

Research Article

Effect of Electronics Workbench Software Utilization on Technical College Student's Academic Performance in Electronics Devices and Circuits in Bauchi State

Kabiru Muhammad^{1*}, Hashimu Hamisu Umar²

¹Dept. of Vocational and Technology Education, Abubakar Tafawa Balewa University Bauchi, Nigeria

²Science Education Department, Faculty of Education, Federal University Lokoja, Lokoja, Nigeria

Corresponding Author: kabirumkabir@gmail.com

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Abstract — This study determined the Effect of Electronics Workbench Software Utilization on Technical College Students' Academic Performance in Electronics Devices and Circuits in Bauchi State. To achieve this, four specific objectives, four research questions and four null hypotheses were tested to guide the study. Quasi-experimental design involving pre-test and post-test was used as the design of the study. The area of the study was Bauchi State of Nigeria. The population of the study comprised of 92 NTC II technical colleges students that are offering Electronics Devices and Circuits. A purposive sampling technique was used in selecting two colleges from the eight technical colleges. 92 students from two intact classes were assigned in to experimental and control groups. The research instruments captioned Electronics Devices and Circuits Performance Test (EDCPT) adopted from NABTEB past questions related to the topics taught was used in the study and the instrument was validated by three experts. The reliability coefficient of 0.81 was obtained using test retest method. The data collected for the research questions were analyzed using mean and standard deviation while, the null hypotheses were tested using t-test at 0.05 level of significant. The findings revealed that, students taught Electronics Devices and Circuits using electronic workbench software outperformed those taught using conventional method, this shows that electronics workbench software can be used to compliment the use of real practical facilities in constructing electronics circuits in Bauchi state technical colleges. The study recommended amongst others that Government should intensify effort at providing instructional material required by Electronics Devices and Circuits teachers to deliver what is expected of them in electronics circuit's construction to avoid the syndrome of leaving and or skipping some part of the curriculum. The study further recommended among others that, Ministry of Education should hesitate to fully introduce and implement the use of computer-aided instructions in Bauchi state technical colleges and beyond to enhance quality teaching and learning of electronic circuit's construction.

Keywords— Academic Performance, Technical College, Devices, Electronics Workbench Software, Utilization and Effect

1. Introduction

The application and important of technological devices and Information Communication Technology (ICT) in the 21st century business and non-business sector especially the education sector cannot be over emphasized. With the application of ICT, Electronics Circuits Devices and Circuits students can be motivated and achieve better academic performance. "Ref. [1]" suggests that teachers who move away from traditional learning environment to new learning environment promote active learning, higher level thinking, collaborative and multisensory stimulation. In the light of this development, the priority for the technological impact in today's service delivery especially in technical colleges cannot be over emphasized. Considering the fact that work and activity management in practical, scientific experimentation, and other related study, physical conducts

requires a greater inducement of technological know-how and practices [2]. Today, there are rising concerned to the use of ICT in education (Technical Colleges) as instructional medium in addition to its application in management and administration. The use of ICT as an instructional strategy have been described in various forms such as Computer-Based Learning (CBL), Computer-Enhanced Learning (CEL), Computer-Based Instruction (CBI), Computer-Aided Instruction (CAI), Computer-Aided Learning (CAL) and Computer-Assisted Instruction (CAI). Among these, CAI has been ended up being successful and beneficial instructional approach for boosting interest, uplifting mentality, building up students' retention capacity and boosting the students' performance [3]. The use of ICT in teaching and learning covers all levels of education [4]. This assertion involved it application to teaching and learning Electronics Devices and Circuits in Bauchi state Technical Colleges.

Technical College is one of the educational institutions that are meant to provide technical education in various forms that include but not limited to radio/television and electronics work, refrigeration and air conditioning, electrical installation and maintenance work, carpentry and joinery, welding and fabrication work among others [5]. Technical education provides work-based skills apart from academic skills namely; creativity, problem solving, collaborative and high order thinking skills so as to increase students' flexibility and job mobility. It is based on that the content of the training in the technical college programme is 40% theory and 60% practical [6]. Radio, television and electronics work (RTVE) is one of the trades offered in technical colleges which aimed at providing the necessary skills leading to the production of craftsmen and women, technicians and other skilled personnel who will be enterprising and self-reliant. RTVE comprise four modules (subject) namely: electronics devices and circuits, radio communication, satellite transmission and reception [7]. Despite the fact that electronic workbench software gained acceptance in to teaching and learning, its application in Nigerian technical colleges especially Bauchi State Technical Colleges is not well defined. The use of technology in either software or hardware deemed necessary in electronics devices and circuit, considering the skill acquisition requirement of the subject. The use of software application in teaching and learning RTVE involves both theory and practical and the importance of using software application in teaching and learning RTVE need not to be over emphasized. Software such as Electronic Workbench (EWB) and others may enhance students learning outcomes in both theory and practical [8].

Electronics Workbench (EWB) is software from Interactive Image Technology Ltd. EWB is a simulation package for electronic circuits. It allows you to design and analyze circuits without using breadboards, real components or actual instruments. In the EWB there are a number of tools that can be applied in manufacturing digital electric circuits system [9]. EWB is a simulation package for circuit. EWB is type of electronic software used to simulate the workings of an electrical/electronic circuit. The need for electrical circuit simulation is to test whether the electrical/electronic circuit that can be run properly and in accordance with the theoretical approach used in electronic books, without having to make it a real electrical/electronic circuit. The need for electrical/electronic circuit simulation is to test whether the electrical/electronic circuit that can be run properly and in accordance with the theoretical approach used in electronic books, without having to make it a real electric circuit. EWB consists of a Menu, Reference, Sources, Basic, Diodes, Transistors, Analog ICs, Mixed ICs, Digital ICs, Indicators, and many more menus contained on the software [10]. Menu source include battery, AC voltage source, Vcc source, and FM source. Keep in mind, simulations done using EWB is a simulation that produces output that is ideal. The output is not affected by factors such as interference (known as noise in electronics) as well as the disruption that often occurs in the electrical/electronic circuit real practical. Via EWB an experiment can be carried out repeatedly without damaging or wasting of components and circuits accessories. In addition,

these can equally save cost of purchasing of electronics components and accessories, it also allows learner to conducts experiment with some level of safety and interest [11]. Electronics Workbench is one of the electronics software that can be used to simulate electronics circuits. By using this software, electronics devices and circuit students can learn to assemble electronics circuits and perform virtual simulations with animations that look attractive and provide an overview of the performance of electrical circuits [12]. It means using this software; electronics devices and circuit students do not need to buy the components needed to assemble electrical circuits and can reduce the occurrence of errors when assembling electrical circuits. The use of this software is very easy and practical; all of its components are displayed on the workspace in the form of symbols and classified according to their type [13]. Electronics Workbench is able to visualize the basic concepts of the electronics world. The use of EWB software can improve students' academic performance [14].

Academic performance generally means how learners (students) accomplished their tasks and studies, but teaching and learning strategy employed by a teacher determine the level of students' academic performance. In educational institutions like technical colleges, success is measured by student's academic performance, or how well a student meets standards set out by institutions. Although, education is not the only road to success in the working world, effort is made to identify, evaluate and encourage the progress of students in college subjects [15]. The purpose of academic performance is to achieve educational goals after learning. In this regard there are several components of the complex unit called performance. They are learning processes promoted by the school that involve the transformation of a given state, into a new state, and they are achieved with the integrity in a different unit with cognitive and structural elements [16]. The study investigated the Effect of Electronics Workbench Software Utilization on Technical College Students' Academic Performance in Electronics Devices and Circuits in Bauchi State, Nigeria.

1.1 Problem Statement

The rate of increase in unemployment in Nigeria, especially Bauchi State required educational institutions to employed students-centered instructional pedagogy in Teaching and learning for effective acquisition of practical skills in Electronics Devices and Circuit. Graduates of technical colleges in Nigeria are expected to have acquired adequate knowledge and skills necessary for effective performance in the workplace [17]. This assertion includes Bauchi State. Curriculum has stipulated that the teaching and learning of trade courses including electronic devices and circuits in RTVE to be more preferably expose the students to acquired skills. This is how students can perform in their practical examination. In furtherance, students' performance in Electronics Device and Circuit is quite discouraging. This cannot be unconnected to the state of practical skill acquisition in the course of teaching and learning in the technical colleges. The above observation has been supported by other researchers like [18] who buttressed that inadequacy

of facilities both qualitative and quantitative has put the learners and the teachers at a disadvantage.

The use of electronic workbench software has gained acceptance in most part of the world including tertiary institution in Nigeria, but is still not well defined in Bauchi State technical colleges which may be because the Electronics Devices and Circuit teacher are not aware of it numerous advantages. Despite all the advantages of EWB software in enhancing students learning outcomes, its effects in improving Electronics Devices and Circuit students' performance at Bauchi State technical colleges is yet to be ascertain in the literature. It is based on this background that this study investigated the Effect of Electronics Workbench Software Utilization on Technical College Students' Academic Performance in Electronics Devices and Circuits in Bauchi State, Nigeria to provide empirical data for relevant stakeholders in the education sector for prompt action.

1.2 Purpose of the Study

The purpose of this study is to determine the Effect of Electronics Workbench Software Utilization on Technical College Students' Academic Performance in Electronics Devices and Circuits in Bauchi State. Specifically, this study sought to;

- 1) Determine the difference between pre-test mean performance scores of students in experimental and control groups in Electronic Devices and Circuits;
- 2) Investigate the difference effect of pre-test and post-test mean performance scores of students in experimental group taught Electronic Devices and Circuits using electronics workbench software as a treatment;
- 3) Find out the difference effect of students' mean performance scores of experimental and control group in Electronic Devices and Circuits; and
- 4) Ascertain the difference effect of students' mean performance score of pre-test and post-test of control group in Electronic Devices and Circuits.

1.3 Research Questions

The study answered the following questions;

- 1) What is the difference between pre-test mean performance scores of students in experimental and control groups in Electronics Devices and Circuits?
- 2) What is the differential effect of pre-test and post-test mean performance scores of students in experimental group taught Electronic Devices and Circuits using electronics workbench software as a treatment?
- 3) What is the differential effect of students' mean performance scores of experimental and control group in Electronic Devices and Circuits?
- 4) What is the differential effect of students' mean performance score of pretest and posttest of control group in Electronic Devices and Circuits?

1.4 Research Hypotheses

The following null hypotheses were tested at 0.05 alpha levels.

H₀₁ There is no significant difference between pre-test mean performance scores of students in

experimental and control groups in Electronic Devices and Circuits.

H₀₂ There is no significant difference between pre-test and post-test mean performance scores of students in experimental group taught Electronic Devices and Circuits using electronics workbench software as a treatment.

H₀₃ There is no significant difference between post-test students' mean performance scores of experimental and control groups in Electronic Devices and Circuits.

H₀₄ There is no significant between students' mean performance score of pre-test and post-test of control group in Electronic Devices and Circuits.

1.5 Significance of the Study

This study would be of immense importance to the following:
Students: The research would be used in classroom to help the students to perform better in their studies, improve the application of electronic circuits and also improve the application of electronics in the field of work in line with global practice.

Teachers: The study would also ease teaching, guide and facilitate the learning process.

Curriculum planners: Moreover, the study would also be important to curriculum planners by enabling them considering electronics workbench software in Electronics Devices and Circuits when designing curriculum.

Government: This research work would enable the government to determine how effective the use of electronics workbench software in teaching Electronics Devices and Circuit. The success of teaching Electronics Devices and Circuits using electronics workbench software would help the government in determining whether to introduce and deploy the software in various technical colleges of Nigeria.

Future Researches: This research work would serve as a source of data for enhancing future related researches. It would also be useful for the researchers as a basis for further researches and also be used for reference purposes as well as in theory building and testing.

1.6 Scope of the Study

The study was delimited to the effect of electronics workbench software utilization on technical college students' academic performance in electronic circuit's constructions in Bauchi State technical colleges. The independent variable in this study is electronics workbench software while, the dependent variable is technical college students' academic performance in Electronics Devices Circuits. Therefore, the content for the instrument were selected from the approved National Board for Technical Education (NBTE) Electronics Devices and Circuits syllabus for National Technical Certificate two (NTC II) by the National Board for Technical Education [19]. The content area covered in Electronics Devices and Circuits include the following sub-topics: Astable Multivibrator, Simple Transistor Amplifier and Power Supply. These contents served as basis for measuring academic performance in Electronics Devices and Circuit before (pre-test) and after (post-test) instruction in electronic workbench as the performance test.

2. Related Work

A study by Sylvester [20] on the effects of Computer Assisted Instructional (CAI) Package on senior secondary school students' achievement in Mathematics: A post-Covid Sustainable Development in Nigeria. The main aim of the study was to investigate effects of Computer Assisted Instructional (CAI) Package on senior secondary school students' achievement in Mathematics: A post-Covid Sustainable Development in Nigeria. Two specific objectives, two research questions and two null hypotheses was used to guide the study. The research design adopted was quasi-experimental. The target population of the study consisted of all senior secondary school two students in public secondary schools in Federal Capital Territory Abuja. The findings among others revealed that students taught mathematics using Computer Assisted Instructional (CAI) Package achieved more than that taught mathematics using the conventional method of teaching. The study concluded by recommending that the use of CAI enhances Achievement of Students in Mathematics especially during post COVID era; therefore, teachers should be discouraged from the use of conventional method of teaching Mathematics but rather to embrace teaching Mathematics using Computer Assisted Instructional (CAI) package.

According to Onyedineke and Mangut [21] who conducted study on the effects of computer-mediated instruction (CMI) on physics student-teachers' misconceptions and achievement in Federal Colleges of Education, South-South Zone, Nigeria. Considering the research topic, three (3) specific objectives were drawn and in line with each specific objective, three (3) research questions and three (3) null hypotheses were formulated. The research design adopted was experimental design, the study population comprised 51 second year physics combination student-teachers. The findings showed that Physics students hold a number of misconceptions on Mechanics and Properties of Matter II. Results equally revealed that CMI can improve students' achievement in Mechanics and Properties of Matter II and can also reduce their misconceptions in the course. Based on findings, Physics lecturers should effectively utilize computer-mediated instruction approach in correcting students' misconceptions and enhancing their academic achievements in physics courses.

"Ref. [22]" conducted a research on, the added value of integrating the electronics workbench simulator in the teaching of electrical concepts to Moroccan High school students. The paramount objective of this study is to highlight the effect of using the Electronics Workbench (EWB) simulator in the study of amplitude modulation and demodulation on the learning of students. Three (3) specific objectives were drawn and three (3) research questions and three (3) null hypotheses were formulated. The research design adopted was mix methods which combine both qualitative and quantitative on the same study. The population for the study comprised of all 50 Moroccan students in the second year of the scientific baccalaureate option physical sciences at the high school Abdellah Laroui

of the city of Fez. The results obtained, in this study, show that the students are very motivated to use the simulator in the process of learning the concepts of electricity, it cannot replace the laboratory experiments. Also (72%) of the students interviewed feel that Electronics Workbench (EWB) simulator can help to understand the concepts of electricity and 98% of the students say that Electronics Workbench (EWB) simulator is a complementary tool to real experiments.

According to Mafudi and Handhika [23] who also carried out study on Virtual laboratory: Using Electronic Workbench as Alternative to Learning Physics in COVID-19 Mass Pandemic. The main purpose of the research is to describe the use of assisted virtual laboratories of Electronic Workbench (EWB) in physics experiments learning. Three (3) specific objectives, three (3) research questions and one (2) null hypothesis. The research design adopted was the quasi-experimental design. The population of the study comprised of all (NTC III) Radio Television and Electronic Work students with the population of eight hundred and twenty (820) students. Findings of the study showed a significant difference in the mean performance score of students taught using multimedia instructional strategies and students taught with lecture method of instruction.

A study by Islahudin [24] on the design of work instruction (WI) electronic workbench-assisted electrical measuring devices to improve the internship concept of students in basic electronic II course. The main objective of the study was to determine the extent of the influence of the design of WI electronics workbench-assisted electrical measuring device on improving of the internship skill of students in basic electronics II course. The study was guided by three research objectives, three research question and three null hypotheses. Quasi-experimental research design was employ for the study and the study was conducted in Indonesia. The population of the research were all physics student Faculty of Training Teacher and Education University of Muhammadiyah Mataram. Findings of the study shown that there is a significant influence on the use of the design of work instruction (WI) electronic workbench-assisted electrical measuring device on improving the internship concept of students in Basic Electronic II course.

"Ref. [25]" conducted a research on effect of computer assisted instruction on the academic performance of technical college students in electrical installation and maintenance work in Enugu State. the study was designed to investigate effect of computer-assisted instruction on the academic performance of students in Electrical Installation and Maintenance Work in technical colleges. Considering the research topic, three (3) specific objectives were drawn and in line with each specific objective, three (3) research questions and three (3) null hypotheses were formulated. Quasi experimental research design consisting of non-equivalent control group and experimental group was adopted for the study, the population of the study consisted of four hundred (400) NTC II students (347 males and 53 females) in the twenty-one technical colleges in Enugu State. The findings

showed that CAI significantly impacted the students' academic performance. It was recommended among others that CAI should be formally adopted in technical colleges, secondary and vocational schools for instruction in Electrical Installation and Maintenance Work to improve academic performance of students.

"Ref. [26]" carried out a study on the Effect of computer aided instruction on students' interest in selected topics in electronic libraries course in federal tertiary institutions in Anambra State, Nigeria. The study was guided by two specific objectives, two research questions and three null hypotheses. The study employed a quasi-experimental research design implemented by a pre-test post-test control group containing intact non-equivalent groups of students (30) thirty in the experimental group and thirty (30) in the control group and the population of this study is all the third year Library and Information Science students in the federal tertiary institutions in Anambra State, Nigeria offering electronic libraries course. The findings revealed that the computer aided instruction method of teaching enhanced students' interest in electronic libraries than the modified lecture method. It was recommended that lecturers should adopt the use of computer aided instruction in teaching of electronic libraries in tertiary institutions in order to enhance students' interest in electronic libraries.

Sunday, [27] in his study on the Impact of AutoCAD Application Instruction on Students' Academic Performance and Motivation in Building/Engineering Drawing in Technical Colleges of Adamawa State, Nigeria. The objective of the study was to examine the use of AutoCAD Application Instruction (AAI) on academic performance and students' motivation in Building/Engineering Drawing. Two specific objectives, two research questions and two null hypotheses was used to guide the study. The study was conducted using quasi-experimental design. The population of the study consisted of 96 National Technical Certificate (NTC) 2 students. The findings of the study, among others, revealed that teaching and learning BED motivates learners and increase academic performance significantly. The study concluded by recommending technical colleges to integrate AutoCAD application instruction in the teaching and learning of building/engineering drawing.

Shu'aibu and Muhammad, [28] carried out a study on the effect of multimedia instructional strategy on academic performance of students in Radio and Television Electronic work in technical colleges of Kano State. The study was guided by four (4) specific objectives, four (4) research questions and one (1) null hypothesis. A quasi-experimental design was used for this study. The study was conducted in Kano State Nigeria. The population for the study comprised all NTC III students (males and females) of Radio and Television Electronic Work Trade in the two technical colleges in Kano State. The total of 40 students was used for the study and the entire population was purposely used as the sample of the study. Based on the findings of this study which indicated the effectiveness of multimedia instruction as compared to the conventional methods of teaching, the

researcher recommends that the stakeholders in education should make available and encourage the use of multimedia in instruction in technical colleges of Kano State by providing multimedia instructional tools.

"Ref. [29]" who also conducted study on the effects of computer-assisted instruction (CAI) on students' academic achievement in physics at secondary level. The main objective of the study was examining the effects of computer-assisted instruction (CAI) on the academic achievement of secondary school students in the subject of physics. Considering the research topic, three (3) specific objectives were drawn and in line with each specific objective, three (3) research questions and three (3) null hypotheses were formulated. The research design adopted was experimental design, All the secondary school students studying in public secondary schools in Karak District constituted the study population. A sample of 46 students of Grade-09 was selected through simple random sampling technique from Government Boys High School Khurram Karak. The findings show that computer-assisted instruction has a significant positive effect on students' academic achievement and retention in Physics. Based on findings, it was recommended that computer assisted instruction technique should be used by the science teachers for stimulating and boosting students' academic achievement in Physics at secondary level.

3. Experimental Method/Procedure/ Design

Research Design

The study adopted quasi-experimental design. Specifically, the pre-test post-test non-equivalent design was adopted for the study. According to [30] quasi experimental research design permits the use of intact classes. This 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 programme and the timetable of the technical colleges involved in the study. This was considered appropriate because full experimental control was lacking as non-random assignment of subjects to treatment and control groups was not done. The design also involved assignment, but not random assignment of participants to groups. This was because the researcher cannot artificially create groups for the experiment [31]

Population of the Study

"Ref. [32]" defines population as the totality or set of all elements, objects, events or members that are of interest for a particular study that pass a specified set of one or more common characteristics or objects or events that are of interest for a particular study. Population also is a group of individual who has the same characteristics [33]. A target population (or the sampling frame) in the other hand is a group of individuals (or a group of organizations) with some common defining characteristic that the researcher can identify and study. The population for this study comprised all NTC II students of Electronic Devices and Circuit in the two technical colleges in Bauchi State and the Electronic Devices and Circuit have been accredited by NBTE. The totals of 92 students were used for the study. NTC II students

were choosing because significant portion of the Electronic Devices and Circuit curriculum were taught to the students.

Table 1: Population of the Study

S/N	Name of Schools	No. of Students
1	Government Day Tech. College, Azare	49
2	Government Day Tech. College, Gar	43
TOTAL		92

Source: Field Survey (2023)

Instrument for Data Collection

The instrument captioned Electronics Devices and Circuits Performance Test (EDCPT) that was used for the study was adopted from NABTEB past questions. The test consists of three practical test questions that were based on technical college Electronics Devices and Circuit curriculum content for NTC II students. Each question has details instructions on how to conduct the practical. The steps were rated base on Likert scale rating points, Excellent = 5point, Very Good = 4point, Good = 3point, Not Good = 2, Not at all Good = 1point. The instrument consists of test items on the following specific Electronics Devices and Circuit topics covered in the study: Power Supply, Astable Multivibrator and Power Amplifier.

A. Method of Data Analysis

The research questions for the study were analyzed using Mean and Standard Deviation. This was because Mean and Standard Deviation has more reliability than other measures of central tendency [34]. Moreover, The Null hypotheses H_{01} - H_{04} of the study were tested at 0.05 level of significant using analysis of covariance (ANCOVA). The results of both groups collected were analyzed using Statistical Package for Social Science (SPSS), a computer analysis software package.

4. Results and Discussion

These analyses of the data collected as well as the discussion of the findings were presented below:

B. Research Questions

C. The results of research questions were as presented in Tables 2 to 9

Research Question One

What is the difference between pre-test mean performance scores of students in experimental and control groups in Electronic Devices and Circuits?

The data collected in respect to this research question was analyzed using mean and standard deviation and presented in Table 2. The result revealed the mean score of 70.69 with standard deviation of 41.477 for students in experimental group. Students in control group had mean of 70.91 with standard deviation of 39.031. The mean difference obtained from the two groups of students was 0.32. The obtained mean difference was tested statistically in the hypothesis testing.

Table 2: Students Mean Performance score of Pre-test of Experimental and Control Groups

Groups	N	Mean (X)	Std. Dev.	Mean Difference
Experimental Group	49	70.69	41.477	0.32
Control Group	43	70.91	39.031	

Source: Field work, 2023

D. Research questions two

What is the differential effect of pre-test and post-test mean performance scores of students in experimental group taught Electronics Devices and Circuits using electronics workbench software as a treatment?

The data collected for this research question was analyzed using descriptive statistics and presented in Table 3. The result revealed the experimental group pre-test means score of 70.63 with standard deviation of 41.477 and post-test mean score of 120.35 with standard deviation of 49.72. The result therefore indicated that there was difference 36.94 between the mean scores of the two groups of students. The difference was tested statistically in the hypothesis testing.

Table 3: Students Mean Performance Score of Pre-test and Post-test of Experimental Group

Experimental Group	N	Mean (X)	Std. Dev.	Mean Difference
Pre-test	49	70.63	41.477	49.72
Post-test	49	120.35	31.262	

Source: Field work, 2023

E. Research question three

What is the differential effect of students` post-test mean performance scores of experimental and control group in Electronics Devices and Circuits?

The result used to answer research question three in Table 4 disclosed the mean score of 120.35 with standard deviation of 31.262 for students taught Electronics Circuits Construction using electronics workbench software. The students taught using conventional teaching method had mean score of 83.91 with the standard deviation of 29.232. The mean difference was 36.44. This difference was tested statistically in the hypothesis testing.

Table 4: Students Mean Performance Score of Post-test of Experimental and Control Groups

Groups	N	Mean (X)	Std. Dev.	Mean Difference
Experimental Group	49	120.35	31.262	36.44
Control Group	43	83.91	39.031	

Source: Field work, 2023

F. Research question four

What is the differential effect of students` mean performance score of pre-test and post-test of control group in Electronics Devices and Circuits?

The descriptive result of research question four presented in Table 5 revealed the control group pre-test mean score of 70.95 with standard deviation of 39.031 and post-test mean

score of 83.91 with standard deviation of 29.232. The mean difference between the two tests stood at 13.40 and it was tested statistically in the hypothesis testing.

Table 5: Students Mean Performance Score of Pre-test and Post-test of Control Group

Experimental Group	N	Mean (X)	Std. Dev.	Mean Difference
Pre-test	43	70.95	39.031	13.40
Post-test	43	83.91	29.232	

Source: Field work, 2023

G. Testing Null Hypotheses

In this study four null hypotheses were tested to achieve the objectives of the study. The pre-test and post-test scores of the Electronics Circuits Construction Performance Test (ECCPT) scores were statistically analyzed at 0.05 level of significant and the results interpreted. For the null hypotheses two and four paired sample t-test was used in analyzing the research data while, independent sample t-test was used in analyzing the null hypotheses of one, and three. In testing the null hypotheses if the p-value is greater than 0.05 level of significant, the null hypotheses were accepted this indicate insignificant difference exist between the variables. On the other hand, if the p-value is less than 0.05 level of significant, the null hypotheses were rejected; this implies that significant differences exist between the variables.

H. Null Hypothesis One

H₀₁: There is no significant difference between pre-test mean performance scores of students in experimental and control groups in Electronics Devices and Circuits.

The analysis of Covariance used to test null hypothesis one in Table 6 revealed the t-value of -1.448 and the p-value was 0.151. The p-value obtained was greater than alpha value (0.151>0.05), the result therefore indicated that there was no significant difference among the pre-test mean performance scores of the two groups of students involved in the study. The hypothesis was retained.

Table 6: Analysis of Pre-test of the Experimental and Control Groups

Groups	N	X	SD	DF	t-cal	P-val	Remark
Experimental	49	70.63	41.447	90	-1.448	0.151	Accepted
Control	43	70.95	39.031				

Source: Field work, 2023

I. Null Hypothesis Two

H₀₂: There is no significant difference between pre-test and post-test mean performance scores of students in experimental group taught Electronics Devices and Circuits using electronics workbench software as a treatment.

The result of paired Sample t-test presented in Table 7 revealed that, the mean value of pre-test of experimental group stood at 70.63 with standard deviation of 41.477 and for the post-test the mean value of 120.35 with standard deviation of 31.262. The t-value obtained was -6.428 and the

p=.000. The p-value obtained was less than the alpha value of 0.05. The result suggested that there was significant difference between pre-test and post-test mean performance score of students in the experimental group. The null hypothesis was therefore rejected.

Table 7: Analysis of Pre-test and post-test of the Experimental group

Experimental	N	X	SD	DF	t-cal	p-val	Remark
Pre-test	49	70.63	41.447	48	-6.428	0.000	Rejected
Post-test	49	120.35	31.262				

Source: Field work, 2023

J. Null Hypothesis Three

H₀₃: There is no significant difference between post-test students` mean performance scores of experimental and control groups in Electronics Devices and Circuits.

The result in Table 8 was used to test null hypothesis three. From the Table, the mean of students in Experimental Group was 120.35 while those in control group scored 83.91 with standard deviations of 31.262 and 29.232 respectively. The degree of freedom was 90 and the t value = -0.051 with p-value of 0.030. The obtained p-value of 0.030 was less than the significant level of 0.05. The result indicated that there was significant difference between post-test mean performance score of both experimental and control groups students taught electronics circuits construction. The hypothesis was therefore rejected.

Table 8: Analysis of Post-test of Experimental and Control Groups

Post-test	N	X	SD	DF	t-cal	P-val	Remark
Experimental	49	120.35	31.262	90	-0.051	0.030	Rejected
Control	43	83.91	29.232				

Source: Field work, 2023

K.

L. Null Hypothesis four

H₀₄: There is no significant between students` mean performance score of pre-test and post-test of control group in Electronics Devices and Circuit.

The result of paired Sample t-test presented in Table 9 revealed that, the mean value of pre-test of control group stood at 70.95 with standard deviation of 39.031 and for the post-test the mean value of 83.91 with standard deviation of 29.232. The t-value obtained was -6.783 and the p=.061. The p-value obtained was greater than the alpha value of 0.05. The result suggested that there was trivial difference between pre-test and post-test mean performance score of students in the control group. The null hypothesis was therefore accepted.

Table 9: Analysis of Pre-test and Post-test of Control Group

Control Group	N	X	SD	DF	t-cal	p-val	Remark
Pre-test	43	70.95	39.031	43	-6.783	0.061	Accepted
Post-test	43	83.91	29.232				

Source: Field work, 2023

M. Discussion of Findings

This study investigated the Effect of Electronics Workbench Software Utilization on Technical College Students' Academic Performance in Electronics Devices and Circuits in Bauchi State, Nigeria.

The findings of test of null hypothesis one disclosed that the difference was not significant. Moreover, the null hypotheses one had being tested using independent sample t-test. The t-value at 0.05 level of significant was -1.448 and the p-value stood at 0.151 which is more than 0.05 level of significant and this shown no significant different between the students scores before the treatment. This indicated that the mean performance score of pre-test of both the experimental and control group had insignificant difference, and provided a basis on which it could be reasonably assumed that both groups had equivalent entry knowledge at the beginning of the treatment. The performance of the both groups on equal flat form also shows the equality of student's entry behavior for the two groups which also means that their prior knowledge is relatively the same. The findings agreed with the thought of [35] that entry knowledge of experimental and control group have to be equal in experimental research. Moreover, in another study by [36] on the design of work instruction (WI) electronic workbench-assisted electrical measuring devices to improve the internship concept of students in basic electronic II course. They found that electronics workbench software insignificantly fostered students' critical thinking and improved understanding internship concept in Basic Electronics II, they concluded that there is need for more accurately measure students' understanding of psychomotor aspect related to electrical concept.

For the null hypothesis two, the result shows that the t-value at 0.05 alpha value was -6.428 and the p-value stood at 0.000 which is less than 0.05 level of significant and this shown significant different between the two tests, therefore the null hypothesis was rejected and upheld the alternate hypothesis. "This means that there is a significant difference between students' means performance score of pre-test and post-test of experimental group". The findings of this research therefore is expected to fill the existing teaching and learning gap, as this study was conducted in the subject Electronics Devices and Circuits found to be very effective in technical colleges in Bauchi State. The findings of this study also agreed with the findings of [37]. The findings among others revealed that students taught mathematics using Computer Assisted Instructional (CAI) Package achieved more than that taught mathematics using the conventional method of teaching. In two subsequent studies [38] and [39] findings provide promising evidence regarding the efficacy of Electronics workbench software and other computer assisted instructional packages. The result of this study presented is with the view of [40] who opined that CAI significantly impacted the students' academic performance.

In the research question three, the findings showed that the null hypothesis 3 was rejected, from the results obtained, the test of null hypothesis shown that there is significant

difference between post-test mean performance scores of students taught Electronic circuits construction with the aid of electronic workbench software and those taught without the software", it is clear that the value of t which is -0.051 and the p-value which stood at 0.030 which is lower than the 0.05 significant level, therefore the null hypothesis was rejected. This means that the electronics workbench software would be effectively utilize to teach students practical in Electronics Devices and Circuit in Bauchi state technical colleges.

For the null hypothesis 4 the result of the paired sample t-test indicated that there was no significant different between pre-test and post-test of the control group. This clearly shows that the conventional approach used in teaching the Electronic Devices and Circuit students really has insignificant effect on their psychomotor skills and therefore the null hypothesis was accepted and the alternate hypothesis rejected. It is clearly that the value of t which is -6.783 and the p-value which stood at 0.061 which is higher than the 0.05 significant level. This result further affirmed that conventional approach is not suitable for students psychomotor development in Electronic Devices and Circuit in Bauchi State technical colleges. The above result agreed with the findings of [41].

5. Conclusion and Future Scope

The study titled "effect of electronics workbench software utilization on technical college students' academic performance in Electronic Devices and Circuits in Bauchi State technical colleges". The major objective of the study determined the effect of electronics workbench software utilization in teaching Electronics Devices and Circuit's construction at technical college level in Bauchi State. The study achieved four specific objectives from which four research questions and four null hypotheses were tested. The research questions and null hypotheses were tested using t test at 0.05 level of significant. The research design for the study was Quasi-experimental pre-test-post-test design; the population for the study comprised of 92 NTC II students in eight Bauchi State Technical Colleges, two technical colleges that are offering Electronics Devices and Circuits were selected from eight Technical Colleges. From the two technical colleges selected, intact classes were used with the total number of 92 students as sampling frame. The experiment was conducted at second term 2023/2024 academic session. The instrument used for data collection captioned Electronics Devices and Circuits Performance Test (EDCPT) adopted by the researcher from NABTEB Examination body was validated by three experts, two from vocational and technology education department and one from Educational Foundation department in the area of measurement and evaluation, the test items were administered prior and after the treatment and the data collection period lasted for four weeks, pre-test and post-test scores were recorded and the scores were statistically analyzed. Null hypothesis one and three were tested using independent sample t-test while, null hypothesis two and four were tested using paired sample t-test. From the analyzed, null hypotheses one and four were accepted and retained while, null hypotheses two and three were rejected.

A reliability coefficient of the tests instrument stood at 0.81 which is high and positive using a split half technique. "Ref. [42]" recommended that any value within the range of 0.5 to 0.9 is acceptable. The researcher and trained research assistance were used during data collection, and the data collected were analyzed. The mean and standard deviation were used to answer all the research questions while t-test was used to test the null hypotheses. The general findings revealed that the pre-test results of experimental and control groups provided a basis on which it could be reasonably assumed that the groups had equivalent entry knowledge at the commencement of treatment. The findings revealed that, Students taught Electronics Devices and Circuits using electronic workbench software outperformed those taught using conventional method, this shows that electronics workbench software can be used to compliment the use of real practical facilities in constructing electronics circuits in Bauchi state technical colleges.

Finally, the study recommended amongst others that Government should intensify effort at providing instructional material required by Electronics Devices and Circuits teachers to deliver what is expected of them in Electronics Circuits construction to avoid the syndrome of leaving and or skipping some part of the curriculum. The study further recommended that, Ministry of Education should hesitate to fully introduce and implement the use of computer-aided instructions in Bauchi state technical colleges and beyond to enhance quality teaching and learning of Electronic Devices Circuit's construction.

Data Availability

None

Conflict of Interest

None

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Authors Contributions

All the authors contributed in the work.

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AUTHORS PROFILE

Kabiru Muhammad – earned his ND (National Diploma) in Electrical/ Electronics Engineering, B. Tech. in Electrical/ Electronics Technology Education from Federal Polytechnic Bauchi, Abubakar Tafawa Balewa University Bauchi, Nigeria in 2008 and 2017 respectively, he is currently M. Tech. Student in ATBU Bauchi. He is currently working in Al-hilal School Bauchi, Bauchi State, Nigeria. He has ten years of teaching experience and five years of research experience.



Hashimu Hamisu Umar – earned his NCE (Nigeria Certificate in Education) Tech., B. Tech., in Electrical/Electronic Technology Education from Plateau State Polytechnic Barkin Ladi, Abubakar Tafawa Balewa University Bauchi, Nigeria in 2012 and 2017 respectively, he is currently M. Tech. Student in ATBU Bauchi. He is currently working in Federal University Lokoja, Ko

