and appreciates the value of using virtual laboratory in instruction in enhancing students' achievement and attitudes.

Introduction

Technological innovative expansion in the last few decades has created new opportunities and possibilities of an expansive approach to teaching and learning processes. Communication gadgets have rapidly become more portable, mobile and accessible with a reduction in both hardware and software cost. This makes it more accessible for individuals and in return has significantly influence learning culture and attitude of students in a manner that reflects modern technological developments adaptable to the classroom, virtual and distance learning environments. Mobile PC and compatible educational software are becoming widely available such that, students can have several textbooks and practical's activities on their mobile communication gadgets, palmtop and laptops, either as a text document or mobile applications (Jacob & Issac, 2008). More so, educational concept simulation in different educational disciplines now exists through Information and Communication Technology (ICT) (Eric, Scot, Jenifer, & Jason, 2009). These developments have opened the way for inclusive and expansive learning. With simulation software and applications, undertaking experiment and practical investigations have come closer to the reach of students.

With the level of sophistication of recent mobile electronic gadgets, smartphones, palmtops and laptops and other gadgets serve the appreciable functionalities of computers as perceived decades ago. These features include; high-speed capacity, the accuracy of data processing, large and extendable storage capacity, high reliability, versatility and high mobility are now helping in computer simulation and its applications. Simulation applications and science-based software development have experienced advance

growth in recent years due to the aforementioned developments. They serve educational purposes as pedagogical and research tool with ease of students learning which can also be through virtual. This can be used for laboratory experience in science and science related subjects.
Virtual laboratory provides three-dimensional environments in which experimental interactions take place over multiple sensory channels and includes tactile and positioning feedbacks. Virtual laboratory applications interpret the actions of the users in its environment as it is being explored, in such a way that it provides visual, audio or audio-visual experiences of real-world laboratory based on the degree of the simulation development. An example of a virtual Automobile Technology laboratory runs on iPad/iPhone and Android devices. Remote triggered virtual laboratory on automotive systems is an initiative by Indian Institute of Technology Kharagpur, where a student can access and conduct experiments on an internal combustion engine over the internet from remote locations. The lab introduces student to the basic experiments on a single cylinder petrol engine loaded by an eddy current dynamometer. The student has a choice to download the actual experimental data over the internet for subsequent analysis or also browse through a sample calculation. The experimental setup consists of an instrumented single cylinder petrol engine coupled to an eddy current dynamometer which is controlled by a PC based controller.

A diverse range of experiments could be performed using this setup which includes noise and vibration monitoring as well as basic performance monitoring of the engine. Students can experiment with various laboratory equipment, procedures, and tools without the risk of being harmed. It contains about 17 virtual laboratories. Experiment is designed to simulate experiments that could take place in a real laboratory. Virtual reality technology, in general, has the unique ability to successfully translate abstract concepts into visualized events along with the possibility of the users' interaction with them, which in real life could be limited due to resources, time, cost and safety factors (Antonios, Christos, & Eleftheria, 2005). The use of a virtual laboratory in the classroom is a student-centred approach in pedagogical processes. It allows general human-computer interaction principles and put educational theories in perspectives.

Virtual learning environments are built on a foundation of two key elements which are computer technology and education (Steve & Mary, 2001). Hence, the design of virtual Automobile Technology laboratory, therefore, must explore an approach that incorporates effective pedagogical concerns and integration of technology elements towards a common objective of simplifying and achieving effective learning experiences. For a virtual laboratory to be considered efficient and effective there must be precision and accuracy in replication and representation of the traditional laboratory experiments being simulated. Simulation of observatory visual and audio effects of chemical reactions in school laboratory must be similar and comparable to observatory reactions observed in virtual Automobile Technology laboratory. Also, to score a virtual Automobile Technology laboratory apparatus and equipment valid, it is essential that they have identical reality to the traditional school laboratory apparatus, equipment and setup.

Many researchers have studied the effect of virtual laboratory on students' academic achievement and attitude among different age groups and fields of study. It is seen that studies have been made on subjects such as: The Effect of the Virtual Laboratory on Students' Achievement and Attitude in Chemistry (Tuysuz, 2010), Effect of a Virtual Chemistry Laboratory on Students' Achievement (Tatli & Ayas, 2013), Virtual and Physical Experimentation in Inquiry-Based Science Labs: Attitudes, Performance and Access, Learning outcome achievement in non-traditional versus traditional (hands-on) laboratories, (Brinson, 2015), The Effect of the Virtual Laboratory on Students' Achievement and Attitude in Automobile Technology (Cengiz, 2010), The Effect of Combined Virtual and Real Laboratories on Students' Achievement in Practical Chemistry (Omilani, Ochanya, & Aminu, 2016). It was observed in

the research works that virtual laboratory has an effect on student's attitudes and academic achievement. Since students' achievement is dependent upon several factors among which are instructional methods, learning environment and attitudes to learning, it thus implies that adequacy of instructional Automobile Technology laboratory materials either traditional or ICT solution tools such as virtual laboratory can greatly influence the attitude of learners and academic achievement in Automobile Technology. Attitudes are the best predictor for estimation of student's success (Shih, 1998).

A look at the preambles, aims and scheme of External Examination of West African Examination Council (WAEC) Automobile Technology syllabus for Senior School Certificate Examination (WASSCE) between 2004 -2009 indicates the following:

1. It was assumed that each school under WAEC has a well-equipped laboratory.
2. The broad aim of the syllabus was to provide knowledge in Automobile Technology adequate for students who:
   a. Will end their study of Automobile Technology at the Senior Secondary School level.
   b. Require application of Automobile Technology in their vocational studies.

   The objectives include:

   a. Enabling students to appreciate the scientific methods which involve experimentation, accurate observation, recording, deduction and interpretation of scientific data.
   b. Enabling students to develop laboratory skills, including an awareness of hazards in the laboratory and the safety measure required to prevent them.
   c. Show Automobile Technology and its link with the industry, the environment and everyday life, in terms of benefits and hazards.

Practical test forms 25% of the total External examination marks with core examination on qualitative analysis, quantitative analysis and students' familiarity with practical activities suggested in classroom instructions. Not much of this requirement has changed until today. Thus, this points to the clear fact of the necessity of laboratory activities in schools and students' regular interactions with the laboratory facilities. Shallcross, Harrison, Shaw, Shallcross, Croker, and Norman, (2013) explicitly pointed out the aims of practical work based on two years of surveys work. These are: to encourage observations and careful recording; to promote simple, commonsense, scientific methods of thought; to develop manipulative skills; to give training in problem-solving; to fit the requirements of practical examinations; to elucidate theoretical work so as to aid comprehension; to verify facts and principles already taught; to be an integral part of the process of finding facts by investigating and arriving at principles; to arouse and maintain interest in the subject; and to make phenomena more real through actual experience.

In line with these, it should be noted that the Automobile Technology syllabus used today in our schools was provided to train students in a functional and effective school system. Therefore, by taking a survey on the teaching techniques and Automobile Technology practical work in our public secondary schools today, we can have an understanding of one of the likely causes of Automobile Technology failure in West Africa Examination Council (WAEC) exams and National Examination Council (NECO) exams. Failure in secondary school external examination is not limited to Automobile Technology subject alone. Studies have shown a major concern about failure in other school subjects too. According to Amuche, Amuche, Bello, & Marwan, (2014) a breakdown of the 2009 WAEC results shows that only 358,981 out of 1,373,009 candidates, representing 25.99 per cent, obtained five credits including English Language and Mathematics, with a failure rate of 75 per cent and a similar percentage was also recorded in NECO 2006.

The importance of laboratory learning of Automobile Technology cannot be overemphasized. Habu, (2005) concluded that laboratory facilities give students some basic insight into practical concepts and leave them with the feeling of the reality of science which in turn improves their academic performance in examinations. Many schools are teaching mere theory because they lack a laboratory Yet studies have shown that laboratories in Nigeria senior secondary schools are poorly or inadequately equipped (Cirfat & Zumyil, 2000; Adeyemi, 2008; Ado 2009). Also, according to Dike (2011), teachers and students are struggling to teach and learn with inadequate and antiquated facilities. This is at variance with the tenets of education in Nigeria which stipulates that education should aim at helping the child acquire appropriate skills, abilities and competences in order to excel in school; live and contribute to the development of his society (Ukpai, 2014).

The common virtual laboratories for secondary school simulated Automobile Technology experiments are relatively low in price. A major advantage of virtual laboratory software; either mobile or computers is that they are transferable and can be installed on more than one computer-based instructional gadgets and mobile phones of students. This, of course, will drastically reduce the net cost per student unlike the traditional laboratory where reagents, chemicals are easily used up and the apparatus wear out, which then needs to be replaced from time to time, virtual laboratory is more economical and experiments can be repeated as many times as possible without worries of changing apparatus over a period of time or purchasing more chemicals, all these because the virtual laboratories do not wear out. Its only cost is that there will be a need for upgrading to accommodate more possible virtual experiment which cost less compared to the upgrade that will be done in a traditional laboratory. This is not to say that virtual laboratory should be a substitute to the traditional laboratory, but in the face scarcity of laboratory resources due to financial constraint across public schools, it is essential to look at virtual realities which portray real-life experiments in a simulated format.

Virtual laboratory enhances the development of competency and skills in scientific processes, methodology and reporting. Virtual Automobile Technology laboratory reduces fatigue and tensions in prolong cognitive learning. More so, student's centred learning is enhanced. Virtual Automobile Technology laboratory facilitates individual learning of Automobile Technology and technical skills development. It also provides feedback with which inferences can be deduced about traditional laboratory experiments. The virtual Automobile technology laboratory is a multilateral methodology approach to the teaching of Automobile Technology. It accommodates methodologies such as practical, demonstration, observation and collaboration. Thus, there is room to cater for various learning styles and the individuality of learners. However, few constraints are surrounding the use of virtual Automobile Technology laboratory. Hawkins, (2013) opined that one of the concerns is that virtual labs will not be the best method to teach laboratory skills when it comes to measurement, use of glassware, analytical balances, etc. and any activity that requires hands-on manipulation of instruments. This raises the question of the goals and objectives of Automobile Technology subject in school and if virtual Automobile Technology laboratory can support the learning outcomes students in Automobile Technology.

Research Questions

1. What is the difference in the academic achievement of students taught automobile technology with virtual laboratory and those taught with the traditional method?
2. What is the difference in the attitude of students taught automobile technology with virtual laboratory and those taught with the traditional method?

Research Hypotheses

H_{O1}: There is no significant difference between academic achievement of students taught automobile technology with virtual laboratory and those taught with the traditional method.

H_{O2}: There is no significant difference between the attitude of students taught automobile technology using virtual laboratory and those taught using the traditional method.

Methodology

Research design

A Quasi-Experimental of the non-equivalent pre-test and post-test control group research design was adopted for the study. The design was adopted because it is not possible for the researcher to randomly sample the subjects and assign them to groups without disrupting the academic activities and the timetable of the secondary schools involved in the study. Hence, the design was considered quite suitable for conducting this study.

Sample and Sampling Techniques

The target population of the study consisted of Senior Secondary School Two (SS II) students in public schools within Ondo West Local Government Area of Ondo State. The choice of SS II class ensured that students that participated in the study were already familiar with the course and not preparing for any external examination. A sample of 104 students offering Automobile Technology was drawn from the target population. Two experimental classes and two control classes were adopted from two schools with 26 students in each class. St. Joseph Grammar School, Ondo (referred to as school A) and St. James Grammar School, Ondo (referred to as school B) were purposefully selected for this study and the criteria used for selection were;

1. The schools have electricity facilities and computer laboratories.
2. There is the availability of experienced Automobile Technology teachers.

Students were assigned to experimental and control groups prior to the administration of the treatment. Two intact classes (one for the experimental group and one for the control group) were used for the study in each school. The detail of the sample is presented thus:

Table 3.1

Schools	Total	Sampled
Control	56	26
Experimental	48	**26**
Total	104	**52**

Research instrument

Three Research instruments were developed for the study; these are:

1. Automobile Technology Achievement Test (CAT)
2. Automobile Technology Attitude inventory

Automobile Technology Achievement Test (ATA):

A 20 item multiple-choice items achievement test developed by the researcher to determine the achievement of students on the topic taught: Chemical Properties of Metals

The items of the Automobile Technology achievement test were drawn from past examination questions of West Africa Examination Council (WAEC, May/June 1988-2015) and the National Examination

Council (NECO, June/July 1988-2015). The (objective) items will be drawn based on the six levels of Blooms' Taxonomy of Educational objectives to ensure the content validity of the CAT.

Automobile Technology Attitude Inventory

The Automobile Technology Attitude Inventory had 20 items and was developed by the researcher. The CAI was used to determine the attitude of students to Automobile Technology. The items were developed using the Likert scale of; Strongly Agreed (S.A); Agreed (A); Disagreed (D); and; Strongly Disagree (S.D). The response categories were assigned numerical values of 4, 3, 2, and 1 for positively worded items and 1, 2, 3 and 4, for negatively worded items.,

Validity of the Instruments

The validity of the Automobile Technology Achievement Test (ATA).

The use of a table of specification with Bloom's Taxonomy of educational objectives to draw the items of ATA ensures content Validity of the instrument. In addition, ATA was subjected to face validation by two experts in the Department of Science and Technology Education of the University of Lagos. The experts' observation and corrections were taken into consideration in the final draft of the instrument.

The validity of Automobile Technology Attitude Inventory

The items of CAI were subject to Face validation by three experts in the Department of Science and Technology, University of Lagos education. Based on their corrections and suggestions, amendments were made on the instrument before a final copy was produced and used for this study.

Reliability of the instrument

Automobile Technology Achievement Test.

The trial test for determining the coefficient of stability of the achievement test (CAT) was carried out using the test re-test reliability technique. The instrument was administered on an equivalent sample of SS II Automobile Technology students. The objectives answer sheet were marked by the researcher and the score kept. After two weeks, the Automobile Technology achievement test was re-administered to the same sample. The objectives answer sheets were also marked by the researcher and the score obtained in the first and second administration of the tests were correlated using Pearson Product Moment Correlation. The correlation Coefficient (r) is 0.82.

Automobile Technology Attitude Inventory Questionnaire

Cronbach Alpha was used to determine the internal consistency of the Automobile Technology Attitude Inventory Questionnaire items at a value of 0.6. The CAI Questionnaire was administered on a sample of SS II Automobile Technology students. The correlation Coefficient (r) is 0.89.

Virtual Automobile Technology Laboratory

Virtual Automobile Technology laboratory software was used by the researcher. The software was used to cover the topics of virtual Automobile Technology laboratory experiments. The virtual Automobile Technology laboratory software displayed the laboratory contents and procedures to students using animation, words and sound.

Research Procedure

To control the effect of variable such as teacher's variability, which could result to experimental bias, the regular teachers in the participating schools taught their own students. The researcher was not directly involved in the administration of the research instruments and the treatment. The lesson plan was developed by the researcher and the topics taught during the treatment includes braking System and lubrication system. The experiment was commenced with the administration of pre-test to the experimental and control groups. The teachers administered the ATA and CAI Questionnaire to the groups in their respective schools. This process provided the pre-test measures on the performance of the two groups before the treatment.

The pretest was followed by the treatment. The experimental groups were taught braking System and lubrication system with the virtual laboratory. At the end of the treatment, ATA and CAI with re-arranged items were administered to the groups as post-test by the teachers.

Data Analysis

The research questions were answered using mean and standard deviation while the hypotheses were tested using Analysis of Covariance (ANCOVA) at 0.05% level of significance.

Results

Research Question 1: What is the differences in the academic achievement of students automobile technology taught with virtual laboratory and those taught with traditional method?

Table 2: Mean of Pretest and Posttest Scores of Experimental and Control Groups in the Automobile Technology Achievement Test.

Methods	N	Pretest $\overline{X}$	Posttest $\overline{X}$	Mean Gain
Traditional	26	7.52	16.38	8.88
Virtual Laboratory	26	7.62	16.94	9.32
Total	52			0.44

Table 2 show that the treatment group taught with traditional method had a mean score of 7.52 in the pretest and a mean score of 16.38 in the posttest, making a pretest, posttest mean gain of 8.88. The treatment group taught with lecture method had a mean score of 7.62 in the pretest and a posttest mean of 16.94 with a pretest, posttest mean gain of 9.32. With these results, students taught with virtual laboratory had a higher mean achievement score than those taught with traditional method in the achievement test. Thus, the use of virtual laboratory is more effective than the traditional teaching method in improving students' achievement in Automobile Technology with a mean difference of 0.44.

Research Question 2: what is the difference in the attitude of students taught automobile technology with virtual laboratory and those taught with traditional method?

Table 3: Mean of Pretest and Posttest Scores of Experimental and Control Groups in the Automobile Technology Attitude Inventory.

Methods	N	Pretest $\overline{X}$	Posttest $\overline{X}$	Mean Gain
Traditional	26	52.84	53.54	0.70
Virtual Laboratory	26	53.08	55.79	2.71
Total	52			2.01

Table 3 shows that the treatment group taught with virtual laboratory had a mean score of 52.08 in the pretest and a mean score of 55.79 in the posttest, making a pretest, posttest mean attitude gain of 2.71. The control group taught with traditional had a mean attitude score of 52.84 in the pretest and a posttest mean attitude score of 53.54 with a pretest, posttest mean attitude gain of 0.70. With these results, students taught with virtual laboratory had a higher mean attitude score than those taught with traditional method in the attitude with a mean gain of 2.01.

H_{O1}: There is no significant difference in the achievement of students taught automobile technology with virtual laboratory and those taught with traditional method.

Table 4: Achievement of Students Taught Automobile Technology with Virtual Laboratory Traditional Method

Source	SS	df	MS	F	Sig.
Corrected Model	5.312[a]	2	2.656	.599	.552
Intercept	166.978	1	165.978	37.627	.000
Posttest	5.072	1	5.071	1.143	.288
Group	.569	1	.569	8.120	.000
Error	448.216	50	4.438		
Total	6409.000	52			
Corrected Total	453.529	51			

The data presented in Table 4 shows F-calculated values for students' achievement in automobile technology (F, 8.120< 0.05). The null-hypothesis is therefore rejected at .05 level of significance. With this result, there is a significant difference between mean achievement scores of students taught with virtual laboratory and those taught with traditional method in Automobile Technology.

H_{O2}: There is no significant difference in the attitude of students taught automobile technology with virtual laboratory and those taught with traditional method.

Table 5: Attitude of Students Taught Automobile Technology with Virtual Laboratory and Traditional Method.

Source	SS	df	MS	F	Sig.
Corrected Model	7737.423[a]	2	3868.711	99.102	.000
Intercept	5353.323	1	5353.323	137.132	.000
Postattitude	.798	1	.798	.020	.887
Group	3612.507	1	3612.507	9.532	.000
Error	3942.798	50	39.038		
Total	470817.000	52			
Corrected Total	10680.221	51			

***Significant at sig of F< .05**

The data presented in Table 5 shows F-calculated values for students' achievement in automobile technology (F, 9.532< 0.05). The null-hypothesis is therefore rejected at .05 level of significance. With this result, there is a significant difference between mean attitude scores of students taught with virtual laboratory and those taught with traditional method in the Automobile Technology.

Discussion of Findings

The result of the study is in line with the findings of Giannakos (2013) who reported that learning activity might be converted via analytics into useful information for the benefit of all video learners. More so, Habu (2005) in his study reported that virtual laboratory facilities give students some basic insight into practical concepts and leave them with the feeling of the reality of science which in turn improves their academic performance. The report of Dike (2011) also aligned with the outcome of the study with the report that teachers and students are struggling to teach and learn with facilities that are inadequate and antiquated but with virtual laboratory, there is a difference in their attitude towards teaching and learning. Steve and Mary, (2001) also affirmed the findings of this study with their report that virtual learning environments are built on a foundation of two key elements which are computer technology and education and it enhances effective instructional delivery.

Conclusion

This study concluded that virtual laboratory is an effective mode of delivering instruction to learners. This will enhance and improve their performance and attitude towards learning.

Recommendation

Based on the findings, the study recommends that virtual laboratory should be incorporate more into classroom activities, curriculum planners and developers should design program and policies to incorporate the use of virtual laboratory in teaching and learning of Automobile Technology. Federal and State Ministry of Education should continue to organize workshops, seminars, and conferences on utilization technology in teaching and learning of Automobile Technology.

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