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Effect of web-based multimedia package on students' academic achievement in electrical power and machines in colleges of education in North-East Nigeria

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Abstract
The rapidly changing technological developments have affected education as it does every other field of human endeavour. The number of technology applications used in education increases every day. One of these tools is web-based multimedia package. The purpose of this study was to find out the effect of web-based multimedia package in electrical power and machines in Colleges of Education in North east Nigeria. Quasi- experimental design was used in the study with experimental and control group. The sample used in the study consisted of 120 students from two Colleges of Education: Federal college of Education (tech), Gombe as the experimental group and Federal College of Education (tech) Potiskum as the control group. While the experimental group was taught using web-based multimedia package, the control group was taught using lecture method. Electrical power and machines achievement test (EPMAT) was used to collect data after being validated by experts and pilot- tested to ensure its reliability which was found to be 0.791 Four research questions and hypothesis were formulated and analyzed using mean and t-test respectively. The data collected from the achievement test was analyzed with SPSS program. At the end of the study, it was concluded that web-based multimedia package increased the academic achievement of students in electrical power and machines compare to the lecture method.

Keywords: Technological developments, education, machines, academic achievement, electrical power

1. Introduction

Education has been acknowledged as the cornerstone to inculcate the adequate skills, values and attitude to the learners to enable them function effectively in a dynamic society (Samson & Godwin, 2013) [21]. Technical and Vocational Education (TVE) is a comprehensive term referring to educational process involving general education, the study of technology and related sciences, the acquisition of practical skills, attitudes, understanding and knowledge relating to economic and social life (FRN, 2014) [10] Electrical Power and Machine is one of the major courses offered in Colleges of Education whose philosophy is to produce technical teachers with the intellectual and professional background adequate for teaching subjects to any unchanging situation not only in the country but also in the world at large (NCCE, 2012) [18]. Teaching only theoretical aspect of Electrical Power and Machine will not suffice to understand the core concept of the subject (Minal & Javeed, 2017) [16]. The different core concept in Electrical Power and Machine in Colleges of Education are power generation, transmission and distribution, AC and DC machines, speed control techniques for various machines (NCCE, 2012) [18]. To learn any Electrical machines, it is always a better practice to first understand the operation of a basic machine such as DC machine which will facilitate thorough understanding of other machines (Minal & Javeed, 2017) [16]. Colleges of Education Institution have used laboratory session to achieve this purpose.

However, these Lab are designed for students in accordance to theoretical course work where understanding of the concept of Power and Machines become a great challenge.

Also, requirement such as cost, space, limited equipment access, equipment size, safety and students' supervision has become a serious problem. Due to abstract, dynamic, and large content nature of the course, the students generally reflect that this course is miscellaneous, inscrutable in content, and difficult to learn. Therefore, they develop less interest in the course leading to poor academic performance of the students (Belu, 2013) [4]. Based on these challenges, the researcher intends to test the effect of Web-based multimedia in teaching Electrical Power and Machines in Colleges of Education. Web-based multimedia is a form of web-based learning which allows learners to access the course materials in all the ties and space they reach the internet and establish synchronous communication with rest of the learners (Lilis, 2022) [15]. The nature of interactivity and discovery in web-based multimedia learning bear a boost to monotony of passive learning bounded by the space of the teacher. Learners in web-based learning environment learn according to their ability. Web-based multimedia learning support the use of animation for abstract topic and enable learners be active in their learning and construct their difficult concept more easily (Babiker, 2015) [3].

The implication of using lecture method in teaching electrical power and machines is that the flexibility of such learning environment is restricted and students are confined to the pace of the teacher making it difficult to learn at their own pace. Also, since only word or static picture are used to describe the dynamic nature of the course, students are unable to understand some abstract concept and visualize important phenomena and ideas in electrical machines thereby leading to poor performance (Ogbuanya & Owodunni, 2015) [19]. Due to these shortcomings the researcher intends to test the effect of web-based multimedia package in teaching electrical power and machine.

According to Abu-Ziden & Abdulraham (2013) [1] multimedia is a combination of two or more elements which include text, graphics, audio, video or animation. Multimedia is a broad term generally referring to a combination of multiples elements, such as text, audio, video, images, graphics, animation and sometimes interactive (Clement, Jerry, & Etim, 2018) [6]. With the combination of multimedia elements in a lesson, teachers can create a learning environment that is full of audio-visual presentation which does not only attract and stimulate students' sense in the learning but also treat a variety of learning style of students.

1.2. Statement of the problem

Electrical and Electronic Technology in Technical and Vocational education (TVE) programs in Nigeria has suffered insufficient, and non-functional supply of material resources such as tools, equipment, and laboratory equipment along with less competent human resources to impact the concept of electrical power and Machines in the learners (Chukwuedo & Omofonmwan, 2013) [5]. These have limited the extent of students' achievement in Electrical Power and Machines because the school system lays more emphasis on the traditional classroom setting, which eventually leads to poor performance (Belu, 2013) [4]. However, poor teaching method is one of the major factors influencing poor performance and retention (Gambari, Falode, & Adegbenro, 2014) [11]. Lecture method involves a verbal presentation of ideas, concepts, and facts. The Practice in this method is that of spoon-feeding the learners with information or facts. The students remain passive in receiving information from their teacher (Omoren in (Onweh & Akpan, 2014) [20] Based on this: the researcher intend to investigate the effect of web-based multimedia on students' academic performance in Electrical Power and Machines in College of Education in North –East Nigeria.

1.3. Purpose of the study

The main purpose of the study is to ascertain the effect of web-based multimedia package on students' academic performance in Electrical Power and Machines. Specifically, the study sought to:

1. Determine the pre-test mean difference of students taught Electrical Power and Machines using Web-based multimedia package and lecture method in College of Education in North-East Nigeria.
2. Determine the pre-test and post-test mean difference of students taught Electrical Power and Machines using Web-based multimedia package and lecture method in College of Education in North-East Nigeria.
3. Determine the post-test mean difference of students taught Electrical Power and Machines using Web-based multimedia package and lecture method in College of Education in North-East Nigeria.
4. Determine the pre-test and post-test mean gain between experimental and control groups.

1.4. Research Questions

1. What is the pre-test mean difference of students taught Electrical Power and Machines using Web-based multimedia package and lecture method in Colleges of Education in North-East Nigeria.
2. What is the pre-test and post-test mean difference of students taught Electrical Power and Machines using Web-based multimedia package and lecture method in Colleges of Education in North-East Nigeria.
3. What is the post-test mean difference of students taught Electrical Power and Machines using Web-based multimedia package and lecture method in College of Education in North-East Nigeria.
4. What is the pre-test and post-test mean gain between experimental and control groups.

1.5. Research Hypotheses

The following hypotheses are set to guide the study at 0.95 confidence level

1. There is no significant difference in the pre-test mean difference of students taught Electrical Power and Machines using Web-based multimedia package and lecture method in College of Education in North-East Nigeria
2. There is no significant difference in the pre-test and post-test mean difference of students taught Electrical Power and Machines using Web-based multimedia package and lecture method in College of Education in North-East Nigeria
3. There is no significant difference in the post-test mean difference of students taught Electrical Power and Machines using Web-based multimedia package and lecture method in College of Education in North-East Nigeria.
4. There is no significant difference in the pre-test and post-test mean gain between experimental and control groups

1.6. Scope of the Study
The research is limited to use of web-based multimedia package to teach students in electrical power and machines in Colleges of Education (technical) in the North- east Nigeria. The study is restricted to all the NCE III students of Colleges of Education in North east, Nigeria.

1.7. Significance of the Study
The result of this study will be of benefit to all the stakeholders in the education system which includes National Commission for Colleges of Education (NCCE), teachers, parents, ministry, Government, students of electrical/electronic technology, curriculum planners, the school administrators, the state and researchers. The study will benefit teachers of electrical/electronic technology to teach those abstract and dynamic subjects which will enhance the students' academic achievement. The teachers will also use the identified teaching method for improving skill acquisition thereby reducing unnecessary stress. The teacher in collaboration with school administrators will adopt whichever teaching method that is found to be more effective in instructional process in stimulating and sustaining students' interest and to evaluate the students' performance both within and outside the Colleges.

3. Research Methodology
3.1. Research Design
This study was a quasi-experimental pre-test and Post-test design. This is because the non-equivalent intact classes of subjects were involved. Quasi-experiment is an experiment where randomization of subject of experimental and control groups is not possible. The researcher randomly assigned intact classes to experimental and control groups. This was necessary in order not to disrupt the normal classes of the students and the school time-table. The subjects were grouped together into classes for the purpose of instruction

3.2. Area of the Study
This study was conducted in North east Nigeria which comprised of Gombe, Bauchi, Yobe, Adamawa, Taraba, and Borno states. The area covers six states in North East Nigeria. North east Nigeria is 9.082 Latitude and 8.6753 Longitude. Adamawa state share national border with Cameroon. Borno state shares national borders with Niger Republic to the North, Cameroon to the East, and Chad to the north east. Yobe share national border with Niger Republic to the north.

3.3. Population for the Study
The population for this study consisted of 146 NCE III students in the four Colleges of Education offering electrical power and machines in Gombe, Yobe, Bauchi, and Taraba. The distribution of NCE III students by institution and location is as seen in table 2.

Table 1: Population Distribution of NCE III Students by Institution

Name of institution	Number of NCE III students
FCE(T) Gombe	74
FCE(T) Potiskum	46
COE Bauchi	30
COE Hong	35
Population	185

***Source*:** Academic record 2022/2023 session

3.4. Sample and Sampling Technique
The study sample consisted of two Colleges of Education randomly selected from the four Colleges of Education in Gombe, Yobe, Bauchi, and Taraba states that offer electrical power and machines. The two Colleges of Education are: Federal College of Education (tech), Gombe and Federal College of Education (tech). The two Colleges of Education selected were randomly assigned to control and experimental groups. Therefore, the sample consisted of 106 students from two out of the four Colleges of Education offering electrical power and machines in Gombe, Yobe, Bauchi, and Taraba States in North east of Nigeria.

Table 2: Sample distribution by groups

S/N	Institution	Number of students	Group
1	Federal College of Education (tech) Gombe	74	Experimental
2	Federal College of Education (tech) Potiskum	46	Control
	Total	120	

***Source*:** Academic record 2022/2023 session

3.5. Instruments for Data Collection
The data was collected by means of an instrument called "Electrical Power and Machines Achievement Test" (EPMAT) which was developed by the researcher. The instrument is a paper and pencil60-items test with four options (A-D) multiple choice objective tests based on NCCE (2012) [18] curriculum.

3.6. Validation of the Instruments
The instrument, Electrical Power and Machine Achievement test (EPMAT) was validated by two (2) experts. One, from the department of Vocational Technology Education, ATBU Bauchi and the other from Federal College of Education (T) Gombe. They established whether the items were strictly in line with the table of specification to ensure that: (i) questions were set from all parts of the topics; (ii) the number of questions set in each section reflects the relative importance of each section.

3.7. Reliability of the Instruments
The reliability of the instrument (EPMAT) was determined by administering EPMAT on a trial of intact class testing of 45 NCE III electrical/electronic students from Federal College of Education Pankshin, Plateau state. A test-retest method was used to calculate the reliability using Pearson Product Moment Correlation formula. After six weeks interval the same instrument was re-administered on the same students in their intact class.The reliability co-efficient of 0.791 was obtained using the SPSS statistical package.

3.8. Treatment
Electrical power and machine taught using web-based multimedia package. The researcher used the teaching and learning environment of you tube to upload course materials into the proposed website. The website was designed in accordance to the way the lesson will be presented with instructions linking to the multimedia materials in the site for

easy understanding. You tube core code was downloaded from http://youtube.com.A public domain name registered for the site waswww.adeniyitaye.com. This domain name is then used for pointing to the local server, while the local server was used as a gateway to the remote server. The researcher then uploaded resources like electrical generator animation, electrical motor animation and electrical power system animation into the site.

The study was conducted during the normal school lesson period after the permission to conduct the study had been obtained from the college authorities. Research assistant from electrical/electronic technology department was given one-week training on how to use the website to teach electrical power and machines before. The two Colleges of Education randomly sampled were randomly assigned experimental group, and Control group. Experimental group (Federal College of Education (tech), Gombe) was taught electrical power and machines using the web-based. The control group (Federal College of Education Potiskum) was taught electrical power and machines using lecture method. The two groups were taught eight topics in electrical power and machine. The two groups were then subjected to a pre-test and post-test. The results of the pre-test and post-test was used for analysis.

3.9. Method of data collection

The researcher administered the instrument (EPMAT) to the students with the help of two trained research assistants. The research assistants were given instructions on how to administer the test. The copies of the test were collected by the research assistants and researcher as soon as the students completed the test.

3.10. Method of Data Analysis

The research questions were analyzed using the mean and standard deviation while the hypotheses were tested at 0.05 level of significance using t –test. According to Sambo t-test is a parametric statistic used to test significance of difference between two population means when the sample size is equal or greater than 30. The inference was drawn and conclusion and recommendation was made.

3.11. Decision Rule

In testing the hypotheses for research questions 1-4, the value of $\alpha = 0.05$ level of significant is chosen. The SPSS package was used for the analysis. Therefore, the following assumptions were considered as the decision rule;

1. The research will reject the null hypotheses when the P-value is less than αat 0.05 level of significance.
2. The research will accept the null hypotheses when the P-value is greater than αat 0.05 level of significance.

Result and Discussion

Data collected were analyzed using the appropriate descriptive and inferential statistics of the statistical Package for the Social Sciences Programme (SPSS version 23). The results of the analysis are presented according to the order of the research questions and hypotheses that guided the study. The research questions were answered and hypotheses tested for proper inferences.

4.2. Results and Analysis

4.2.1. Research Question One

What is the pre-test mean difference of the students taught electrical power and machines using the lecture method and those taught using web-based multimedia package in Colleges of Education in North east Nigeria?

Table 3: Mean and Standard deviation of the Experimental and control groups' performance in pre-test

Groups	N	Pre-test mean	SD Mean diff
Experimental	74	20.23	3.869
			0.07
Control	46	20.16	4.612

***Source*:** 2022/2023 Field work

Table 5 present the result of research question one. The result shows that the Experimental group (students taught using web-based multimedia package) had a mean score of 20.23 in the pre-test with standard deviation of 3.869 while the control group (students taught using lecture method) had a mean score of 20.16 in the pre-test with standard deviation of 4.612. The result shows that the pre-test mean of both groups are almost equal.

4.2.2. Research Question Two

What is the pre-test and post-test mean difference of students taught electrical power and machine using web-based multimedia package in Colleges of Education in North east Nigeria?

Table 4: Mean and Standard Deviation of the Experimental Group's Performance in Pre-test and Post-test

Experimental Group	N	Mean	SD Mean diff
Post-test	74	50.86	8.150
			30.63
Pre-test	74	20.23	3.869

***Source*:** 2022/2023 Field work

Table 6 present the results of research question two. The result shows that the Experimental group (students taught using web-based multimedia package) had a mean score of 50.86 in the post-test with standard deviation of 8.150 and a mean score of 20.23 in the pre-test with the standard deviation of 3.869 The mean difference is 30.63.

4.2.3. Research Question Three

What is the post –test mean difference of students taught electrical power and machines using web-based multimedia package and those taught using lecture method in Colleges of Education in North east Nigeria?.

Table 5: Mean and standard deviation of the experimental and control groups' performance in Post-test

Groups	N	Post-test mean	SD Mean diff
Experimental	74	50.86	8.150
			29.13
Control	46	21.73	3.672

***Source*:** 2022/2023 Field work

Table 7 present the results of research question three. The result shows that the Experimental group (students taught using web-based multimedia package) had a mean score of 50.6 in the post- test with standard deviation of 8.150 and the control group (students taught using lecture method) had a mean of 21.73 with standard deviation of 3.672. The mean difference is 29.13 with this result, it can be seen that the effect of the treatment on the experimental group is higher

than that of the control group.

What is the pre-test and post-test mean gain between experimental and control group?.

4.2.4. Research Question four

Table 6: Mean gain and Standard Deviation of the Experimental and Control groups' Performance in Pre-test and Post-test

Group	N	Pre-test	Post-test	
		Mean SD	Mean SD	Mean Gain
Experimental	74	20.23	50.86	30.63
		3.869	8.150	
Control	46	20.16	21.73	1.57
		4.612	3.672	

Source: 2022/2023 Field work

Table 8 shows the result of research question four. The result shows that the experimental group had a mean score of 20.23 in the pre-test and a mean of score of 50.86 in the post-test making a pre-test, post-test mean gain in experimental group to be 30.63 The control group had a mean score of 20.16 in the pre-test and a post-test mean of 21.73 with a pre-test, post-test mean gain of 1.57. With this result, the students in the experimental group performed better in the achievement test than the students in the control group. Hence, web-based multimedia package is effective than the lecture teaching method on students' achievement in Electrical Power and Machines.

4.3. Test of Hypotheses

4.3.1. Hypothesis One (H_{01})

There is no significant difference in the pre-test mean of the students taught electrical power and machine using lecture method and those taught using web-based multimedia package in Colleges of Education in North east Nigeria.

Table 7: T-test Analysis for Students' Pre-test Scores for Experimental and Control group

Groups	N	Mean	SD	*Df*	t-value	P-value
Experimental	74	20.23	3.869	118	0.316	0.610
Control	46	20.16	4.612			

p=0.789 >0.05 the null hypothesis is accepted

Table 9 shows the result obtained when an independent sample t-test was run between the experimental and the control group at pre-test. The result shows there is no meaningful difference in the achievement scores between control and experimental groups prior to the study. Testing at an alpha level of 0.05 [t $(_{118})$ =0.316, p=0.610 >0.05]. The null hypothesis which states that there is no significant difference in the pre-test mean of the students taught electrical power and machine using lecture method and those taught using web-based multimedia package in Colleges of Education in North east Nigeria was retained.

4.3.2. Hypothesis Two (H_{02})

There is no significant difference in the post-test and pre-test mean difference of students taught electrical power and machines using web-based multimedia package in Colleges of Education in North east Nigeria.

Table 8: T-test Analysis for Students' Post-test and Pre-test Scores for Experimental Group

Experimental Group	N	Mean	SD	D*f*	t-value	P-value
Post-test	74	50.86	8.150	147	-20.542	0.000
Pre-test	74	20.23	3.86			

P=0.000 <0.05 the null hypothesis is rejected

Table 10 shows the result obtained through a paired sample t-test between pre-test and post-test score of experimental groups. Testing at an alpha level of 0.05 [t (147) = -20.542; p = 0.000 <0.05]. Therefore, the null hypothesis which state there is no significant difference in the post-test and pre-test mean difference of students taught electrical power and machines using web-based multimedia package in Colleges of Education in North east Nigeria is rejected.

4.3.3. Hypothesis Three (H_{03})

There is no significant difference in the post-test mean of students taught electrical power and machines using web-based multimedia package and those that will be taught using lecture method in Colleges of Education in North east Nigeria.

Table 9: T-test Analysis for Students' Post-test Scores (after treatment) for Experimental and Control Group

Group	N	Mean	SD	D*f*	t-value	P-value
Experimental	74	50.86	8.150	118	23.014	0.012
Control	46	21.73	3.672			

p = 0.000 <0.05 the null hypothesis is rejected

Table 11 shows the result obtained when an independent sample t-test was run between the post-test and pre-test of the experimental group. Testing at an alpha level of 0.05 [t (118) = 23.014, p = 0.012 <0.05]. Therefore, the null hypothesis which state that there is no significant difference in the post-test mean of students taught electrical power and machines using web-based multimedia package and those taught using lecture method in Colleges of Education in North east Nigeria is rejected.

4.3.4. Hypothesis Four (H_{04})

There is no significant difference in the pre-test and post-test mean gain between experimental and control groups.

Table 10: T-test Analysis for Students' Difference in Pre-test and Post-test Mean Gain between Experimental and Control groups

Groups	N	Pre-test Mean	Post-test Mean	Mean gain	D*f*	t-value	P-value
Experimental	74	20.23	50.86	30.63	118	22.038	0.000
Control	46	20.16	21.73	1.57			

p = 0.000 <0.05 the null hypothesis is rejected

Table 12 shows the result obtained when an independent sample t-test was run between the mean gain of the experimental and control group. Testing at an alpha level of 0.05 [t (118) = 22.038, p = 0.000 <0.05]. Therefore, the null hypothesis which state there is no significant difference in the pre-test and post-test mean gain between experimental and control groups is rejected.

4.4. Findings of the study

The main purpose of this study was to find out the effect of web-based multimedia package on students' academic performance in Electrical Power and machines. Specifically, the study made the following findings.

1. There is no significant difference in the pre-test mean achievement of students taught Electrical Power and Machine using web-based multimedia package (experimental) and those taught using lecture method (control).
2. There is significant difference in the mean achievement of the post-test and pre-test of the experimental group, with the post-test higher than the pre-test mean achievement
3. There is a significant difference in the post-test mean achievement of the experimental and control group, with the experimental group having a higher mean achievement over the control group.
4. There is a significant difference in the mean achievement gain of the experimental group and control group, with the experimental group having a higher mean achievement gain over the control group.

4.5. Discussions of findings

The findings of this study were discussed in relation to the available literature reviewed based on the research questions and the hypotheses. The study had four objectives, four research questions and four hypotheses.

Data collected to answer research question one showed that the pre-test of the two groups, that is, the experimental and control group have almost the same mean. This finding was in agreement with the findings of Aloranini (2012) [2] whose research findings indicated that both groups have the same entry level, this in turn proves the equivalence of the two groups at pre-test.. This study is also consistent with the study by DwiSurjono (2015) [9] who find out that there is no difference in the pre-test mean of the experimental and control group. Sudha and Amutha (2015) [22] also have the same result

The study also found that the post-test mean score of experimental group is higher than pre-test mean score. The students performed better in the post-test than in the pre-test in the experimental group, which revealed the effect of the treatment. This result is similar to Kaur and Kaur (2017) [13] who concluded that students achieved higher when taught through web-based instructional strategy as compare to their counterparts. De Sousa, Richter and Nel (2017) [8] affirmed that using various multimedia combinations can address the unique nature of social sciences effectively. Also, Sudha and Amutha (2015) [22] revealed that there was significant mean difference between the achievement of pre-test and post-test scores using web-based instructional method since it provides multisensory experience to the students. The hypothesis two which state that There is no significant difference in the post-test and pre-test mean difference of students taught electrical power and machines using web-based multimedia package in Colleges of Education in North east Nigeria, was rejected, Since the P=0.00<0.05. This work is similar to the work of who concluded that there is meaningful difference in favour of the experimental group on the academic achievement in pre-test/post-test. Kim, Shin, and Jung (2005) [14] also ascertained that web-based multimedia contents maximizes the effectiveness of teaching process, just like Mi-Ra (2005) [17] concluded that web-based learning was found to be effective in nursing practice, student satisfaction and knowledge.

Findings from the study also revealed that there is difference between the post-test of the experimental (students taught using web-based multimedia) and the control (students taught using lecture method). It was found that students in the experimental group performed better in the post-test than the students in the control group. The finding is similar to who suggests that an increased level of effort using the tool provided in the online program can statistically improve exam scores. Expressed that web-based instruction does not only increase cognitive and psychomotor learning but also extended an excellent pedagogical platform. The hypothesis three which state that there is no significant difference in the post-test mean of experimental group (students taught electrical power and machines using web-based multimedia package) and control group (students taught using lecture method), was rejected. Since p=0.000<0.05, the null hypothesis is rejected. A parallel study by Abu Ziden (2013) [1] agrees that the use of web-based virtual simulation help students to increase their achievement in a topic of pilgrimage. Conducted a study title 'Comparative Study of Lecture-Based and Multimedia-Based Training Method on the Second Year Students Competency in General Electronics Course in the Technical and Vocational School'. The results indicated that the electronic functional skills

training score on multimedia-based group was significantly higher than lecture-based group. The result is supported by Dehghanpour and Hashemian (2015) [7]. Also Ilhan and Oruç (2016) [12] confirmed the result. Based on data collected, the study reveals that using Web-based Multimedia Package has direct effect in improving students' achievement in Electrical Power and Machines in Colleges of Education in North-East Nigeria. All the hypothesis tested show a significant difference in the mean achievement between the experimental group and control group at post-test, and between the post-test and pre-test of the experimental group with exception of the hypothesis one which is mainly aimed at testing the student entry level at pre-test between the group prior to starting the experiment.

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