

Research Paper

Effect of Electronics Workbench Software on Technical College Students' Performance in Electronics Devices and Circuits in Bauchi State, Nigeria

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Abstract— This study examined the effect of electronics workbench software on technical college students' performance in electronics devices and circuits. To achieve this, three specific objectives, three research questions and three null hypotheses were formulated to guide the study. Literatures were reviewed in the areas related to the study. Quasi-experimental design was used as the design of the study. The area of the study is Bauchi State of Nigeria. The population of the study comprises of 92 NTC II technical colleges students that are offering electronics devices and circuits. A purposive sampling technique was used in selecting two colleges for the study. 92 students from two intact classes were assigned in to experimental and control groups. The research instruments Electronics Devices and Circuits Performance Test (EDCPT) were validated by three experts. The instruments were administered by the researcher with the help of two research assistants, the experimental group taught using electronics workbench software for four weeks while, the control group were taught using traditional method for same period. 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 result shows insignificant different between the pretest mean results of both the experimental and control groups, which showed that both groups have equal entry knowledge, while, the posttest mean performance score of experimental group stood at (62.52) which is significantly higher than the posttest mean performance score of control group (52.09) with mean difference of (10.43), this showed that, the students taught using electronics workbench software outperformed the students taught using traditional method. It was recommended among others that; Teachers should ensure that low-performing electronics devices and circuits students are exposed to electronics devices and circuits to equip them with learning skills.

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

1. Introduction

It is no longer a news, the importance of technological devices and their applications in the 21st century business and non-business sector especially the educational sector cannot be underestimated. Without missing a word, proper utilization of technology and its efficiency in learning will doubtless impact on the academic performance of students. Information and communication technology (ICT) have provided innovative tools [1]. With the help of ICT, learners can be more motivated and achieve better results. [2] 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 emphasised. 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 [3].

Today, there are more attention to the use of technology in education as instructional medium in addition to its application in management and administration. The use of technology as an instructional medium 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 [4]. The use of technology in teaching and learning covers all levels of education [5].

In Nigeria, technical college is one of the educational institution that is 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 [6]. Technical education provides workplace 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 [7]. Radio, television and electronics work (RTVE) is one of the trades offered in technical colleges which aim is to give training and impart 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 namely: electronics devices and circuits, radio communication, satellite transmission and reception [8]. The fact that technology has gained acceptance in teaching and learning, it is an ingredient for its application in Nigerian technical colleges. The use of technology in either software or hardware deem necessary. 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 emphasised. Software such as Electronic Workbench (EWB) and others may enhance students learning outcomes in both theory and practical [9].

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 [10]. EWB is a simulation package for circuit. EWB is one type of software electronic 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 menu contained on the software [9]. 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].

The term academic performance refers to how well a student does in school/college subjects. An under expected grades are considered as bad academic performance. It also refers to how students deal with their studies and how they cope with or accomplish different tasks given to them by their teachers. Academic performance generally means how students are accomplishing their tasks and studies, but there are quite a number of factors that determine the level and quality of students' academic performance. In educational institutions, success is measured by academic performance, or how well a student meets standards set out by institutions. The importance of students doing well in school subjects has caught the attention of parents and government's education departments alike. 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 [12].

The purpose of academic performance is to achieve an educational goal, 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 [12].

It is based on this background that the study intends to determine the effect of electronics workbench software on technical college students' interest and performance in electronics devices and circuits in Bauchi State technical colleges.

1.2 Problem Statement

Teaching and learning at secondary school particularly in technical colleges employed on the acquisition of practical skills. Student graduating from technical colleges in Nigeria are expected to have acquired adequate knowledge and skills necessary for effective performance in the workplace [6]. The National Board for Technical Education [13] 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 discouraging [14]. This cannot be unconnected to the state of practical facilities in the technical colleges. The above observation has been supported by other researchers like [15] who buttressed that inadequacy of facilities both qualitative and quantitative has put the learners and the teachers at a disadvantage. The teacher may also have problem in a class with large students' population. The implication of this scenario is that only a small proportion of the learners benefit from the current instructional strategy.

The use of electronic workbench software has gain acceptance in most part of the world [16] including tertiary institution in Nigeria. The use of electronic workbench software has yielded good results in technical education. According to [17] with the availability of information and communication technology facilities in technical colleges, students of RTVE work trade require computer software that will help them in learning practical electronics virtually as an alternative to hand-on demonstration method of learning practical electronics work. Despite all the advantages of EWB software in enhancing students learning outcomes, its effects in improving RTVE students' interest and performance at colleges level is yet to be ascertain in the literature. It is based on this that this study intent to determine the effect of electronics workbench software on technical college students' interest and performance in electronics devices and circuits in Bauchi state technical colleges.

1.3 Purpose of the Study

The main purpose of this study is to determine the effect of electronics workbench software on technical college students' learning interest and performance in electronic devices and circuits in Bauchi State. Specifically, this study intends to find out the following:

- i) Determine the difference between pre-test mean performance scores of students taught Electronic devices and circuits with the aid of Electronic workbench software and those taught without the software.
- ii) Determine the difference between pre-test and post-test mean performance scores of students taught electronic devices and circuits with the aid of electronic workbench software.
- iii) Determine the difference between post-test mean performance scores of students taught Electronic devices and circuits with the aid of electronic workbench software and those taught without the software.

1.4 Research Questions

The study will provide answers to the following research questions:

- i) What is the difference between pre-test mean performance scores of students taught Electronic devices and circuits with the aid of Electronic workbench software and those taught without the software?
- ii) What is the difference between pre-test and post-test mean performance scores of students taught electronic devices and circuits with the aid of electronic workbench software?
- iii) What is the difference between post-test mean performance scores of students taught Electronic devices and circuits with the aid of electronic workbench software and those taught without the software?

1.5 Research Hypotheses

In line with research questions, the following null hypotheses are postulated:

- H₀₁: There is no significant difference between pre-test mean performance scores of students taught electronics device and circuit with the aid of electronic workbench software and those taught without the software.

- H₀₂: There is no significant difference between pre-test and post-test mean performance scores of students taught electronic device and circuit with the aid of electronic workbench software.

- H₀₃: There is no significant between post-test mean performance scores of students taught Electronic devices and circuits with the aid of electronic workbench software and those taught without the software

1.5 Significance of the Study

The findings of this study will be of immense benefit to the following:

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

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

Curriculum planners: Moreover, the study will also be important to curriculum planers by enabling them considering electronics workbench software in electronics devices and circuits when designing curriculum.

Government: This research work will enable the government to determine how effective the use of electronics workbench software in teaching electronics devices and circuit can improve the performance of technical college students in Bauchi State. The success of teaching electronics devices and circuits using electronics workbench software will help the government in determining whether to introduce and deploy the software in various technical colleges of Nigeria.

Society: This research will help the society to be aware on the importance of teaching students electronics devices and circuits using electronics workbench software against the conventional method.

Basis for further researches: This research work will 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 will focus on the examination of the Effect of electronics workbench software on technical college students' learning interest and performance in electronics devices and circuits in Bauchi State, Nigeria. The independent variable in this study is electronics workbench software while, the dependent variable is technical college student' interest and performance in electronics devices and circuits.

Therefore, the content for this study will be selected from the approve 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 [6]. The content areas that will be

covered in electronics devices and circuits include the following sub-topics:

- i) Electronic Components.
- ii) Semiconductors.
- iii) Number System.
- iv) Logic Gate

These contents serve as basis for measuring performance in electronics devices and circuit before and after instruction in electronic workbench as the performance test.

2. Related Work

[18] conducted a research 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 sampling technique was multi stage sampling techniques. The instrument employed for the study, was Mathematics Achievement Test (MAT) of 30 multiple choice items. Descriptive statistics such as mean and standard deviation were used to answer the research questions while inferential statistics such as student t-test was used to test the hypotheses. Hypotheses were tested at 0.05 level of significant. 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.

The present study is similar to the past study under reviewed on the following: both studies adopted mean and standard deviation for mean performance score analysis and purposive sampling method in selecting the schools. Meanwhile, the present study differs from the past study under reviewed in the following: the present study also differs from the past study, in the. Population for the present study comprised of all NTC II 92 radio television and electronic work students while population for the past study comprised of 178 senior secondary schools students offering mathematics, the present study determine the effect of electronics workbench software on technical college students` learning interest and performance in electronic devices and circuits in Bauchi State while the past study compared the effects of Computer Assisted Instructional (CAI) Package on senior secondary school students' achievement in Mathematics: A post-Covid

Sustainable Development in Nigeria. However, the study enables the researcher to acquire broader and wider knowledge on research design, sample and selection, measuring instrument and data analysis.

Also, [19] conducted a research 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. There was no sampling of the students because of the nature of quasi-experimental design which prescribes the use of intact classes. The instrument for data collection was Mechanics and Properties of Matter Misconceptions and Achievement Test (MPMMAT). The study was experimental and therefore, data was collected through pretest, posttest and retention test. The data was analyzed and interpreted based on descriptive statistics i.e., mean, standard deviation and inferential statistics i.e., independent samples t-test through SPSS. 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.

The present study is similar to past study in the following areas: The research design for both studies is an experimental design, in both studies instrument for data collection was pre-test and post-test items, both studies focused on students' academic performances. both studies adopted test retest method in testing reliability coefficient of pre-test objective questions, in the same time the present study differs' from past study in the location for the present study is Bauchi state, while the location for the past study was south-south zone of Nigeria. The present study is based on the electronics workbench software and the past study was Computer-Mediated Instruction, the population of the past study was all secondary students studying in public schools and the population of the present study was 92 the findings of the past study guided the researcher in carrying out the field experimental work.

[20] 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 method 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. All the fifty students were purposely selected for the study. The instrument for data collection was interview and pretest/posttest which comprises of two multiple choice questions and one exercise in form of open questions. The study adopted test retest in testing reliability coefficient of pre-test objective questions. The study used two statistical methods, the independence t-test and analysis of covariance (ANCOVA) in testing null hypotheses. In the pre-test, there was no significant difference between the two groups employing the methodological pre-test and post-test with an experimental group and a control group.

After using the Electronics Workbench (EWB) simulator in the post-test, also there was no statistically significant difference between the experimental group and the control group, as the p-value of student's t-test is higher than the selected alpha level ($p > 0.05$); a p-value of 0,624 allows to reject the null hypothesis and to admit that the use of the Electronics Workbench (EWB) simulator and the laboratory experiments can reach similar objectives in the study of amplitude demodulation, the Electronics Workbench (EWB) simulator will be an alternative to do the inaccessible experiments, Also, 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. The interviewed students declare that the Electronics Workbench (EWB) simulator is easy to operate for most of them (85%), 85% of the students confirm that the Electronics Workbench (EWB) simulator is easy to use, the majority (79%) of these students think that the use of Electronics Workbench (EWB) requires little knowledge in computer, 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. Some of the recommendations made by the researchers are: The use of EWB simulator for instructional facilitation should be employed by teachers and administrators to facilitate meaningful learning in electrical and electronics courses.

The present study is similar to past study in the following areas: The research design for both studies are experimental design, in both studies instrument for data collection was pre-test and post-test items, both studies employed the use of Electronic workbench software. both studies adopted test retest method in testing reliability coefficient of pre-test objective questions, in the same time the present study differs' from past study in the location for the present study is Bauchi state, while the location for the past study was Morocco. The present study focused on electronics devices and circuit while the past study is focused on amplitude modulation and demodulation, the population of the past study was 50 students and the population of the present study

is 92. The findings of the past study will guide the researcher in carrying out the field experimental work.

Another research was conducted by [21] 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. Purposive sampling technique was used to select schools for the study. Radio and Television Electronic Work Trade Pre-test National Business and Technical Examination Board (NABTEB) past question paper was adopted by the researchers based on approved syllabus of year (2007). A pretest method was used to estimate the reliability of the instrument which gave a reliability coefficient of 0.63. 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. Based on the research findings, it was concluded that the use of multi-media instructional strategies in place of lecture method will improve students' achievement in radio television and electronic work. Recommendations were made which include, Stakeholders in education should make available and encourage the use of multimedia instruction in technical colleges of Kano State by providing multimedia instructional tools.

The present study is similar to past study in the following areas: Both studies adopted mean and standard deviation for mean achievement score analysis and purposive sampling method in selecting the experimental schools. Meanwhile, the present study differs from the past study under reviewed in that, the present study also differs from the past study, in the. Population for the present study comprised of all NTC II 92 radio television and electronic work while population for the past study comprised of 40 NTC III students offering Physics, the present study determine the effect of electronics workbench software on technical college students' learning interest and performance in electronic devices and circuits in Bauchi State while the past study examine the Virtual laboratory: Using Electronic Workbench as Alternative to Learning Physics in COVID-19 Mass Pandemic. However, the study enables the researcher to acquire broader and wider knowledge on research design, sample and selection, measuring instrument and data analysis.

Another research was conducted by [10] 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 employed 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. The sample of the research was the classes 2018 with a total of 8 students who took Basic Electronics II course. The Instrument used to determine the student learning outcomes obtained through the production of research tools by the researcher. A pretest method was used to estimate the reliability of the instrument which gave a reliability coefficient of 0.63. 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. This is indicated by the specified value of $t_{count} (= 5017) > t_{table} (= 2,365)$ at a confidence level of 95%. In addition, the improvement in understanding internship concept of student in Basic Electronic II course after using the Work Instructions (WI) was in the medium category. The researcher suggests that there is need to more accurately measure students' understanding of psychomotor aspects related to electrical meters.

The present study is similar to the past study under reviewed in the following area: both studies adopted the use of electronic workbench software, the designed for the both study is quasi-experimental design and both used purposive sampling technique. Meanwhile, the different between the present study and the past study under reviewed is that, the population for the present study comprised of all NTC II 92 radio television and electronic work while The population of this research were all physics student faculty of training teacher and education university of Muhammadiyah Mataram, the present study determine the effect of electronics workbench software on technical college students' learning interest and performance in electronic devices and circuits in Bauchi State while the past study determine the extent of the influence of the design of work instruction (WI) electronic workbench-assisted electrical measuring devices to Improve the internship concept of students in basic electronic II course. However, the study enables the researcher to acquire broader and wider knowledge on research design, sample and selection, measuring instrument and data analysis.

[7] 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 sample consisted of 22 (14 males and 8 females) students who were purposively selected from the two colleges. The instrument used for data collection was EIAMW Performance Test titled EIAMWPT which was developed by the researcher. The second term scheme of work for technical colleges was used. The fifty item multiple choice objective test that made up the EIAMWPT were validated and its reliability determined using Pearson correlation coefficient formula yielded 0.81 coefficient reliability. The research question was answered using mean and hypothesis was analyzed using Analysis of Covariance (ANCOVA) at 0.05 level of significance. 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.

The present study is similar to past study in the following areas: The research design for both studies is experimental design, in both studies instrument for data collection was pre-test and post-test items, both studies focused on students' academic performances. both studies adopted test retest method in testing reliability coefficient of pre-test objective questions, in the same time the present study differs' from past study in the location for the present study is Bauchi state, while the location for the past study was Enugu State. The present study is based on the electronics workbench software and the past study was based on computer assisted instruction, the population of the past study was 400 NTC II students and the population of the present study is 92 NTC II students the findings of the past study will guide the researcher in carrying out the field work.

[22] 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. Purposive sampling technique was used to select two (2) federal tertiary institutions out of three federal tertiary institutions in Anambra State. A27 item structured questionnaire was used for data collection. It was subjected to content validity by experts in Computer Science, Library and Information Science, Vocational Education and Measurement and Evaluation. 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.

Both this study and the present study are related in employing Computer Assisted Instruction (CAI) to determine the students interest on the certain subject matter, both studies adopted mean and standard deviation for mean achievement score analysis and purposive sampling method in selecting the experimental schools. Meanwhile, the present study differs from the past study under reviewed in the Population for the present study comprised of all NTC II 42 radio television and electronic work while population for the past study comprised of 100 tertiary institution students offering library science, the present study determine the effect of electronics workbench software on technical college students` learning interest and performance in electronic devices and circuits in Bauchi State while the past study determine the effect of computer aided instruction on students` interest in selected topics in electronic libraries course in federal tertiary institutions in Anambra State, Nigeria. However, the study enables the researcher to acquire broader and wider knowledge on research design, sample and selection, measuring instrument and data analysis.

Also, the study conducted by [23] 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. There was no sampling the intact classes were used. The instrument of this study were test questions adapted from NABTED past questions from 2014-2018 of Building/Engineering Drawing and structured questionnaire designed by the researchers to elicits response on student`s level of motivation on the use of AutoCAD application instruction method. SPSS was used to analysed data. Mean and standard deviation were used to answer the research question while, ANCOVA and t-test were used to test the null hypotheses at 0.05 level of significance. 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.

The present study is similar to the past study under reviewed is that, both studies adopted mean and standard deviation for mean achievement score analysis and purposive sampling method in selecting the experimental schools. Meanwhile, the present study differs from the past study under reviewed in that, the present study also differs from the past study, in the. Population for the present study comprised of all NTC II 92 radio television and electronic work while population for the past study comprised of 40 NTC III students offering radio television and electronic work, the present study determine the effect of electronics workbench software on technical

college students` learning interest and performance in electronic devices and circuits in Bauchi State while the past study compared the effect of multi-media instructional strategies on academic performance of students in radio television electronics work trade in technical colleges in Kano State. However, the study enables the researcher to acquire broader and wider knowledge on research design, sample and selection, measuring instrument and data analysis.

Another study by [24] 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 were used for the study and the entire population was purposely used as the sample of the study. Radio and Television Electronic Work Trade Pre-test National Business and Technical Examination Board (NABTEB) past question paper was adopted by the researchers based on approved syllabus of year (2007). The results was analyzed at the alpha level of 0.05 using t-test statistical method. There is significance difference in the post-test mean academic performance of students taught (Radio Communication, Satellite Transmission/ Reception and Television) in Radio and Television Electronic Work Trade using multimedia and traditional teaching methods. Therefore, H_0 was Rejected. 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.

This study is at the same lane with the past study, the two studies focuses on academic achievement, both studies also use to approaches of teaching the subject, both the two studies used the same research design. The present study in the same differs with the past studies in the following area: present study concentrates on the electronics device and circuit while, past study focuses on electrical installation and maintenance work, the population of the past study was 100 students and the population of the present is 92 students.

[25] conducted a research 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 instrument for data collection was 60 MCQs in the said achievement test carrying 120 marks in total. The study was experimental and therefore, data was collected through pretest, posttest and retention test. After collection of data, it was organized properly, classified, tabulated, analyzed and interpreted based on descriptive statistics i.e., mean, standard deviation and inferential statistics i.e., independent samples t-test through SPSS. 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. The present study is similar to past study in the following areas: The research design for both studies is an experimental design, in both studies instrument for data collection was pre-test and post-test items, both studies focused on students' academic performances. both studies adopted test retest method in testing reliability coefficient of pre-test objective questions, in the same time the present study differs' from past study in the location for the present study is Bauchi state, while the location for the past study was Khuram Karat. The present study is based on the electronics workbench software and the past study was Computer Assisted Instruction, the population of the past study was all secondary students studying in public schools and the population of the present study is 92 the findings of the past study will guide the researcher in carrying out the field experimental work.

3. Research Method

3.0 Research Design

The study adopted quasi-experimental design. Specifically, the pre-test post-test non-equivalent design was adopted for the study. According to [4] 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. Specifically, the pre-test post-test non-equivalent treatment group design was adopted for 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 [26]. The design was symbolically represented in table 1:

Table 1: Quasi-Experimental Pre-test Post-test design

Groups	Pre-Test	Treatment	Post-Test
G ₁	Y ₁₁	X	Y ₁₂
G ₂	Y ₂₁		Y ₂₂

Source: Adopted from Sambo, 2005

Where:

- G₁– Stand for the experimental group
- G₂- Stand for control group
- Y₁₁– Stand for pre-test of the experimental group
- Y₂₁–Stand for pre-test of the control group
- X– Stand for treatment
- Y₁₂- Stand for post-test of the experimental group
- Y₂₂– Stand for post-test of the control group

3.2 Population of the Study

[27] 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 [26]. 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 Radio, Television and Electronic Work Trade in the 8 technical colleges in Bauchi State. The total of 92 students were used for this study. NTC II students were choosing because significant portion of the Radio and Television Electronic Work Trade curriculum will be taught to the students.

Table 2: Population of the Study

S/N	Name of Schools	Number of Students
1	Government Day Technical College, Bauchi	49
2	Government Technical College, Gumau	43
3	Government Day Technical College, Azare	NIL
4	Government Day Technical College, Tafawa Balewa	NIL
5	Government Day Technical College, Jama`are	NIL
6	Government Day Technical College Kafin Madaki	NIL
7	Government Day technical College, Gar	NIL
8	Government Day Technical College, Gamawa	NIL
		92

Source: Field Survey (2023)

3.3 Sample and Sampling Technique

The researcher used purposive sampling technique in selecting two schools for the study, purposive sampling is a non-probability sampling that is selected based on the characteristics of a population and the objective of the study [4]. The purposive random sampling was used because the intact class. Intact class means that entire classes are assigned to specified treatments. The researcher used intact classes for the study. The two schools selected are Government day technical college Bauchi and Government technical college Gumau as shown in the table below.

Table 3: Sample Size for the Study

S/N	Name of Schools	Group	Number of Students
1	Government Technical College, Gumau	Control Group	43
2	Government Day Technical College, Bauchi	Experimental Group	49
		Total	92

Source: Field Work (2023)

3.4 Instrument for Data Collection

The instruments used for collection of data in this study was Electronics Devices and Circuits Performance Test (EDCPT). The EDCPT was adopted from NABTEB examination practical questions which was generated from the topics treated in the research

3.5 Method of Data Collection

The study involved two groups of subjects. They were control and experimental groups. In each school, the control group was taught using conventional demonstration method while the experimental group was taught using electronic workbench software as shown in appendix X. In all, a total of 92 students were involved in the study which was the population of the study.

On the first day of the experiment, the test instruments; Electronics Performance Test (EPT) and the Electronics Interest Inventory (EII) was typed in white papers and administered as pre-test to all students' involved in the study. After this, both groups were taught electronics devices and circuits for a period of four weeks. A total of eight lesson periods were involved which covered Electronic Components, Semiconductors, Number System and Logic Gate both in the two different instructional packages.

The students in the experimental group were drilled using electronics workbench software that was installed on the school computers. Two research assistances were trained on how to use the software before the commencement of the study. Lesson Plan for both experimental and control group were developed by the researcher for NTC II students. Students were taught electronics devices and circuits using Electronics workbench software during the four weeks lesson period. They were responding to questions and activities accordingly using the software. Students who encountered difficulties in the course of the study were assisted by the class teachers. The control group were taught using the conventional demonstration teaching method for the period of four weeks by the research assistance.

3.6 Method of Data Analysis

The research questions for the study was analysed using Mean and Standard Deviation. This was because Mean and Standard Deviation has more reliability than other measures of central tendency [28]. Moreover, The Null hypotheses H_{01} - H_{04} formulated for the study was tested at 0.05 level of significant using analysis of covariance (ANCOVA). The results of both the groups collected was analysed using Statistical Package for Social Science (SPSS) (computer analysis software package).

4. Results and Discussion

The chapter present and analyze data collected for drawing conclusion on the four research questions and four null hypotheses formulated to guide the study on "Effect of electronics workbench software on technical college students' interest and performance in electronics devices and circuits in Bauchi".

4.1 Research questions one

What is the difference between pre-test mean performance scores of students taught electronic devices and circuits with the aid of electronic workbench software and those taught without the software?

The result of pre-test mean performance scores for both experimental and control groups is presented in Table 4. The result indicated the mean score of 51.95, SD of 16.08 and the standard error of 2.29 for the experimental group while, for control group 49.90 mean score with 18.24 standard deviation and the standard error of 2.78 with mean difference of only 2.05 this shows the mean performance score of students in electronics devices and circuits in both groups is almost the same. That is to say the difference is insignificant.

Table 4: Students Mean performance score of Pre-test of Experimental and Control Group.

Groups	N	Mean (X)	Std. Dev. (SD)	S.E	Mean Difference
Experimental group	49	51.95	16.08	2.29	2.05
Control group	43	49.90	18.24	2.78	

Source: Field work, 2023

4.2 Research question two

What is the difference between pre-test and post-test mean performance scores of students taught electronic devices and circuits with the aid of electronic workbench software?

Table 5: is the result of post-test and pre-test of the experimental group which indicated mean of 62.57, standard deviation 17.97 and standard error of 2.56 in the post-test which is higher than the pre-test mean performance of 51.96, standard deviation of 16.08 and the standard error of 2.29 with the mean difference of 10.61. This clearly showed that, the observed difference was as a result of the effect of electronics workbench software on the technical college students' performance.

Table 5: Students Mean performance score of Pre-test and Post-test of Experimental Group.

Experimental group	N	Mean (X)	Std. Dev. (SD)	S.E	Mean Difference
Post-test	49	62.57	17.97	2.56	10.61
Pre-test	49	51.96	16.08	2.29	

Source: Field work, 2023

4.3 Research question three

What is the difference between post-test mean performance scores of students taught Electronic devices and circuits with the aid of electronic workbench software and those taught without the software?

The result presented in the Table 6 shows the post-test mean performance score of experimental and control group, that is the experimental group had a post- test mean performance

score of 62.57, Standard deviation of 17.97 and the Standard error 2.56. Thus, the control group with the post -test mean performance score of 52.09, Standard deviation of 18.14 and Standard error of 2.76 with mean difference of 10.48 shows that, students in electronics devices and circuits taught using electronics workbench software had a higher mean performance score than the students taught without the software. Therefore, significant differences exist between the experimental group and control group.

Table 6: Students' mean performance scores of post-tests of experimental and control groups

Post-test	N	Mean (X)	Std. Dev. (SD)	S.E	Mean difference
Experimental Group	49	62.57	17.97	2.56	10.48
Control Group	43	52.09	18.14	2.76	

Source: Field work, 2023

4.4 Testing Null Hypotheses

In this study four null hypotheses were formulated to achieve the objectives of the study. The Electronics Devices and Circuit Interest Inventory and the pre-test and post-test scores of the Electronics Devices and Circuits Performance Test scores (EDCII & EDCPT) were statistically analyzed at 0.05 level of significant and the results interpreted. For the null hypotheses two paired sample t-test was used in analyzing the research data while, independent sample t-test was used in analyzing the null hypotheses one and three. In testing the null hypotheses if the p-value is greater than 0.05 level of significant the null hypotheses will be 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 hypothesis will be rejected, this implies that significant differences exist between the variables. For details performances of the students see appendix XIII, the summary of results from Tables 4.4.2 to 4.4.3 were used for testing the four null hypotheses.

4.1 Null Hypothesis one

H₀₁: There is no significant difference between pre-test mean performance scores of students taught electronics device and circuit with the aid of electronic workbench software and those taught without the software.

Table 7: Showed the analysis of an independent samples t-test which compare the pre-test mean performance scores between the control and experimental groups on the variable. The mean score for the experimental group was 51.95 and the standard deviation 16.08, while the mean score for the control group was 49.90 and the standard deviation 18.24. The t-value at 0.05 level of significant is 0.574 and the p-value is 0.568. The p-value of 0.568 is higher than the 0.05 level of significant which implies that the null hypothesis is accepted. In summary, the results of the independent samples t-test suggest that there was no significant difference in scores between the control and experimental groups. The effect size was small, indicating that the difference between the means was not practically significant.

Table 7: Test for difference between students mean performance score of students in Pretest of the Experimental and control groups

Pre-test	Mean(X)	SD	N	df	t-val	p-val	Decision
Experimental	51.95	16.08	4	9	0.574	0.568	Accepted
			9				
Control	49.90	18.24	4	3	0.574	0.568	Accepted
			3				

Source: Field work, 2023

4.4.2 Null Hypothesis two

H₀₂: There is no significant difference between pre-test and post-test mean performance scores of students taught electronic device and circuit with the aid of electronic workbench software.

Table 8: The data showed the result of a paired samples t-test that was conducted to compare pretest and post-test scores on the outcome variable. The mean of pretest score was 51.96 and standard deviation of 16.08, while the mean of post-test score was 62.57 and standard deviation of 17.97. The t-value at 0.05 level of significant is -2.777 and the p-value is 0.007. The p-value of 0.007 is less than the 0.05 level of significant which implies that the null hypothesis is rejected.

The results of the paired sample t-test indicate a significant difference between the pretest and post-test scores on the outcome variable. The effect size was large, indicating a substantial difference between the means.

Table 8: Test for difference between students mean performance score of pre-test and post-test of experimental group.

Experimental	Mean(X)	SD	N	df	t-val	p-val	Decision
Pre-test	51.96	16.08	4	9	-2.777	0.007	Rejected
			9				
Post-test	62.57	17.97	4	9	-2.777	0.007	Rejected
			9				

Source: Field work, 2023

4.4.3 Null Hypothesis three

H₀₃: There is no significant between post-test mean performance scores of students taught Electronic devices and circuits with the aid of electronic workbench software and those taught without the software

Table 9: Shows the result of an independent samples t-test was conducted to compare scores between the control and experimental groups on the variable "Scores". The mean score for the experimental group was 62.52 and the standard deviation 17.97, while the mean score for the control group was 52.09 and the standard deviation 18.14. The t-value at 0.05 level of significant is -9.614 and the p-value is 0.000. The p-value of 0.000 is less than the 0.05 level of significant which implies that the null hypothesis is rejected.

The results of the independent samples t-test suggest that there was a significant difference in scores between the control and experimental groups. The effect size was moderate, indicating a meaningful difference between the means.

Table 11: Test for difference between students mean performance scores of post-test of experimental and control groups

Post-test	Mean(X)	SD	N	d _r	t-val	p-val	Decision
Experimental	62.52	17.97	49	90	-9.614	0.000	Rejected
Control	52.09	18.14	43				

Source: Field work, 2023

4.6 Summary of Findings

The study established that:

1. The findings of the first research question revealed that, the interest of the students in both the experimental and control groups conducted by the researcher is almost the same, their mean interest scores were 73.28 and 72.90 almost found to be equal with an insignificant difference, this indicate that, the students' interest is the same while, the null hypothesis 1 in table 8 was upheld.
2. The second research question revealed that, the initial behavior of the students in both the experimental and control groups conducted by the researcher is almost the same, their pretest mean performance scores were 49.90 and 51.95 almost found to be equal with an insignificant difference, this indicate that, the students' entry behavior is the same before the treatment while, the null hypothesis 2 in table 9 was accepted.
3. The post-test mean performance score were significantly higher than the pretest that was conducted before the electronic workbench software was used as a treatment to the students. The change in the student's learning outcome is an indication that use of an electronic workbench software in teaching electronics devices and circuits proved to be very effective.
4. From the experimental and control groups, posttest mean performance scores of students in the experimental group is significantly higher than the mean performance score of students in the control group.

Therefore, the use of electronics workbench software in teaching electronics devices and circuits may be more effective.

4.7 Discussion of Findings

The findings of the research work were discussed by explaining the result found on the research questions and research hypotheses and the result of the null hypotheses was tested at 0.05 level of significant and was explained one after the other.

In research question one; the pre-test mean performance score of the electronics devices and circuits in the experimental and control groups was found to be 51.95 and 49.90 and the standard deviation 16.08 and 18.24 respectively. The result showed that a little difference exists between the pretest mean performance score of the two groups. Moreover, the null hypotheses two had being tested using independent sample t-test. The t-value at 0.05 level of significant was -0.574 and the p-value stood at 0.568 which is more than 0.05 level of significant and this shown no significant different between the students scores before the treatment. This indicate 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 [29] that entry knowledge of experimental and control group have to be equal in experimental research.

Moreover, in another study by, [30] 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.

In research question two, pre-test and post-test mean performance of the experimental group compared stood at 51.96 and 62.57. Higher performance of the students in post-test was not due to chance factor but was as a result of the treatment given, which is an indication of effectiveness of electronics workbench software over the traditional instructional strategy. Discussion also, from the finding that was obtained from the null hypothesis that "there is no significant difference between pre-test and post-test mean performance scores of students' taught electronics devices and circuits using electronics workbench software' mean performance score of pretest and posttest", it is evidently clear that t-value of -2.777 and the p-value stood at 0.007 which is less than 0.05 level of significant and this shown significant different between the two groups, therefore the null hypothesis was rejected and upheld the alternate hypothesis. "This means that there is a significant difference between students' mean performance score of pretest and posttest 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 [18]. 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, [20] and [21] 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 [7], who opined that CAI significantly impacted the students' academic performance.

In the research question three, the findings showed that the null hypothesis 4 was rejected; this led to acceptance of the alternate hypothesis, from the results obtained, the test of null hypothesis that "There is no significant between post-test mean performance scores of students taught Electronic devices and circuits with the aid of electronic workbench software and those taught without the software", it is clear that the value of t which is -9.614 and the p -value which stood at 0.000 which is less than the 0.05 significant level, therefore the null hypothesis was rejected and the alternate hypothesis were upheld. This means that the observed difference is a true difference that "there is a significant difference between students' mean performance score of posttest of control and experimental groups. The difference in the control groups' score of posttest indicates the change in the value of the dependent variable that could be expected to occur without exposure to the treatment.

5. Conclusion and Future Scope

This chapter summarized the study, conclusions were drawn and recommendations were made.

5.1 Summary

The study titled: "Effect of Electronics Workbench Software on Technical College Students' Performance in Electronics Devices and Circuits in Bauchi state Technical Colleges". The major objective of the study is to determine the effectiveness of electronics workbench software use in teaching electronics devices and circuits at technical colleges level in Bauchi state. The study aimed at achieving four specific objectives from which four research questions and four null hypotheses were postulated. 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 pretest-posttest design; the population for the study comprised of 92 NTC II students in 8 Bauchi State Technical Colleges, two technical colleges that are offering Electronics devices and circuits were selected from 8 Technical Colleges. From the two technical colleges intact classes were used with the total number of 92 students. The experiment was conducted at second term 2022/2023 academic session. The instrument used for collection of data for the study was the Electronics Devices and Circuits Performance Test (EDCPT) adopted by the researcher from NABTEB Examination body. The instrument was validated by 3 experts two from vocational education and one in the Department of Foundation of Education 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, two and four were tested using independent sample t -test while, null hypothesis three was tested using paired sample t -test. From the analysis, null hypothesis one and two were accepted and retained while, null hypotheses three and four were rejected.

A reliability coefficient of the tests instrument stood at 0.72 and 0.81 which is high and positive using a split half technique, [31] recommended that any value within the range of 0.5 to 0.9 is acceptable. The researcher and trained research assistance collected the research data 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 pretest 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.

Finally, the findings revealed that, Students taught electronics devices and circuits using electronic workbench software performed better than those taught electronics devices and circuits using traditional demonstration (teaching) method, also there was posttest difference between the performance of students taught electronics devices and circuits using electronics workbench software and those taught using traditional teaching method.

5.2 Conclusion

The findings of this study revealed that, the electronic workbench software is an effective teaching aid that enhanced the performance of technical college students in electronics devices and circuits. Therefore, the persistent and constant failure of electronics devices and circuits students in national examination particularly in Bauchi State may be reduced and their performance in the subject may also be improved when teachers of electronics devices and circuits uses electronic workbench software.

5.3 Recommendations

The following recommendations were brought forward based on the research findings:

Teachers should ensure that low-performance electronics devices and circuits students are exposed to use of electronics workbench software to equip them with learning skills. Technical colleges authorities should encourage electronics devices and circuits teachers to be using electronics workbench software in teaching students electronics devices and circuits practical. Teaching electronics devices and circuits practical using traditional demonstration method should be avoided, this is because of its failure to pave way for technical college students to pass external examination in Bauchi state. Electronics workbench software should be adopted as a teaching aid in other subjects such as Basic Electronic, Basic Electricity, Computer and Communication, etc.

5.4 Implication of the study

Findings of this study, provided data for comparison between students mean performance that were taught electronics devices and circuits using the Electronics Workbench software and those taught using traditional method of instruction. It is clear that electronics workbench software used in teaching electronics devices and circuits to technical colleges students was found very effective, therefore, there are strong indication that the traditional method the students are receiving overtime led to the students' failure in electronics devices and circuits in external examination in Bauchi state.

5.5 Limitations of the study

In course of carrying out this study, the researcher experienced limitations, these include among others: Initial differences across groups emanating from the use of intact classes may not have been taken care of completely by the statistical technique developed for this purpose. This condition will to the extent it prevails affect the validity of the findings. Students who are less motivated or possibly less self-regulated may be more challenged in a similar educational environment. The researcher was aware of the intervening variables that would exist in a quasi-experimental research such as this in which subjects from each of the schools were used as both experimental and control groups. Such variables include the school environment and the social climate. These could affect the result of the study. The use of only NTC II students may affect the generalization of the findings.

5.6 Suggestion for Further Studies

Based on the study findings presented, several avenues for further research could be explored to enhance understanding and extend the insights gained. Among which are:

Long-Term Effects: Consider conducting a follow-up study to examine the long-term effects of the Electronics Workbench Software on students' learning outcomes. Tracking their performance over a more extended period could provide insights into the sustainability of the software's impact.

Differential Impact: Investigate whether certain subgroups within the Experimental group benefited more from the Electronics Workbench Software compared to others. This could involve analyzing factors like prior knowledge, learning styles, or technical aptitude to determine if the software's impact varies based on individual characteristics.

Qualitative Analysis: Incorporate qualitative research methods such as interviews or surveys to gather more in-depth insights into students' experiences with the Electronics Workbench Software. Understanding their perceptions, challenges, and suggestions could provide valuable context for the observed quantitative outcomes.

Usage Patterns: Explore how students engaged with the Electronics Workbench Software during their training sessions. Analyze usage patterns, time spent, and specific

features utilized to gain insights into the software's effectiveness and identify potential areas for improvement.

Comparative Analysis: Extend the comparison beyond just the Control and Experimental groups. Compare the impact of the Electronics Workbench Software with other instructional methods or tools to determine its relative effectiveness in enhancing student performance.

Incorporating these suggestions into further research could help refine and expand the understanding of the effects of the Electronics Workbench Software on student learning outcomes and provide valuable insights for educators, researchers, and educational institutions.

Data Availability

None

Conflict of Interest

I do not have any conflict of interest

Funding Source

None

Authors' Contributions

All the authors contributed in every stage of the work.

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