THE EFFECT OF PERSONALISED SYSTEM OF INSTRUCTION ON TECHNICAL COLLEGE STUDENTS' ACHIEVEMENT IN BASIC ELECTRICITY

by

SIMEON OLUWOLE ODEDE

Student no: 64095991

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DECLARATION

I declare that the thesis “The *Effect of a personalised system of instruction on technical college students’ achievement in Basic Electricity*” is my work and that all the sources that I have used or quoted have been indicated and acknowledged employing complete references.

______________________ 24-02-2022

SIGNATURE DATE

Simeon Oluwole ODEDE

Student no: 64095991

KAKARETŠO

Nyakišišo e laeditše khuetšo ya mokgwa wo o hlaotšwego wa mmotlolo wa thuto wa go ruta (PSI) go phihlelelo ya baithuti ba mo go Mohlagase wa Motheo ka dikholetšeng tša setegeniki. Diteori tša tlwaetšo, tšhomišo ya tshedimošo, le leano la go ithuta di dikologile nyakišišo. Nyakišišo e šomišitše sehlopha sa taolo ye e sa lekanego ya teko ya pele/teko ya ka morago, le ya go se kgethe, moakanyetšo wa boitekelo bja tlholo ya khuetšo ka factorial matrix wa 2 x 2 x 2 woo ka gare ga wona o šomago tshwaro maemong a mabedi a go kgabaganywa ka bong le lefelo la sekolo. Palo ya batho ba ba lego mo nyakišišong e na le baithuti ba ngwaga wa bobedi ka moka ba mešomo ya go amana le boentšeneere ka dikholetšeng ka moka tša setegeniki ka Osun State, Nigeria. Ka go šomiša thekniki ya go dira sampole ka go kgetha, dikholetše tša setegeniki tše nne tša go ba le n = 152 ya baithuti ba Mohlagase wa Motheo gomme barutiši ba bane ba kgathile tema ka nyakišišong. Dikolo tše pedi (se setee sa motsesetoropo gomme se setee sa motsemagae) tšeo go tšona n = 57 e lego ya motsesetoropo gape le ya motsemagae n = 30, di bopile sehlopha sa boitekelo (n = 87), gomme dikolo tše dingwe tše pedi (se setee sa motsesetoropo sa go ba le = 39 le se setee sa go ba le n = 26) di bopile sehlopha sa taolo (n = 65).

Mokgwa wo o hlaotšwego wa tlhahlo o phethagaditšwe ka dikolong tše pedi tša boitekelo ka barutiši ba Mohlagase wa Motheo ba go fapana bao, bjalo ka bathuši ba nyakišišo, ba hlahletšwego tšhomišo ya maano a mokgwa wo o hlaotšwego wa tlhahlo mo go ruteng Mohlagase wa Motheo. Dikolo tše pedi tša taolo le tšona di rutilwe ke barutiši ba tšona ka go šomiša mokgwa wa go ruta wa tlwaelo (CLM). Dihlopha tša baithuti ka moka tše di kgathilego tema ka gare ga nyakišišo, ka ge go sa kgonege go kgetha ka sewelo bakgathatema ba nyakišišo. Nyakišišo e dirilwe ka dibeke tše tshela (beke ye tee ya tlhahlo le dibeke tše tlhano tša nyakišišo ye kgolo). Haephothesese le dipotšišo tša nyakišišo tše lesomenne di botšišitšwe, di arabilwe, ebile di lekilwe ka gare ga nyakišišo. Datha ya khwalithethifi e kgobokeditšwe ka go šomiša diteko tša phihlelelo tše di lekaneditšwego mo go Mohlagase wa Motheo le Maikutlo a Baithuti go lenaneopotšišo la Mohlagase wa Motheo. Didirišwa tše di šomišitšwego di dirilwe teko pele gomme dipoelo di tsentšwe ka khomphutheng ka go šomiša Kuder-Richardson (K-R) fomula ya 20 le Cronbach-alpha, yeo e filego r = 0.937 ya diteko tša phihlelelo ya Mohlagase wa Motheo le α = 0.952 ya Maikutlo a Baithuti go mananeopotšišo a Mohlagase wa Motheo. Datha ye e kgobokeditšwego go tšwa nyakišišong e sekasekilwe ka go šomiša palelo ya boipoeletšo, phesente, tšhate ya paa le palogare ya dipotšišo tša nyakišišo le Tshekatsheko ya Kelo ya Phapano (ANCOVA) ya haephothesese ye e lekilwego maemong a 0.05 a bohlokwa.

Dipoelo tša nyakišišo ye di laeditše gore baithuti ka sehlopheng sa boitekelo ba šomile bokaone kudu go feta dithaka tša bona ka sehlopheng sa taolo ka gare ga dintlha tša phihlelelo ya Mohlagase wa Motheo. Baithuti ba banna ba rutile Mohlagase wa Motheo ba šomiša PSI gomme ba CLM ba šomile bokaone go feta dithaka tša bona tša basadi. Baithuti ba go tšwa dikolong tše di lego ka motsesetoropong ba rutile Mohlagase wa Motheo ba šomiša PSI gomme ba CLM ba šomile bokaone mo go dintlha tša phihlelelo tša palogare go feta baithuti ba go tšwa dikolong tša ka metsemagaeng. Sehlopha sa

boitekelo se bile le ntlha ya maikutlo ya palogare ya godingwana go feta dithaka tša bona tša basadi. Baithuti ba go tšwa dikolong tša ka motsesetoropong ba rutile Mohlagase wa Motheo ba šomiša PSI ba bile le ntlha ya maikutlo ya palogare ya godingwana go feta dithaka tša bona tša go tšwa dikolong tša motsemagae.

Go ya ka dipalopalo go bile le khuetšo ye kgolo ye bohlokwa ya godimo ya tshwaro (PSI) go phihlelelo ya baithuti mo go Mohlagase wa Motheo [$F_{(1,143)} = 171.937$, $P < .05$, $\eta^2 = .546$]. Gape go bile le khuetšo ye kgolo ye bohlokwa ya bong godimo ga phihlelelo ya baithuti ba kholetše ya setegeniki mo go Mohlagase wa Motheo [$F_{(1,143)} = 43.943$, $P < .05$, $\eta^2 = .235$]. Se sengwe gape, go bile le khuetšo ye kgolo ya bohlokwa ya lefelo la sekolo godimo ga phihlelelo ya baithuti ba kholetše ya setegeniki mo go Mohlagase wa Motheo [$F_{(1,143)} = 17.581$, $P < .05$, $\eta^2 = .109$]. Go bile le khuetšo ya kopantšho ye bohlokwa ya mokgwa wo o hlaotšwego wa tlhahlo le lefelo la sekolo godimo ga dipoelo tša thuto tša baithuti ba kholetše ba setegeniki mo go Mohlagase wa Motheo [$F_{(1,143)} = 4.191$; $P = .042$, $\eta^2 = .028$] gomme kopantšho e be e le ya tatelano, e laetša gore khuetšo ya tsenelelano e be e le maatla ka baithuti ba go ruta Mohlagase wa Motheo ba šomiša PSI. Go bile le khuetšo ye bohlokwa ya godimo ya mokgwa wo o hlaotšwego wa tlhahlo godimo ga maikutlo a baithuti go Mohlagase wa Motheo, [$F_{(1,143)} = 11.863$, $P < .05$, $\eta^2 = .077$].

Fela, go šišinywa gagolo gore barutiši ba Mohlagase wa Motheo ba šomiše maano a tlhahlo a PSI ka dihlopeng tša bona tša baithuti go kgontšha phefomentshe ya baithuti. Barutiši ba Mohlagase wa Motheo ba swanela go lekolaleswa tirišo ya tlhahlo ka phapošiborutelong bja bona go akaretša go tloga go tirišo ya tlhahlo yeo e dirago gore baithuti e be batheeletši ba go se tshwenye, go ya go tirišo yeo e kgathišago baithuti tema ka mafolofolo ka gare ga ditshepetšo tša ditshepetšo tša tlhahlo. Se sengwe gape, barutiši ba setegeniki ba swanela gape go tsebišwa maano a kaonafatšo a go fapana ao a tlago ba thuša go hlokomela diphapano gare ga baithuti ka gare ga phapošiborutelo. Se se tla thuša baithuti go ba le maikutlo a mabotse go Mohlagase wa Motheo, ba be le boitshepho, le go itokišetša gabotse go ya go hwetšeng dipoelo tše di botse mo go Mohlagase wa Motheo. Go swanela go ba le kabo ye e lekanego ya ditlabakelo tša motheo tša phethagatšo ye botse ya mokgwa wa PSI mo go ruteng le go ithuteng Mohlagase wa Motheo. Bjalo ka ge go laeditšwe, PSI gape e ka huetša gabotse maikutlo a baithuti go Mohlagase wa Motheo. Go na le nyakego ya gore barutiši ba amogelege mabapi le leano la go ithuta la PSI pele e ka phethagatšwa ka gare ga phapošiborutelo gomme, bjalo, ba swanela go tsenela dikhonferentshe kgafetša, diwekešopo le diseminare, fao ba kago ithuta mabokgoni bja maleba le go amogela go swaragane le leano le la thuto ya boithomelo.

ABSTRACT

The study determined the effect of a personalised system of instruction (PSI) teaching model on students' achievement in Basic Electricity in technical colleges. The behaviourism, social cognitive, and mastery learning theories framed the study. The study employed a pre-test/post-test non-equivalent control group, and a non-randomised, quasi-experimental design with a 2 x 2 x 2 factorial matrix in which the treatment operates at two levels crossed with gender and school location. The population of the study consisted of all year-two students of engineering-related trades in all the technical colleges in Osun State, Nigeria. Using the purposive sampling technique, four technical colleges with n = 152 Basic Electricity students and four teachers participated in the study. Two schools (one urban and one rural) of which urban n = 57 and rural n = 30, formed the experimental group (n = 87), and the other two schools (one urban with n = 39 and one rural with n = 26) formed the control group (n = 65).

The personalised system of instruction was implemented in the two experimental schools by the respective Basic Electricity teachers who, as research assistants, had been trained on the use of the strategies of the personalised system of instruction in teaching Basic Electricity. The two control schools were also taught by their teachers using the conventional lecture method (CLM). Intact classes participated in the study, as it was not possible to randomly select participants for the study. The study lasted six weeks (one week for training and five weeks for the main study). Seven research questions and fourteen research hypotheses were raised, answered, and tested in the study. The quantitative data were collected using standardised achievement tests in Basic Electricity and a Students' Attitude to Basic Electricity questionnaire. The instruments used were pilot-tested and the results were computed using the Kuder-Richardson (K-R) 20 formula and Cronbach-alpha, which gave r = 0.937 for the Basic Electricity achievement tests and α = 0.952 for the Students' Attitude to Basic Electricity questionnaires. Data collected from the study were analysed using the frequency count, percentage, bar chart and mean for the research questions and the Analysis of Covariance (ANCOVA) for the hypotheses tested at the 0.05 level of significance.

The results of this study indicated that the students in the experimental group performed significantly better than their counterparts in the control group in the Basic Electricity achievement scores. Male students taught Basic Electricity using PSI and CLM performed better than their female counterparts. Students from schools located in the urban area taught Basic Electricity using PSI and CLM performed better in the mean achievement scores than students from schools located in the rural area. The experimental group had a higher mean attitude score than the control group. Female students taught Basic Electricity using the PSI model had a higher mean attitude score

than their male counterparts. Students from the schools located in the urban area taught Basic Electricity using PSI had a higher mean attitude score than their counterparts from the rural schools.

There was a statistically highly significant main effect of treatment (PSI) on the achievement of students in Basic Electricity [$F_{(1,143)} = 171.937$, $P < .05$, $\eta^2 = .546$]. There was also a significant main effect of gender on technical college students' achievement in Basic Electricity [$F_{(1,143)} = 43.943$, $P < .05$, $\eta^2 = .235$]. Furthermore, there was a significant main effect of school location on technical college students' achievement in Basic Electricity [$F_{(1,143)} = 17.581$, $P < .05$, $\eta^2 = .109$]. There was a significant interaction effect of the personalised system of instruction and school location on technical college students' learning outcomes in Basic Electricity [$F_{(1,143)} = 4.191$; $P = .042$, $\eta^2 = .028$] and the interaction was ordinal, showing that the interaction effect was stronger with students taught Basic Electricity using the PSI. There was a highly significant effect of the personalised system of instruction on the attitude of students to Basic Electricity, [$F_{(1,143)} = 11.863$, $P < .05$, $\eta^2 = .077$].

Therefore, it is strongly recommended that Basic Electricity teachers use PSI instructional strategies in their classes to facilitate students' performance. Basic Electricity teachers should re-assess their classroom instructional practice to accommodate a shift from an instructional practice that makes learners passive listeners, to a practice that engages learners actively in the instructional processes. Furthermore, technical teachers should also be exposed to different enhancement strategies that will assist them in taking care of individual differences between students in the classroom. This will help students develop positive attitudes towards Basic Electricity, have self-confidence, and be more positively disposed towards obtaining good results in Basic Electricity. There should be adequate provision of the basic facilities necessary for the effective implementation of a PSI approach to teaching and learning Basic Electricity. As indicated, PSI could also positively influence the students' attitude toward Basic Electricity. There is a need for teachers to be knowledgeable about the PSI learning strategy before it can be implemented in the classroom and, therefore, they should regularly attend conferences, workshops and seminars, where they can learn the requisite skills and knowledge to handle this innovative teaching strategy.

DEDICATION

I dedicate this thesis to the Glory of God my creator, who has protected and sustained my life, as well as the lives of my entire household in actualising my lifelong dream. To him, I return all honour and adoration. May his name be praised forever and ever. Amen.

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KEY TERMS

Personalised System of Instruction Strategies

Basic Electricity

Technical College

Technical Education

Behaviourism Theory

Social Cognitive Theory

Mastery Learning Theory

Academic achievement

Traditional or Conventional Lecture method

Innovative Teaching Strategy

LIST OF ABBREVIATIONS AND ACRONYMS

ANCOVA	Analysis of Covariance
H_0	Null Hypothesis
TM	Teaching Method
PSI	Personalised System of Instruction
DI	Direct Instruction
CLM	Conventional Lecture Method
FRN	Federal Republic of Nigeria
BE	Basic Electricity
ANTC	Advanced National Technical Certificate
WAEC	West Africa Examination Council
NBTE	National Board for Technical Education
NABTEB	National Business and Technical Examination Board
TC	Technical College
TE	Technical Education
NTC	National Technical Certificate
BT	Behaviourism Theory
SGT	Social Cognitive Theory
ML	Mastery Learning Theory
EMF	Electromotive Force
AC	Alternating Current
DC	Direct Current
NPE	National Policy on Education
ERC	Education Resource Centre
NERDC	National Educational Research and Development Council
SPSS	Statistical Package for Social Sciences
FME	Federal Ministry of Education
BEAT	Basic Electricity Achievement Test
SABEQ	Students Attitude to Basic Electricity Questionnaire
OSBTVE	Osun State Board for Technical and Vocational Education

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CHAPTER ONE
ORIENTATION OF THE STUDY

1.1 Introduction

Educational literature, practices, as well as the attitude of psychology towards learners, has witnessed radical changes in the education sector in the last decades (Alalwneh & Alomari, 2018:81-92). The concern is being directed to the achievement of high levels of balance between the educational systems on one hand and learning on the other hand. The changes in all the aspects of education are reflected in the instructional deliveries (i.e. how the teacher teaches) and learning modalities (i.e. learners' preparation) both academically (Olatide, 2018:24-36) and in several challenges introduced to current educational systems as a result of the knowledge explosion and economics, as well as the introduction of modern educational technologies (Alalwneh & Alomari, 2018:81-92). Koh, Reddy and Chatterji (2014:42-52) submit that educational policymakers frequently placed the modes of delivering instruction at the centre of concern that need to be revamped. This resulted in them looking out for new techniques and approaches to help the learners cope with these changes (Alalwneh & Alomari, 2018:81-92).

The main objective of providing quality instruction is for learners to excel in their academic activities, mould character and bring about behavioural changes (Onah, 2017:126; Kalaivani, 2014: 28-30). Nonetheless, Alieme (2014:1) posits that the quality of instruction in any teaching-learning situation is governed by how the contents are being presented and explained and how the elements of the task to be learned are being ordered, which eventually influence learners' attitudes. He went further to reiterate that teachers should determine in advance how best to present a given task. He believes that the quality of instruction can affect both learners' learning rate and achievement levels. In essence, the use of inappropriate instructional techniques can lead to poor academic achievement of the students. That is why Olagunju and Babayemi (2014:119-132) specify that ''educational gains, the acquisition of scientific knowledge, attitudes and skills of the students depend on the right type of instructional strategies employed by the teacher". All students are not the same in all ramifications. They acquire learning at different times and rates. For this reason, any inappropriate method used by the teacher affects the objectives of the lesson, makes students scientifically illiterate and places students' performance on a level worse than it could ever be (Olagunju & Babayemi, 2014:119-132).

Amaechi and Thomas (2016:598-603) opines that teaching in this present dispensation has transformed into a non-traditional practice and profession from the former teacher-monopolised (centred) instruction which thrived in antiquity leaving the learners as mere benefactors and recipients of knowledge. Teaching methods, according to Alexandre and Enslin (2017:5-15) in this present educational set-up have gone to non-traditional and modern methods; it is no longer initiation as it has been at the early stage of educational development. Costa (2014:1-120) believes that, during teaching and learning processes, the interaction between the teacher and the learners should encourage the learners to seek knowledge on their own instead of the teacher taking over the passage of information to the students**.**

Different techniques or strategies have been developed through contemporary, efficient and inventive instructions with supportive structures, to get the best out of every learners. Thus, offers students the privileges to express what they want and explore diverse means to unravel a specific academic problem or to organise materials, thereby reducing the appearance of the teacher to that of an ordinary facilitator (Odo, Adenle, & Okwori, 2012:21-29). Therefore, this research uncovered the effect of the personalised system of instruction (PSI) on technical college students' achievement and attitudes towards Basic Electricity in Osun State, Nigeria crossed with gender and school location.

The personalised system of instruction (PSI) is a teaching and learning method that can be included in students' teaching and learning activities. This strategy postulates that all students can learn if they are given the right learning environment. Precisely, Mastery Learning (ML) is an approach in which learners are unable to proceed to the next learning objective until they have demonstrated mastery of the present one (Bandura, 1977; Joiner, 2015). The application of Skinner's theories of learning, grounded in operant conditioning tactics of behaviourism principles with a focus on overt behaviours that can be witnessed and measured, gave rise to the concept of PSI (Alalwneh & Alomari, 2018:81-92).

1.1.1 Background to the study

The process of invention, innovation, and diffusion in technology in any country hinges on the study of science and technology. The significance of technical education and technology instruction cannot be overstated as it is used in almost every man activity, and profession incorporates some aspect of the technical education concept (Olugade, Adekomi, & Sofowora, 2016:1657-1660; Oviawe, Uwameiye, & Uddin, 2017:7-14). According to the Federal Republic of Nigeria, FRN, (2013:24), Technical education is an aspect of an educational process that involves the study of technologies and related sciences, as well as the acquisition of practical skills, understanding, and knowledge relating to occupations in various sectors of the economy and social life.

Mapotse (2019:1) defines technical education as the process of skills transfer that is established by teaching specific skills directed toward a specific type of work, such as electrical house wiring, carpentry, electronic repair, automobile maintenance, and cleaning services, baking, décor, building, etc. Ogundu, Amadi, and Igrubia (2015:369-381) posits that effective technical education and training intend at providing the students with the appropriate skills and information in their respective choice of careers. Technical education programmes (Ogbuanya & Akinduro, 2017:2347-2371) provide the opportunity for students to possess the required information and manipulation skills for an efficient national building. Technical education has contributed tremendously and extensively to nation-building and has influenced directly citizens and national welfare in such areas as building, mechanical/automobile, electrical and electronics, metalwork, and woodwork technology (Bashir, 2018:226-233). Therefore, Technical education is perceived as an agent of development for technical systems as well as for all other transformations in society.

In Nigeria, the principal vocational institutions are the technical colleges (TCs) where Technical Education is provided. This implies that technical colleges play a crucial role in the execution of technical education programmes. These institutions were established to give adequate vocational training designed to equip learners to enter diverse professions and prepare students for a variety of vocations and to generate craftsmen at the secondary and post-secondary levels (Federal Ministry of Education [FME], 2006; Babagana & Medugu, 2012:17-22; Ogundu, Amadi, & Igrubia, 2015:369-381). Technical colleges in Nigeria offer two types of certificates, namely, the National Technical Certificate (NTC) and the Advanced National Technical Certificate (ANTC) (Taale & Mustapha, 2014:16-25). All the technical colleges accredited by the National Board for Technical Education (NBTE) adopted a national curriculum that was modularised into trade-related and trade groups such as electrical/electronic trade, auto-electrical work trade, mechanical engineering trade, building trade, fabrication and welding trade, computer trade, as well as related trade courses like physics,mathematics, chemistry, English, and technical drawing (FRN, 2013).

Nigeria as a nation emphasised significantly on technological and industrial development. Given this, students are being urged to undertake science and engineering-related courses in technical colleges. However, Basic Electricity (BE) is the only subject in technical college that span the entire technical and engineering-related subjects. Basic Electricity is stipulated as one of the trade-related subjects in the National Business and Technical Examination Board (NABTEB) syllabus of technical college (NABTEB, 2019). It is a subject that is taught in year-one, two and three in technical colleges as required by the national policy on education (FRN, 2013).

At the technical college level of education, Basic Electricity according to FRN (2013:21) is an essential trade subject that is offered, intending to foster students with the fundamental knowledge, skills, and disposition to be self-reliant economically. Basic Electricity is the foundation for every other technological subject and serves as a crucial element in the industrial development of any nation because electricity brings life and no industry can operate in the absence of electricity (Amadike, 2007 & Robinson, 2017). Today, Basic Electricity pervades virtually the whole sphere of human activities and occupies a significant position in a country's economic development. Therefore, the social, economic and industrial system of a country is embellished by the knowledge of Basic Electricity. Hence, all students intending to pursue an occupation or profession and progress in the area of electrical and/or electronic technology or relevant course must offer Basic Electricity (Atsumbe, Raymond, & Ajuwon, 2015:598-603; Eze, Nwalo & Udu, 2021:34-45). Basic Electricity affords the students to acquire practical skills in jobs related to electronic devices in their circuit's services and maintenance, for instance on television, radio, electrical installation, and telecommunication devices/equipment.

In technical colleges, the curriculum for Basic Electricity covers the main area of Basic Electricity skills, which comprise: the structure of matter, conductors, and insulators, Ohm's law and its applications; resistors, capacitors and valves and function of resistors, Electromotive Force (E.M.F); and Alternating Current (A.C) and Direct Current (D.C). Others are electrical circuits, indicating and measuring instruments; magnetism, induction and transformer, fluxes, soldering, electrical sign and symbols, wiring and connection of electrical/electronic components. Despite the significance of the subject in technical colleges as a prerequisite for most specialised technical and vocational courses, students' achievement in Basic Electricity is not encouraging.

A critical examination of the NABTEB reports shows persistent reports of the students' low achievement in Basic Electricity (Sanni, 2014; Taale & Mustapha, 2014:16-25; Atsumbe et al, 2015; Robinson, 2017:14-21). The reports revealed that approximately 40% of candidates who enrol for Basic Electricity from 2012 to 2017 obtained credit in the examination (NABTEB, 2018). Education Resource Centre [ERC] (2010:27) also observed apparently, that there is a colossal drop in the students' achievement in technical subjects in Nigeria generally and in Osun state in particular. This was so disheartening to the extent of affecting the student's attitude towards learning negatively (Okonkwo, 2014:15-24). These unsatisfactory situations have been major sources of concern to schools, parents and examination bodies. This revelation appeals for immediate action to prevent the dwindling in the admission of students into Electrical craft and related trade.

The attainment of the Basic Electricity objectives and enhancement of students' achievement in technical colleges rely extensively on many factors. These include the failure of the Basic Electricity curriculum to satisfy the day-to-day exigencies, the comfort of the people and the technological development of the country (Okonkwo, 2014:15-24). Other challenges include inadequate qualified teachers, inadequate methods of instruction, and inadequate teaching facilities and equipment (Atsumbeet al.,2015; Dorgu, 2015:77-87;Ogbu, 2015:162-168; Amaechi & Thomas, 2016; Robinson, 2017:14-21 & Usoro, Akpan & Ikpe, 2018:53-61). Regarding the quality and quantity of teachers, relevant literature reveals that there is a shortage of trained teachers to teach Basic Electricity in technical colleges in Nigeria. Apart from this, some pedagogical skills to impact the knowledge of the students are conspicuously lacking by many of these teachers, they are also deficient in technical knowledge of the subject matter (Ogbu, 2015:162-168; Oviawe et al., 2017:7-14, & Bashir, 2018:226-233).

Other factors identified by Olugbadeet al. (2016:1657-1660) and Eguabor and Adeleke (2017:1-7) that do affect the students' performance in Basic Electricity are; studying methods, student intelligence, gender, motivation, the attitude toward technical teachers and students, self-comportment, students cognitive style and intellectual pattern, career interest, socioe-conomic background, parental influences, school environment as well as school location among others, have a negative influence on the students. Kumazhege (2016:116) further says that excessive use of the lecture technique, inadequate teaching approaches, and a lack of student motivation in learning are all factors that contributed to students' poor performance in the trades. This made them afraid of the subjects and consequently led to poor performance in examinations. The inappropriate facilities for teaching Basic Electricity made the matter worse.

However, the most prominently mentioned and discussed contributing cause to students' low performance in technical college is instructional methods and approaches adopted by technical teachers. Instructional methods or approaches imply the strategies adopted by a teacher to deliver his or her subject matter to learners to promote learning, based on some predetermined instructional objectives (Ayonmike, 2014; Omori, Okon,

& Etan, 2019). Over the years in teaching and learning processes, teachers extremely considered the usage of words to communicate and delivered concepts or facts to their students (Musa, Diraso, L'Kama, & Adamu, 2019:143-150). In the same view, Eze, Ezenwafor, and Molokwu (2015:101-108) agreed that in the technical colleges, teachers always employ traditional teaching approaches, such as lectures, which have been shown to demoralised students and causes learning difficulties. This process is noted by Okafor (2014:48) as an influential antecedent that contributes significantly to the students' poor achievement in Basic Electricity. Onasanya, Adegbija, Olumorin and Daramola (2009:259-272) and Education Resource Centre [ERC] (2010:16) termed this practice the "Chalk-Talk Method". Okafor further emphasised that teachers depend excessively on employing the conventional method, which he submits is not innovative enough because they believe that the method can be used to cover a wider area of subject contents within a short time. Darling-Hammonda, Flooka, Cook-Harveya, Barronb, & Osher, (2020:97-140) affirms that the teachers adopt the method of instruction that simplify their work without much effort, based on their beliefs, individual interests, and discipline norms.

The technical college curriculum specifies various approaches that technical teachers may employ to deliver their lesson. These include lecture, expository approaches, discussion, problem-solving, explanation and demonstration methods (NBTE, 2016). All these approaches to teaching are teacher-centred (Allen, 2015; Atsumbe et al., 2015:380-387; Amaechi & Thomas, 2016; Alaxandre& Enslin, 2017; Friskawati, Ilmawati, & Suherman, 2017:2-6& Robinson, 2017) as the teacher does more of the activities in the teaching and learning processes (Onah, 2017:6). Ogbonna (2013:1-138) asserts that curricular activity in conventional teaching methods depends greatly on textbooks and workbooks. In this condition, the teacher rather than assessing the processes involved in the learning activities sought the correct answer to validate students' learning.

The conventional lecture method (CLM) has failed to recognise the learner's individuality and to encourage creative thinking in the learners leading to poor academic achievement. Consequently, Kimmani, Kara and Njagi (2013:1-14) established that if the instructional strategies of the teachers are ineffective, then there will be inadequate progress in the academic achievement of the students. Ordinarily, schools are appraised basically on their student's performance, and teachers are inextricably linked to the schools they teach and the academic outcomes of those schools (Heck, 2009:227-249). Hence, the student's performance level in the school hangs on the degree of effectiveness of the methods of instruction used by the teachers (Costa, 2014:5). Thus, instructional approaches that teachers employed must be effective, useful, and satisfactory. Teachers needto motivate their students to obtain better results.This denotes that when teachers adopt instructional strategies that are aligned with students' preferred learning styles; learners develop more favourable attitudes toward their teachers' pedagogical attributes (Omori, Okon, & Etan, 2019). Omori, Okon, and Etan, (2019:123-132) concludes that students' academic attainments are influenced when instructional strategies are adjusted in line with students' needs and preferred learning.

At the technical college level of education in Nigeria, teachers are expected to demonstrate competencies in the interpretation of an approved curriculum in their subject area, transforming schools into motivating learning environments. This fact was supported by Costa, (2014:4) who in her study states emphatically that during interactions with students, the teacher is primarily responsible for converting policy into actions and principles based on practices, thus playing an imperative role in educational attainment. The teacher equally serves as an intermediary for the dissemination of knowledge, value and skills in the learning process through instructional approaches they use in the classroom (Kimani, Kara, & Njagi, 2013:1-14). Okafor (2014:48) however, reiterates that the teacher needs a more innovative approach to establish adequately the practical skills which are compatible with today's current-flow management in Basic Electricity. When teachers modify their tactics towards a more creative student-centred strategy can assist the learner to perform excellently well (Zakari, Chine, & David, 2015).

The teaching of Basic Electricity requires a strategy that would enhance students understanding so that their academic achievement can improve. Thus, during the teaching and learning of this course, learners must fully get involved to grab the basic concepts and skills that would be needed for further studies or personal development. Othniel (2015:59-62) while ascertaining the teaching methods technical collegeteachers utilised to facilitate effective teaching of Basic Electricity submits that most concepts in Basic Electricity are best assimilated by the students when the teacher uses a suitable teaching method. As a result, to meet engineering trade objectives, teachers must use an effective technique of lesson delivery that will help learners develop physically, intellectually, emotionally, ethically, and socially in such a way that they will be able to maximise their potential (Saba, Ma'aji & Tsado, 2011:123-136). It is therefore prudent for technology/technical teachers to employ an instructional method that would get learners involved throughout the teaching-learning process. Thus, to ensure that learners' exhibit desired behavioural changes after instruction, some instructional strategies were developed by some researchers. Examples such as Direct Instruction (DI) was developed Siegfried Engelmann and Wesley C. Becker in 1960; the personalised system of instruction (PSI) was developed by Fred Keller in 1968 and Mastery Learning (ML) is attributed to Benjamin Bloom in 1971 (Badru, 2016: 89-95). All these teaching methods or strategies are aimed at ensuring that learners attain a level of mastery in a given task before introducing a new one. For this study, the personalised system of instruction (PSI) will be used to facilitate learning.

In the late 1960s, Fred Keller introduced the personalised system of instruction (PSI) in Brazil, to assist students in learning school subjects without the help of teachers. Keller applied for the PSI programme in the USA due to its huge success in Brazil. According to Paiva, Ferrira, and Frade (2017:370-381), the programme is designed based on behaviourist principles, which has led to widespread adoption by university tutors as well as different groups.The personalised system of instruction is defined by Al-Zboun et al. (2016:101-117) as a system that focuses on teaching the learner through activities performed individually, based on his or her needs and potential, to gain knowledge, attitudes, and competence, as well as self-learning skills, with little or less supervision and guidance from the teacher. Murphy, Redding, and Twyman (2016:3-18) argue that PSI is rooted in guiding learners through different learning components at their speed and with the pre-condition of mastery of the previous learning component, with motivation, guidance, and assessment from peers who have completed the units and tasks before them.

Allen (2015:6) and Friskawati et al. (2017:1-6) view it as a student-centred and person-oriented instructional model that equips learners to work at his/her own pace, master skills and progress through prescribed learning tasks with the teacher acting as a facilitator, tutor and motivator, rather than as the primary source of knowledge. It is an educational pedagogy method of delivering student-centred instruction and addressing changes in educational environments (Houchenset al., 2014 & Clark, 2017) such as changing demographics and socioeconomic needs.

Bautista (2012:573) maintains that in the PSI, the teacher's task is limited to providing support to learners to develop personalised learning plans, likewise identifying their knowledge areas of strength and weaknesses, and adjusting the learning environment and the teaching process in conformity with the learners aspirations, as well as exploring an original learning experience for the students. As a result, the PSI's concept is built on adapting teaching methods to meet the requirements of students rather than forcing students to cope with the applied conventional or traditional teaching approaches (Alalwneh & Alomari, 2018:81-92). Flexibility is one of the basic notions associated with the PSI, because learning can occur at any time, in any place, and through any method. The goal of this activity is to encourage learners to be creative and accountable for their learning (Houchens et al., 2014; Kalaivani, 2014:28-30).

Keller's PSI is otherwise called the Keller Plan (Allen, 2015:6, Kalaivani, 2014:95-107). It entails structuring a learning content into short self-paced modularised instructional entities with study manuals, which is directing learners through the component. At the end of each unit, learners are assessed on each module where they are expected to exhibit mastery of the module by scoring at least 90%. In creating PSI, Keller divided the process into four distinct steps. They include determining what to cover (covering materials) in the course; dividing the materials by breaking them down into small segments; creating means of evaluating the extent of mastery of the material in a given module by the learner and allowing a self-pace progression of learners from a module to module.

Keller established five fundamental elements for the application of the programme, these aremastery of the school subject, the employment of proctors, learning based on the learners, emphasis on written texts, and employing lectures as motivational tools. (Eyre, 2007:317-329; Olatide, 2018:24-36; Mitee & Obaitan, 2015:34-38).On the other hand, learning for mastery speculates that a focused mastery learning classrooms, in contrast to the conventional form of instruction will narrow the performance gap between distinct groups of students in the classroom (Bloom 1971: 47-63; Guskey, 2010). Here, it is the teacher that controls several numbers of group-based instructional techniques in a mastery learning environment, this is done by giving regular and precise evaluative information using diagnostic and formative tests and frequently correcting learners' mistakesduring the learning process (Metzler, 2011).

The personalised system of instruction is a model of instruction that if properly executed can effectively improve students' modes of learning in both the cognitive and non-cognitive outcomes (Zakaria, Septiana & Kurnia, 2018). Diverse research from wide areas or fields of study has stressed the capabilities of PSI as a credible and reliable mode of teaching (Springer & Pear, 2008:829-835). The successful use has been documented for mathematics (Alieme, 2014; Paiva, Ferreira, & Frade, 2017:370-381), physics (Gutmann, Gladding, Lundsgaard, & Stelzer, 2018:1-12), physical education (Prewitt, 2014; Allen, 2015; Friskawati et al., 2017), and vocational courses (Alalwneh & Alomari, 2018:81-92).

In the view of Wei-Li (2016:105-112), conventional or traditional teaching is a teaching method that involves a face-to-face classroom relationship between the teachers and the learners. These teachers introduced the lesson by initiating class conversation and discussions and broadly focused on knowing the textbooks' contents and their notes. He does all the talking and writes on the chalkboard if he wishes as he explains; thus, making the students' involvement and participation very low because communication is often one-way time in the process of teaching. Therefore, the existing traditional (lecture) method of instruction in the normal classroom setting is hitherto referred to as the conventional teaching method (Wei-Li, Mai, & Tse-Kian, 2016:147-156).

Over the years, students have always been exposed to the conventional way of teaching because the teachers see learners as possessing 'knowledge holes' which require to be supplied with knowledge. However, the strategy is not completely bad neither is it being advocated for relegation nor to be out-rightly discarded. Most of these new approaches still use the conventional or traditional method at one point or another; as the new strategy develops, the quest for a more learner-centred and result-oriented learning strategy is to maximise learning opportunities and diversify their benefits concealed in the learning outcomes (Wei-Li Yap et al., 2016:147-156). A learner-centred approach or strategy must take into cognizance the attitude of the learners with the task ahead in reaching one's goal, hence the introduction of attitude as a dependent variable in this study. The teachers' attitude may invariably influence the students' attitudes, and this may influence students' achievement in terms of learning outcomes. In educational research, attitude continues to be a source of concern. It is worth noting that a learner's attitude can be influenced by their confidence in their capacity to execute a task.

The location of the school in this study is a measure concerning schools located in a rural or an urban area. The rural area is characterised by poor and inadequate social amenities, while the urban area is made up of good and accessible roads, good drinkable water, health care centres, a steady power supply and good schools. The school location has had a considerable influence on the academic success of the students (Alieme, 2014). According to Alieme (2014:96-97), schools located in the urban area have the possibility of having better and state-of-the-art equipment and adequate infrastructural facilities which their students have been exposed to, which their counterparts in the schools located in the rural area are not exposed to. Furthermore, he emphasised that the learner's higher degree of interest is likely to arouse in a better educationally stimulating environment, thereby helping them to learn more and perform better. It is pertinent to note that the location of a school can significantly influence teaching and learning. The poor performance of learners in Basic Electricity might also be associated with the school location.

Gender is another moderating element in this study, in addition to school location. Gender is a mental consciousness of being male or female (Agbara, Chagbe & Achi, 2018). It is a behavioural sequence and disposition recognised as masculine or feminine within a society (Onah, 2017). The gender of students may be a decisive factor in students' achievement in Basic Electricity. The question of whether boys or girls have superior academic proficiency in school subjects is a hotly discussed topic. The issue of gender disparity in technical/technology education, especially in Basic Electricity has implications for their future career and the technological advancement of the nation. There are a variety of perspectives and reports on the relative abilities of male and female students in technical education. From the researchers' experience as a teacher for more than fourteen years, right from the number of male and female enrolment in technical education, it appears that technical education is a male-dominated course. Sanni (2014:55) remarked that there is the existence of disparities between the male students' performance and female students' performance in technical education. The issues of gender becomes germane in this present study because technical colleges in the study area are co-educational institutions, which are made up of boys and girls; hence it is necessary to explore what impact gender has on the achievement of students using PSI.

In pursuance and in fulfilling the aim and objectives of technical education, and the desire to impart to the technical college students, the fundamental and employability skills that would enable them adapt accurately to the workplace and enhance their academic achievement, inculcate in them a positive attitude, eradicate gender differences and strengthen female students' enrolment required adequate and efficient instructional technique. It is worthy to note that there are various methods of enhancing the teaching and learning of Basic Electricity in technical colleges, but this has been neglected hence this study hopes to fill this gap.

1.1.2 PSI in enhancing teaching approach

The search for methods of enhancing the students' achievement in Basic Electricity has been a continuous exercise, most especially in this type of course which is practically oriented. Literature shows that diverse factors influence students' achievement, among which are: school quality, teacher quality, the inappropriate method of teaching, inadequate preparation, a scarcity of trained teachers, a lack of proper instructional aids, inadequate school environment and poor infrastructural facilities, among others. Many studies have shown that the constant low students' achievement in Basic Electricity and other related courses was accounted for by the inappropriate teaching methods (Raj, 2012; Faremi, 2014:391-396; Sanni, 2014; Taale & Mustapha, 2014; Atsumbe et al., 2015).

There is evidence that some learners learn quite well through independent study while others need highly structured teaching-learning situations. Many studies have confirmed the inadequacies of the conventional method of teaching in producing expected learning outcomes (Atsumbe et al., 2015:380-387; Amaechi & Thomas, 2016; Robinson, 2017; Allen, 2015; Alexandre & Enslin, 2017; Friskawati et al., 2017), teachers mainly employed teacher-centred lecture method, for implementing the curriculum this cumulates into an inefficient use of varieties of instructional methods. There is a conspicuous lacks of student-centred teaching methods that encourage activities that will develop reasoning skills and processes through a scientific approach.

The personalised system of instruction (PSI) strategy is intended to foster students' individualistic learning while also giving teachers more freedom to connect with students who require more assistance (Metzler cited in Allen, 2015). Keller (1968:79-88) originally designed the PSI model for psychology courses of large sizes. Prewitt (2014:1-173), Allen (2015:1-153), Alaxandre and Enslin (2017:5-15) and Alalwneh and Alomari (2018:81-92) suggest that PSI could have favourable benefits in other educational domains, their findings reveal that the students' pre-test and post-test scores were statistically significant. They concluded that, when properly applied, the PSI model was effective in boosting achievement levels.

While findings such as these propose the PSI model to have the capability of enhancing students' achievement, the model was not used in technical colleges even where practical skills are required. Critics pointed to the declining popularity of the model as its inapplicability to today's educational system (Prewitt, 2014). The decline in use could be due to the inadequate time required to develop the PSI model (Alieme, 2014), difficulty in integrating the self-paced/mastery mode to school academic calendars (Allen, 2015), resistance by the teachers to transit from typical teacher-centred to student-centred approach; so also, the administrators' disposition not to value the model. The vast changes in the landscape of education could be the reason why teachers in technical colleges do not adopt the PSI model. Another possibility is that there is not enough research on the concept as it applies to technical education. Given the foregoing, there is a research gap in the PSI model. More research is indispensable, in particular, to determine the PSI's potential influence on technical college students. Furthermore, the PSI model's groundwork hinges on social cognitive theory, behaviourism theory, and the theory of mastery learning, all of which argue that learning is a result of psychological and environmental factors (Allen, 2015 & Joiner, 2015).

1.2 Statement of the problem

Basic Electricity is the cornerstone for every other technological subject and serves as a crucial element in the industrial development of any nation. Basic Electricity is the only subject in technical college that traverse the entire technical and related engineering subjects. It is an essential trade subject that affords the students to acquire practical skills in jobs related to electronic devices in their circuit's services and maintenance, for instance on television, radio, electrical installation, and telecommunication devices/equipment. The National Business and Technical Examination Board (NABTEB) reports show the persistent records of the students' low performance in

Basic Electricity. This has been attributed to teachers' inappropriate pedagogical approaches, as mentioned earlier. Various methods of improving the poor performance of students have been neglected, hence there is the need to look for more proactive methods that will incorporate individual differences of learners and make them learn in a friendlier but profitable way. To search for more efficient methods that will improve students' academic performance call for the trial of another individualised approach such as personalised system of instruction (PSI) package.

The PSI was proven to be effective in boosting academic achievement in a variety of areas, including human growth and development, economics, writing skills, biology, medical school biochemistry, introductory psychology, and applied behaviour analysis (Warner, 2021:56-57). The PSI has also been found to be effective in subject like students' engagement (Wood, 2018), physical education, chemistry, social studies (Nnamani & Oyibe, 2016a; Olatide 2018), mathematics (Paiva, Ferreira, & Frade, 2017; Adeniyi, 2019), physics and vocational studies (Alalwneh & Alomari, 2018). Alalwneh and Alomari (2018:81-92) found that the PSI method has an explicit influence on the students' achievement, compared to the traditional teaching method. According to Zakaria, Septiana, and Kurnia, (2018:95-107) students in PSI classes generally report more satisfaction with their experiences than non-PSI students. Ginanjar (2019:32-36) reported that the PSI approaches were more effective in improving academic achievement, course satisfaction, and motivation. As a result, the purpose of this research is to investigate the effect of the personalised system of instruction (PSI) on technical college students' achievement in Basic Electricity in Osun state, Nigeria.

1.3 Main and sub-research questions

The major research question in this study is:

What are the effects of the personalised system of instruction (PSI) on technical college students' achievement in Basic Electricity?

The main research questions of this study will be addressed by the following sub-research questions;

i) What is the profile of the participants in terms of their;

a. Age;

b. Gender; and

c. Location of school.

ii) What is the mean difference in the achievement scores of students exposed to the personalised system of instruction method and those that were exposed to the conventional lecture method?

iii) What is the mean difference in the gender scores of students exposed to the personalised system of instruction method and those that were exposed to the conventional lecture method?

iv) What is the mean difference in the school location scores of students exposed to the personalised system of instruction method and those that were exposed to the conventional lecture method?

v) What are the mean attitude scores of students exposed to the personalised system of instruction method and those that were exposed to the conventional method?

vi) What is the effect of gender on students' attitude when taught Basic Electricity using the personalised system of instruction method and the conventional lecture method?

vii) What is the effect of school location on students' attitude when exposedto the personalised system of instruction method and the conventional lecture method?

1.4 Aim of the study

This study was conducted to examine the effect of the personalised system of instruction (PSI) strategy on technical college students' achievement in Basic Electricity in Osun state, Nigeria.

1.5 Objectives of the study

Specifically, the following objectives were designed to achieve in this study. The study:

1. Determine the respondents' profile in terms of:

   a. Age;

b. Gender; and

c. Location of school.

2. Find out the mean difference in the achievement scores of students exposed to the personalised system of instruction method and those that were exposed to the conventional lecture method
   a. students' achievement in Basic Electricity.
   b. students' attitude to Basic Electricity.
3. Investigate the influence of gender of students exposed to the personalised system of instruction and those that were exposed to the conventional lecture method on the
   a. achievement in Basic Electricity.
   b. attitude to Basic Electricity.
4. Determine the influence of school location of students exposed to the personalised system of instruction and those that were exposed to the conventional lecture method on the
   a. achievement in Basic Electricity.
   b. attitude to Basic Electricity.

1.6 Research hypotheses

The following hypotheses were formulated and tested at a .05 level of significance.

H_{01}: There is no statistically significant main effect of treatment (PSI) on technical college students'

(a) Achievement (pre-test and post-test scores) in and

(b) Attitude to Basic Electricity.

H_{02}: There is no statistically significant main effect of gender on technical college students'

(a) Achievement (pre-test and post-test scores) in and

(b) Attitude to Basic Electricity.

H_{03}: There is no statistically significant main effect of school location on technical college students'

(a) Achievement (pre-test and post-test scores) in and

(b) Attitude to Basic Electricity.

H_{04}: There is no statistically significant interaction effect of treatment (PSI) and gender on technical college students'

(a) Achievement (pre-test and post-test scores) in and

(b) Attitude to Basic Electricity.

H_{05}: There is no statistically significant interaction effect of treatment (PSI) and school location on technical college students'

(a) Achievement (pre-test and post-test scores) in and

(b) Attitude to Basic Electricity.

H_{06}: There is no statistically significant interaction effect of gender and school location on technical college students'

(a) Achievement (pre-test and post-test scores) in and

(b) Attitude to Basic Electricity.

H_{07}: There is no statistically significant interaction effect of treatment (PSI), gender, and school location on technical college students'

(a) Achievement (pre-test and post-test scores) in and

(b) Attitude to Basic Electricity.

1.7 Significance of the study

Notable assumptions and assertions have been raised concerning the effectiveness of the personalised system of instruction (PSI) approach to teaching in other subject areas. It is, therefore, believed that the findings of the research will be of tremendous assistance to technical educators in their search for the best method(s) of teaching Basic Electricity.

The outcomes of this study will contribute tremendously to the teachers' choice of method of teaching. Teachers, students, curriculum planners, stakeholders, policymakers and the nation at large will gain significantly from the findings of this study. The outcomes of this research are anticipated to have a reasonable influence on the participating students after they have been exposed to the personalised system of instruction (PSI), which will assist the learner in repeatedly studying practical skills at his/her own pace. The findings from this study could generate empirical evidence for technical teachers to develop and apply new methods and techniques of teaching which would aid learners to attain mastery of curriculum content areas they are exposed to. It could also provide educational policymakers with information useful in formulating educational policies like the development of the technical college Basic Electricity curriculum and considering the level at which technical college teachers discharge their duties.

Further, the outcome of the study could also contribute significantly towards curriculum planning, development and training of technical college teachers at large for better classroom effectiveness, which could culminate in improved learners' academic performance in Basic Electricity, promote conceptual understanding and improve learners' attitude as well as their teachers. Besides, it will help technical teachers to consider gender issues when teaching Basic Electricity. It would also allow teachers to be more creative without having to rely on a dogmatic approach to the established method defined in the curriculum.

Finally, the outcome of this research may be useful to stakeholders by providing them with information to revitalise the technical education sector by citing schools in a conducive environment, so that the stated goals and objectives of the programme could be achieved.

1.8 Scope of study and research site

The effect of the personalised system of instruction (PSI) (teaching style), gender, and school location on students' achievement and attitudes to basic electricity were investigated in this study. This study focused on the entire technical colleges in Osun State. Osun state in South Western Nigeria was created in August 1991. It has a landmass of 9,251 Km^2, a population of 3.42 million by the 2006 population census and is located at longitude 7º 30'N and latitude 4º 30'E.

There are ten (10) National Board for Technical Education (NBTE) approved technical colleges in Osun State, out of which nine (9) are owned by the state government and one (1) is owned by the federal government whose students were used as participants for this study. Besides, needed facilities such as workshops and other types of equipment required for conducting this study were available in these schools. These schools include; Government Technical College Osogbo, Ile-Ife, Gbongan, Iwo, Ara, Inisa, Otan Ayegbaju, Ijebu-Jesa, Osu and Federal Science and Technical College Ilesha. The study covered Capacitors in an alternating circuit; Series Resistor-Inductor (R-L), Resistor-Capacitor (R-C), and Resistor-Inductor-Capacitor (R-L-C) circuits; Resonance and resonance frequency; Magnetism and Electromagnetism; Mutual inductance; Transformer (losses and how to minimize losses in a transformer); Transformer lamination; types of transformers.

1.9 Limitations and delimitation

The current research is confined to determining the effect of the personalised system of instruction (PSI) on technical college students' learning outcomes and attitudes toward Basic Electricity. The investigation was restricted to only the Basic Electricity course in the technical college curriculum of the Federal Republic of Nigeria. The PSI is effective in teaching skills in various activities (Friskawati et al, 2017), but this study solely compares Basic Electricity content knowledge to a conventional lecture class.Only year-two students of engineering and the related courses participated in the research. The study was delimited to the capacitor in an alternating circuit; series resistor-inductor, resistor-capacitor, and resistor-inductor-capacitor circuits; Resonance and resonance frequency; Magnetism and Electromagnetism; Mutual inductance; Transformer (losses and how to minimise losses in transformer); Transformer lamination; types of transformers. Besides, the study was limited to state-owned technical colleges.

1.10 Definition of terms

Academic achievement: In this study, it denotes the learners' scores on the Basic Electricity Achievement Test (BEAT) after being exposed to treatment (PSI).

Assessment: can be described as achievement in a single subject, or a group of subjects, as measured by examination scores. In this study, this is the strategy used by teachers in the selected Technical Colleges to obtain data on how much students have learnt after being exposed to the treatment (PSI and CLM).

Personalised System of Instruction: It is a teaching methodology that is self-paced and mastery-oriented and which allows learners to proceed only after the mastery of the previous lesson. This study denotes the method of teaching utilised by teachers used as the treatment to obtain achievement scores in a Basic Electricity lesson.

School location: This refers to the Technical Colleges which are found in both rural and urban areas.

Instructional Strategy: This is the method that the teacher uses or adopts to achieve stated objectives in the classroom.For this study, instructional strategies employed are the PSI and the conventional method.

Pedagogy: This refers to the creative way of using PSI strategies by the teachers to teach learners Basic Electricity to attain mastery of the curriculum contents.

Gender: This refers to the psychological characteristics or attributes that are associated with such categories as female or male (feminine or masculine).

Effect: is the capability of producing a result.

Feedback: Teachers' comments on their students' performance in the classroom. This includes things like strengths, weaknesses, grades, and so on.

1.11 RESEARCH REPORT FORMAT

The following outlines were followed in this research report:

CHAPTER ONE

ORIENTATION OF THE STUDY

Chapter one gave an introduction and background to the study; this involves the effects of a personalised system of instruction on the achievement of students. In addition, it also discusses the study motivation, problem statement, main and sub-research questions, the aims and objectives of the study, research hypotheses, significance of the study and study site, limitations and delimitation and definition of terms.

CHAPTER TWO

REVIEW OF RELATED LITERATURE, THEORETICAL FRAMEWORK AND RELATED EMPIRICAL STUDIES

The chapter explains the conceptual framework of PSI. The history of technical education in Nigeria was discussed. The importance of Basic Electricity as a subject in technical college was highlighted. Current assessment practices in schools, the personalised system of instruction and students' achievement, lecture method and students' achievement, attitude and students' achievement, gender and students' achievement, school location and students' achievement was discussed. Last, the behaviourism theory, the social cognitive theory and mastery learning theory were also discussed. Empirical studies related to the study were reviewed and a summary of the literatures was presented in the chapter.

CHAPTER THREE

RESEARCH METHODOLOGY, PARADIGM AND PROCEDURE FOR DATA COLLECTION AND ANALYSIS

The methodology used to answer the study questions and hypotheses is described in this chapter. In this chapter, the research paradigm, research design, philosophical assumption, population, sampling technique and sample, research instrument and instrumentation, data collection procedure, data analysis and interpretation procedure, permission to conduct research, ethical considerations/issues, and methodological challenges were all discussed.

CHAPTER FOUR

DATA PRESENTATION, RESULTS AND DISCUSSION OF FINDINGS

This chapter summarises the findings from the main study to respond to the research questions and hypotheses. The data collected in the field for the pre and post achievement tests, as well as the attitude questionnaire in the experimental and control groups, were analysed and summarised. The findings were also discussed in this chapter.

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

This chapter gives a summary of the study's major findings, conclusions, and study limitations, as well as the study's implications, recommendations, and suggestions for further research on PSI.

1.12 INFERENCES

The researcher provided background and context for the study in this chapter. The impact of teachers' weak teaching pedagogy on technical college learning outcomes was explored, as well as the study motivation on students' low performance in Basic Electricity. The background and orientation of the study allows the researcher to understand how the quality of instruction can affect both learners’ learning rate and achievement level. In essence, the use of inappropriate instructional techniques was found to lead to poor academic achievement of the students. Finally, the objectives, major questions and sub-questions, significance of the study, scope, and study site were discussed. In Chapter Two, a review of the selected and relevant literature will be done.

CHAPTER TWO

REVIEW OF RELATED LITERATURE, THEORETICAL FRAMEWORK AND RELATED EMPIRICAL STUDIES

2.1 Introduction

This chapter reviewed important research literature relevant to this research study. The literature reviewed poses a review on technical colleges in Nigeria, as well as the development of technical education in Osun State; Basic Electricity as a subject in technical college; Current assessment practices in technical colleges; teaching approaches in Basic Electricity; students' achievement, conventional lecture approach and students' achievement, personalised system of instruction as an innovative method of teaching, gender and students' achievement, school location and students' achievement; attitude and students' achievement. The theoretical framework that underpins the practice of the personalised system of instruction (PSI) teaching strategy was discussed. A review of related empirical studies was also performed. The conceptual structure of this study concludes this section, which is based on the combination of concepts and assumptions explored in the literature.

2.1.1 Technical Colleges in Nigeria

Technical colleges (TCs) in Nigeria are educational institutions tasked with the responsibility of training a qualified technical workforce for the nation's technological and economic development (Diraso, Baba, Ibrahim & Musa, 2019). Trade schools are another name for technical colleges. TCs are Nigeria's most important vocational institutions, providing substantial practical training to prepare students for careers in a variety of fields. To meet the set goals for this component of education, the primary elements of the curriculum exercise for technical colleges are designed in the foundation and course modules of each programme of study. In other words, TCs in the Nigerian educational structure are equivalent to traditional secondary schools and are considered one of the post-primary education sectors, with a curriculum that includes "general education, theory and associated courses, workshop practice, industrial training/production works, and small business management and entrepreneurial training" (FRN, 2013:16). Technical colleges are specifically intended to teach individuals to gain manipulating skills, fundamental scientific knowledge, and the mindset demanded of sub-professional craftsmen and artisans (Okolie, Igwe& Elom, 2019).

Technical education, according to Puyate (2016), is a subject/field that allows students from elementary to higher education to gain knowledge of technical, consumer, occupational, recreational, organisational, managerial, social, historical, and cultural aspects of industry and technology. Vocational/technical education, in his opinion, is a programme in which students gain industrial-technical knowledge and skills through creative and problem-solving learning experiences that include activities such as experimentation, planning, design, construction, evaluation, and using tools, machines, materials, and processes.

Technical colleges (TCs) were established in Nigeria for the secondary and post-secondary education of craftsmen and master craftsmen (Raymond, 2013; Federal Republic of Nigeria (FRN), 2013:16-17). Nigeria has 107 technical colleges certified by the National Board for Technical Education (NBTE). Out of which 11 were federal technical colleges and 95 were owned by states, and one was privately owned, spread over Nigeria's various geographical zones and places (NBTE, 2016). These TCs are designed to help students develop skills in 34 trade areas, including computer craft, building, woodwork, hospitality, textile, printing, beauty culture, business, and electrical and mechanical engineering. Related trade courses include mathematics, English, physics, chemistry, and technical drawing. (FRN, 2013).

According to the National Policy on Education, for excellent student performance, a teacher-to-student ratio of 1:20 should be maintained, and private cubicles should be allocated for practice to allow pupils to be versatile in practice (FRN, 2013). The craft training curriculum lasts three years, similar to senior secondary school, and one year for advanced programmes. Each school was required to establish a section where trainees may receive on-the-job experience and training for the benefit of the institution and the general public. Specifically, the technical college programme aims to help technical college graduates gain employment either at the end of the programme or on completion of one or more modules of employable skills, start their own businesses and become self-employed, as well as create jobs for others, and continue their education in advanced technology programmes at higher institutions such as Colleges of Technology, Polytechnics, Monotechnic, Colleges of Education (Technical) or Universities (FRN, 2013).

According to the National Policy on Education, the major components, are:

- Creating an atmosphere that allows students to apply their attitudes, awareness, abilities, and values in a realistic work setting; this involves maintaining practical linkages with a variety of agriculture, business, and industry-related fields (general education);
- Theory and practice knowledge that pertains to how students will likely perform in the workplace;
- Provide learners with opportunities to practice critical skills (workshops);
- Prepare students to be well-equipped to perform a unified function in a range of job or professional contexts (industrial training/production work), both within and outside of manufacturing or commercial domains (FRN, 2013).

Hence, Abdullahi (2010:17-22) underlined that classroom and laboratory experiences assist students in making better informed educational and career decisions. This indicates that vocational/technical education is recognised as the component of education that prepares people for employment. It serves as the backbone of the country's job-related training and education programmes (FRN, 2013). As a result, technical education necessitates that both classroom instruction and workshop practice be included in its teaching and learning (Okwelle, 2016). Teaching and learning at technical colleges should be structured in a precise environment to monitor student performance (Zais, 2011; Ogundu, 2010).

The technical college curriculum outlines a variety of delivery methods that technical teachers might use. Lecture, expository approaches, discussion, problem-solving, explanation, and demonstration methods are only a few examples (NBTE, 2016). All these teaching methods are teacher-centered (Allen, 2015; Atsumbe et al., 2015; Amaechi & Thomas, 2016; Alaxandre & Enslin, 2017; Friskawati, Ilmawati, & Suherman, 2017& Robinson, 2017), as the teacher performs the majority of the activities in the teaching and learning processes (Onah, 2017:6). Traditional teaching approaches, according to Ibe, (2017:129-137) rely heavily on textbooks; the knowledge that teachers disseminate to students is directly aligned with the viewpoint of the textbook; most classrooms encourage competition among students, structurally discourage cooperation, and require students to work in relative isolation on tasks that require low-level thinking rather than higher-order thinking; students' independent thought is devalued in most classrooms. When asking students questions, most teachers do not want to see if they can think through complex topics; instead, they want to see if they know the "correct" answer, and schooling is based on the idea that there is a fixed reality that students should be able to comprehend. (Ekon, Ekwueme & Meremikwu, 2014; Ibe, 2017).

According to Mazi (2016), in public examinations, it is becoming clear that technical college students are no longer achieving well. This is confirmed in a report from the National Business and Technical Examination Board (NABTEB), which indicated that technical college students are no longer dedicated to learning, resulting in low performance on public examinations (NABTEB, 2015). The government, parents, instructors, and even students themselves have been concerned about the issue of student’s poor academic performance in Nigeria. The standard of education is determined not only by how well instructors perform their jobs but also by how well the school environment is being coordinated. (Thomas & Amaechi, 2019; Onodugo, Akubue, &Eneh, 2020). Inadequate teaching methods may be responsible for students' poor performance at technical colleges.

Based on the philosophical framework highlighted above, this study sought to find a means to improve the students learning outcomes in technical colleges in Osun State. Therefore, the research investigates the impactof the personalised system of instruction on student achievement in Basic Electricity. It primarily focuses on technical colleges in Osun state.

To explore technical education in Osun State, the growth and expansion of the technical college in Osun state as discussed below.

2.1.2 The development of technical education in Osun State

The history of technical education in Osun State is dated back to the Old Western State when four institutions were created in 1959 under the auspices of UNESCO.Between 1980 and 1985, the Oyo State government planned to build 18 new technical institutes and develop the current six, including the one in Ile-Ife, according to the Fourth National Development Plan. Oyo State intends to promote Technical Education by incorporating technical subjects into the curriculum of 700 secondary schools, and the Ibadan Polytechnic will be expanded with four satellite campuses in Saki, Esa-Oke, Eruwa, and Iree, with Business and Technical Education for teachers at the National Certificate in Education (N.C.E.) level (Lawal, 2012:208-217). Except for the 18 Technical Colleges, which were unable to be established due to a change of administration during the same time, all of these were completed. After splitting from the official Oyo State in 1991, Government Technical Colleges in Osogbo and Ile-Ife, as well as the Ibadan Polytechnic's two satellite campuses in Esa-oke and Iree, became part of Osun State.

In 2001, the Chief Akande-led administration in Osun State established seven new Technical Colleges throughout the state, each with trade and basic subjects, in recognition of the importance of Technical Education as the foundation of technological development and accordance with the government's self-employment policy, according to Lawal (2012:208-217). Some of them are as follows: Government Technical College, Inisha, specialises in ceramics; Government Technical College, Gbongan, specialises in textiles; Government Technical College, Ara, focuses on food technology, while Government Technical College, Osu, focuses on computer science. Government Technical College, Otan-Ayegbaju, focuses on electrical and electronic engineering, whereas Government Technical College, Iwo, focuses on block laying and concrete construction while the Government Technical College at Ijebu-jesa specializes on Mechanical aspect. These technical colleges are situated in both rural and urban areas and are all mixed schools having both boys and girls.

The concept of Basic Electricity is discussed below to enable us to understand how important the subject in the technical college curriculum in Nigeria is.

2.1.3 Basic Electricity as a subject in technical college

Basic Electricity refers to the generation, transmission, and distribution of electricity (Amadike cited Robinson, 2017). Basic Electricity, according to Robinson (2017:14-21), is the base of all technological topics and is also essential to every nation's economic development, because no industry can function without electricity. Basic Electricity knowledge is essential for improving the country's social, industrial, and economic systems. Basic Electricity is a trade-related module in the curriculum of a national technical institution that seeks to provide trainees with the fundamental knowledge and practical abilities in the field of electricity and electronics. There are more opportunities for practical investigations offered by Basic Electricity including knowledge demonstration and understanding through both talk and activity for students (Mbonyiryivuze, Yadav, & Amadalo, 2019).

Basic Electricity is a technical college course that provides students with foundational information to help them perform better in all elective courses in the field of electricity and electronics (Ogbuanya, Attahiru, Tiough & Obe, 2017:4199-4221). Every student who wants to pursue a profession and progress in the area of electrical/electronic technology or a related field must study this subject. Additionally, Basic Electricity as one of the important subjects in technical college have applications encompassing many aspects of oureveryday life.

According to the National Business and Technical Examination Board's (NBTE, 2010:1-130) syllabus, students should be able to demonstrate an understanding of the following: structure of matter and its relevance to electricity, chemical sources of electromotive force, electric circuit analysis, principles of A.C. and D.C. generation, principles of magnetism, series/parallel connection of electrical components, and operations involving electricity. Topics in Basic Electricity, on the other hand, have been noted to feature several concepts in which students form beliefs that are not scientifically acceptable. Basic electricity ideas are particularly difficult to grasp since they are abstract and complex, making them challenging for students to comprehend. According to Usman and Madudili (2020:259-271), gaining a good understanding of Basic Electricity demands a firm knowledge of some manipulative and analytical skills, which, if correctly taught, will help students enhance their academic performance.

To achieve the objectives of Basic Electricity, any module that begins at the commencement of a term must end at the end of the term. Therefore, teachers must devise mechanisms for reliably assessing learners to provide final grades to students at the end of the term. In the case of students who have completed their modules, a national examination will be taken for them. It is observed in the curriculum that the conventional approach of teaching trade science and trade calculation as separate and independent disciplines in technical college programmes is no longer appropriate (NBTE, 2010). To improve students' achievement in Basic Electricity, various instructional methodologies have been adopted. However, a critical question that has remained largely unaddressed is whether instructional practices that result in high conceptual knowledge increases have long-term consequences (Mbonyiryivuze et al., 2019). It is only with innovative teaching approaches by teachers that the objectives can be achieved during their instructional delivery. As a result, research into the effects of the instructional approach in enhancing students' learning outcomes in Basic Electricity is a contentious issue.

The section below elaborates on the curriculum evaluation techniques, which measured how far students have attained the given objectives, for a better understanding of Basic Electricity as a subject in technical institutes. This will provide an understanding of the importance of assessment and how the students learning outcome in a particular domain has been measured in Basic Electricity.

2.1.4 Current Assessment Practices in Technical Colleges

Assessment is used to judge how well technical college students perform in Basic Electricity. The process of acquiring information, information collection devices, and interpretation procedures are all part of the assessment process. As a result, assessment pervades every aspect of the lives of educators and students, necessitating the use of an object-oriented decision-making process. A part of this is educational institutions or schools. Assessment within the school, or educational assessment, is viewed by Satterly cited in Adebule (2016:35-42) as a catch-all word for all activities and outcomes that describe the nature and scope of children's learning, as well as the degree of correspondence with the learning environment. The assessment of learning in technical colleges is usually based on the demonstration of competence in certain domains. Curriculum frameworks and course outlines codify the domains, as well as the goals and objectives that address them. Therefore, to establish whether technical college students have achieved the aims or objectives set for them, some indicators must be used. The indicators used range from simple observational data to a group given standardised tests; from a simple homework or assignment to the execution and analysis of a complicated laboratory experiment.

Adebule (2016:35-42) believes that educational performance is measured by how low or high students' test scores are. It is difficult to separate school assessments from schooling. In education, school assessments are commonly used to judge how far learners have learnt or mastered a specific task in the classroom (Anikweze, 2011;

Aduloju, Adikwu & Agi, 2016). It is also used to see how well an educational process is meeting its goals. Assessment is carried out to determine the status or level of a learner's progress based on expected results that must be established as objectives before exposing students to educational procedures (Anikweze, 2013; Adebule & Adebule, 2014:5-11). In technical college, for example, assessing students is a continuous process. Assessments are used to evaluate education policies and programmes, monitor the quality of school systems, make crucial instructional decisions regarding children, and leverage substantial educational change (Clarke, 2017:1-42).

The evaluation of students' level of understanding and comprehension is indeed had a significant impact on how and what teachers teach (Orubu, 2013:57-68; Raudonyte, 2019:1-35). To Onuka and Akinyemi (2012:37-52) assessments are a powerful tool for motivating learners to modify their behaviour. However, multiple types of evaluation tools are required to do this job in the teaching and learning of Basic Electricity in technical college, each of which is created to serve a special purpose. These purposes generally encompass: (a) permitting governments or other agencies to keep track and compare the performance of schools and education systems; (b) utilising test results to enable advancement through or selection within a school system; c) giving employers confidence in and specifics about educational results; and d) giving teachers information about students' knowledge, comprehension, and skills so that both teachers and students can monitor teaching and learning.The variety of ways that can help the teachers to keep track of the learners' progress include; (i) activities such as reading, watching videos or other materials, conducting rudimentary experiments, classroom debates, explaining or giving class presentations about natural phenomena, and 'pre-tests' to determine what students already know; and (ii) common classroom or laboratory activities, like as oral questioning and written assignments, are used to provide 'feedback' to both students and teachers, which the latter can utilise to improve the effectiveness of subsequent instruction. (Trumbull & Lash, 2013).

In technical colleges, students are subjected to two forms of assessments. The school-based assessment is the first and most employed in any school context. The second type, known as systemic evaluation, is used to ascertain what learners can do at critical points of the educational cycle (Aduloju, Adikwu, & Agi, 2016); that is, year three for technical colleges. The first assessment is a formative evaluation, whereas a summative evaluation is the second. Formative assessment is a collaborative effort between instructors and students to gather, analyse, and apply evidence about what and how students are learning to improve student learning over time. The method has the potential to assist educators in making timely mid-course adjustments to instruction to fit the students' needs (Chemeli, 2019).

According to Chemeli (2019: 212-229), formative assessment is an integral part of teaching because it determines what students have learned and can do as a result of lessons received, while summative assessment provides a summary of student achievement, often in the form of the results of an external examination, whereas the formative assessment is primarily concerned with advice, support, and guidance and is aimed at improving learning (Ifeanyieze & Aneke, 2013:29-37; Oyebola, 2013:92-100; Ukwuije & Opkara, 2013:1–8)

A school-based assessment is another term for formative assessment (Usman, 2018:48-55). School-based assessment combines testing with teaching for the benefit of students, giving teachers a unique opportunity to participate in the assessment procedure that results in their students' final grades. As a result, Aduloju, Adikwu, and Agi (2016:1-8) state that the ultimate focus of assessment is to provide accurate and timely feedback to improve student learning, instructional practice, and educational alternatives. That is, evaluation is not and should not be viewed as a goal in and of itself, but rather as a valid learning goal. The entire school environment is expected to provide a conducive setting for learning and later assessment procedures.It is apparent, however, that current school-based assessment practices in technical colleges need to be improved.

In Nigeria school-based assessments are undertaken regularly. Formerly, authentic means of measuring learners' performance or achievement in schools included tests, assignments, homework, projects, and other forms of assessment (Aduloju, Adikwu, & Agi, 2016:1-8; Raudonyte, 2019:1-35). However, in recent years, tests have been used to examine not only all aspects of education, such as teaching methodologies, resources, and so on but also the overall efficacy of the educational programme. It also determines if the educational system is on track, but if not, it provides information on how to correct it (Orubu, 2013:57-68). This is solely a formative assessment.Any flaws or misconceptions about a topic that are identified in the youngsters are addressed, and appropriate remediation is supplied.

Teaching requires involving students as active learners to bring about good, long-term changes in their knowledge, abilities and attitudes. Teachers need subject-specific material knowledge, as well as pedagogical abilities and experience. Teachers play a crucial role in any academic discipline's teaching and learning (Ifeanyieze & Aneke, 2013:29-37). According to Bautista (2012: 573-583), new types of teaching resources, as well as new classroom practices, necessitate an alert sort of teacher, whose responsibility involves monitoring their students' progress. As a result, effective teachers planned effectively for the class, including interesting activities and frequent assessment of students' learning objectives, which can assist students in developing a positive attitude toward learning (Adegbola, 2019:655-660). To a large part, the quality of education, whether formal or informal, is determined by the person who influences knowledge and, through that process, interacts with students, causing changes in them. This shows that students will not gain greatly from any learning scenario in which the teachers are not qualified, competent, or available. It is understandable because one cannot give what one does not have.

Farhah, Saleh and Safitri, (2021:267-274) claim that good teachers are essential for a good school. The school has long been seen as the most commendable vehicle for the transmission of societal values. Because the school curriculum defines what is taught or learned to a considerable part, the curriculum provided in any community unquestionably determines the standard of education in that society. Therefore, the content (subjects taught) and procedure (how they are taught) will continue to be important and draw stakeholders' attention. Learners' performance is greatly determined by the quality, quantity, motivation, and competence of their teachers. In a similar vein, the National Policy on Education stated that specialist teachers for specific subjects such as mathematics, basic science, basic technology, physical and health education, language arts (including English, Arabic, French, Sign Language, and Nigerian languages), music, fine art, home economics, and agriculture should be provided (FRN, 2013:24).

For this study, however, both formative and summative assessment were used. The PSI procedure allows the topic to be taught to be divided into a module. Each module consists of; an introduction, objectives, procedures, study questions, a written text supplement and a self-test. The introduction contains the researcher’s comments on the relevant portion of the textbook and/or provides a summary or synopsis of the text and informs the students about the importance of the unit. The objectives outline what students should be able to accomplish as a result of studying the unit. The procedure specified the activities which proved adequate for the students to accomplish the unit objectives. Study questions inform of formative assessment help the students to amplify the objectives and self-test whether they had learnt the objectives fully or not. At the end of the whole module, summative tests were given to determine how well the student have achieved in the module.

A discussion follows below on the teaching approaches in Basic Electricity.The following section will explain the concept of teaching methods and their effects on learning Basic Electricity. This will lead to an understanding of the different teaching approaches and strategies that teachers can employ to ensure effective teaching and learning of Basic Electricity.

2.1.5 Teaching approaches in Basic Electricity

Basic Electricity is one of the disciplines taught in Nigerian technical institutes to give students the skills and knowledge they need for industrial production and self-sufficiency. Basic Electricity should be taught effectively and using appropriate teaching methods to guarantee that students gain the requisite knowledge and skills for post-graduation employment (Atsumbe, Raymond, & Ajuwon, 2015:598-603; Robinson, 2017:14-21; Eze, Nwalo, & Udu, 2021:34-45; Eze, Obidile, & Akamobi, 2019:58-64). Many teaching approaches are ineffective when it comes to students' ability to understand and recall important concepts (Giridharan & Raju, 2016:174-186). Collaboration, critical thinking, and creative reasoning are not promoted by traditional teaching methods (such as lectures and recitation).Poor teachingstrategies may be to blame for students' poor performance in engineering education (Vincent & Akpan, 2014: 80-86).

Teachers utilise teaching methods to impart skills and knowledge to pupils through stages, means and procedures (Ogbuanya, Akintonde& Bakare, 2017:7501-7514). According to the definitions above, teaching methods are those procedures and approaches that assist students in acquiring acceptable and useful abilities in a setting that allows them to perform effectively in meeting societal needs. Similarly, teaching methods entail complicated actions that teachers utilise to lead students through a variety of situations aimed at developing human capability in terms of ideas, knowledge, principles, attitudes, and experiences. Teaching methods aid teachers in instilling core scientific knowledge, trade theories, and trade practices in technical education students, allowing them to be creative upon completion of their studies.

Dorgu (2015:77-87) said that students' learning and happiness are aided by teaching approaches. Students' practical experiences in Basic Electricity will undoubtedly be enhanced by effective teaching methods. Teaching strategies, according to Hains and Smith (2012: 357–374), prepare students to provide a solution to problems, adapt the material to real-life situations, collaborate, and become lifelong learners. Teaching methods are generally used to encourage learners' participation in learning activities, fostera sense of reasonability and direct application of learning principles to the attainment of stated educational objectives. This could help learners' performance and retain more information during the learning process.

In national examinations, students' performance and attitude toward Basic Electricity were found to be low. One of the causes of this poor performance could be the old methods used to teach Basic Electricity classes. The subject matter is almost often taught in monologue format in front of a passive audience in a traditional class (Muise, 2015; Uwizeyimana, Yadav, Musengimana, & Uwamahoro, 2018). It is difficult to provide appropriate opportunities for students to critically think during established arguments while employing traditional teaching strategies. Lectures stress problem-solving as the most important way to master the content. Due to the way contents are presented, only outstanding lectures can keep students' attention for the whole traditional-based lecture time (Muise, 2015). Furthermore, traditional teacher-centred teaching practices are ineffective in building students' conceptual comprehension (Von Korff, et al., 2016; Amadalo, Ocholla, & Sakwa, 2016). According to certain research, learners' notable conceptual understanding changes after being taught using traditional teaching approaches were just temporary. Learners create observations to reinforce their pre-teaching understanding rather than being challenged by what they have learnt during teaching periods (Mbonyiryivuze, Yadav, & Amadalo, 2019:55-67).

A good teaching technique selection can assist teachers in achieving certain goals in their subject areas including Basic Electricity. As students are active architects of their knowledge (Mbonyiryivuze, Yadav, & Amadalo, 2019), student-centred teaching methodsassist students in constructing knowledge on their own and improving conceptual understanding with the assistance of the teacher serving as a facilitator.Valls and Ponce (2013:1-22) asserted that adequate learning is rare in teacher-centred teaching techniques and advocated for the implementation of efficient teaching methods such as individualised teaching methods. Any Basic Electricity teacher must get familiar with instructional methods that will assist students in achieving their learning objectives (Amaechi & Thomas, 2016:598-603). The authors went on to suggest that there are general teaching approaches that teachers can employ to ensure effective teaching and learning.

Okafor (2014:52) listed the following approaches in the instance of Basic Electricity: demonstration, discussion, project, guided discovery, enquiry, lecture, questioning, and simulation, field excursions, individualised instruction, and so on. For this study, the conventional lecture approach (CLA), which is teacher-centred and the personalised system of instruction package (PSI), which is an innovative, individualised, and student-centred learning approach were considered and their effects on students' academic achievement were determined and compared.It is vital to determine the benefits that result from the PSI teaching approach's effectiveness and application in the teaching of Basic Electricity in technical institutes.Although the personalised system of instruction (PSI) technique is widely used in many educational settings, it remains a low priority in technical colleges.

Following the discussion above, the section that follows will investigate the students' learning outcomes in Basic Electricity. It was indicated above that the teaching methods often employed to encourage students to participate in learning activities, create a sense of reasonability, and apply learning principles directly to the realisation of stated educational objectives. Therefore, discussion on academic achievement may lead to an understanding of factors that link to students' poor performance in Basic Electricity.

2.1.6 Students' academic achievement in Basic Electricity

Academic achievement refers to the information and skills acquired by students in a school subject or course, as measured by a test score (Atsumbe et al., 2014:380-387). Academic performance shows a student's success based on what they do and how they do it during the implementation of curricular initiatives. Academic achievement is the measure of a student's, teacher's, or institution's success in achieving their educational objectives (Unity & Igudu, 2015:101-106; Ibeneme & Emeasoba, 2017:17-28). According to Dinga, Mwaura, and Ng'ang'a (2018:53-68), academic achievement involves the observable and measurable performance of pupils that takes place in the context of a criterion for measuring academic excellence. Understanding students' academic achievement status and causes are critical for successful and effective intervention to offer quality education to them (Muhdin, 2016). Academic achievement, which is measured by examination results, is one of the most important methods for assessing students' academic performance.

Academic achievement, according to Ali (2013:283-289), is a result of schooling that demonstrates how well a student or a group of students are achieving academically. It is a critical indicator to consider when establishing and planning educational interventions at both the national (e.g. curriculum definition) and classroom levels (e.g. teaching strategy). Garbanzo (2017:43-63) refers to it as the learning outcome that a student exhibits after teaching and learning processes. Similarly, Kayode and Ayodele (2015:1-7) define academic achievement as students' ability to manage their studies and cope with or complete the tasks that their teachers prescribe to them. It is the ability to memorise and recall facts, as well as the ability to articulate knowledge vocally or in writing. Thus, academic performance in any society is the result of education, i.e., the degree to which a student, instructor, or institution has reached their educational goals and objectives, and it indicates the success of the educational system (Alemu & Feyssa, 2020).

In Nigeria, the quality of a school is mostly determined by students' academic achievement, particularly in external examinations such as NECO, WAEC, and NABTEB, as well as the instructional facilities allocated to them. The academic achievement of students appears to play an important role in deciding whether the educational aims and objectives are met. When performance is high, it tends to show effectiveness in educational achievement. When performance is low, on the other side, it demonstrates ineffectiveness in educational success. The availability of instructional facilities and how successfully such physical resources are used to improve students' academic achievement appear to be determinants of educational efficiency (Ackermn & Heggestad, 2017).

The low performance of students in Basic Electricity has elicited criticism and worry from educators (Atsumbe, Raymond & Ajuwon, 2015; Robinson, 2017; and Usoro, Akpan & Ikpe, 2018).The findings of Eze, Nwalo, and Udu's (2021:34-45) study showed that despite all the measures taken thus far, the level of achievement in Basic Electricity remains low, indicating that students' achievement was still very poor. As a result, it is critical to figure out how to boost students' performance in Basic Electricity in the National Business and Technical Examination. This is because improving their performance will allow them to pursue engineering and related courses at a post-technical institution in the future.The realisation of set instructional objectives is what defines success in the teaching/learning process. In technological instructions, for example, a student is considered to have succeeded if s/he completes a task effectively and meets the set goal for a given learning experience.The achievement of the objective of technology/technical education remains the most significant concern of educational policy, and technological literacy is one of the major concerns (FRN, 2013).

The reduction in technical college studentS' academic achievement in Basic Electricity is traceable to so many factors (Adetula & Salam, 2017; Atsumbe, Owodunni, Raymond & Uduafemhe, 2018; Ndukwe, 2018; Sunday, Olaoye& Audu, 2021); such as governments' poor funding of education; lack of qualified teachers (Shittu & Olanike, 2015:67-79); teaching methodologies employed by teachers; poor conditions of service for teachers; lack of instructional facilities and equipment; learning environment (Stockinger, Rinas, & Daumiller, 2021).

Parenting styles are another issue to consider. Parental involvement in their children's education increases their performance. However, some of the methods used by parents to groom their children can harm their academic achievement.In real life, some parents who are in charge of their children's schoolwork. Parenting styles have been shown by researchers that can harm their children’s performance (Jacob& Ryan, 2018). Permissive and uninvolved styles cannot assist inmaking children value their education. The permissive style is when the strictness over the children has been lifted. The children have the freedom of choice in their studies. Children raised in this environment frequently ignore their education in favour of more immediate and enjoyable successes (Baidoo-Anu, Abiaw& Kaedebi-Donkor, 2019). All in fairness, it should be recognised that sparing the rod is akin to spoiling the child. The uninvolved parenting style has been identified as the worst parenting style, contributing to low student achievement. Similarly, parents hand over control of their children's schoolwork to them. They do not assist youngsters with homework or provide emotional assistance when they are experiencing personal difficulties. As a result, pupils become demotivated and lose interest in schooling.

Poor study habits could also play a role in a student's poor performance. Academic performance is negatively impacted by students' lack of study skills and commitment to success (Stockinger, Rinas, & Daumiller, 2021). Students are not prepared for tests and examinations due to negative attitudes about schools, students' reluctance to study and work preparation before lessons begin. Academic accomplishment is influenced by other factors such as students' IQ, socio-economic situation, and lack of resources. A lack of the aforementioned indicates poor academic performance by students. Kosterelioglu, (2018:91-107) believes in the authoritative approach because it is less harmful to a child's self-esteem and ability to think independently than the uninvolved form, in which parents hand over the responsibility of their children's schoolwork. They do not assist children with homework or provide emotional assistance when they are experiencing personal difficulties. As a result, children get demotivated and lose interest in school.

Students' home backgrounds and socioeconomic position have also been linked to their academic success. According to Mphale and Mhlauli (2014:111-127), students' family backgrounds influence academic and educational performance, whereas socioeconomic status reinforces instructors' and students' actions and functioning.Students' low achievement has also been linked to a lack of academic motivation. It was discovered that a lack of academic enthusiasm appears to be a significant barrier to many high school student’s academic success (Berweger, Born& Dietrich, 2021).

Further researchers have found that a student's internal state of mind, Intelligence level, health, and anxiety have the greatest impact on their capacity to perform well academically (Dinga et al., 2018; Alemu & Feyssa, 2020). They will not like teaching and learning if they lack the mental capacity to comprehend and remember the imparted knowledge and abilities. It has also been noted that intelligent students frequently assist low achievers in improving their grades and boosting their self-esteem (Alemu & Feyssa, 2020). Other relevant factors include a negative public attitude toward education, as well as the location of the school. (Emaikwu, 2012:371-379; Ayonmike, 2014; Moges, 2017).

Poor performance in Basic Electricityhas also been linked to a dearth of qualified technical teachers, overcrowding in classrooms, and a lack of appropriate technical equipment, among other things (Ezechi, & Ogbu, 2017; Olatunde-Aiyedun & Ogunode, 2021a). Recent research has shown that several areas of classroom science and technology (including Basic Electricity) are proving challenging for students to comprehend, due to the teaching techniques employed and a lack of suitable instructional tools (Ezechi, & Ogbu, 2017; Orji, Ogar & Aiyedun, 2018). Consequently, many students struggle with Basic Electricity because they are unable to organise materials well in the time allotted for study and retention (Owodunni, 2018). Because of the huge courses and heterogeneous ability levels, students perform low in Basic Electricity. Furthermore, the workshop is under-equipped, and the Basic Electricity curriculum is overloaded (Robinson, 2017; Atsumbe et al., 2018). It is, therefore, necessary to explore for variables that may be changed to improve this scenario and, as a result, to determine their influence on learning outcomes, as well as to address the issues with Basic Electricity teaching and learning at technical colleges.

However, Henson (2014:145-149) claimed that the teacher methodology has been established as one of the primary variables that lead to loss in students' academic achievement. Ajemba, Ahmed, Ogunode and Olatunde-Aiyedun, (2021:118-129) characterised the approaches utilised by the teachers as being teacher-centred, instead of being students-centred that will be of help to them. Eze and Osuyi (2018:666-678) affirm that the continuous usage of the lecture-demonstration teaching technique appears to be the cause of students' low performance intechnical colleges in Nigeria. Due to students' lack of active participation in the teaching-learning process, the lecture-demonstration teaching approach for Basic Electricity may not be particularly effective. According to Eze, Ezenwafor, and Molokwu (2015:101-108), learners-centred strategies can enhance students' academic achievement in various subjects better than teacher-centred strategies. Regardless of how numerous these factors are, the researcher intends to build this study on the teacher's method of teaching; consequently, the necessity to employ the more active and students-centred techniqueto improve student learning outcomes in Basic Electricity. Hence, the researcher believes it is necessary to investigate whether thepersonalised system of instruction can improve students' learning outcomes in Basic Electricity in technical colleges in Osun state.

2.1.7 Conventional Lecture Approach and Students' Academic Achievement

The lecture method is a typical example of a teacher-centered technique for teaching school courses such as Basic Electricity. The Jesuit Schools, which flourished from the fourteenth to the nineteenth century and were examples of classical humanist education, best represent the method historically. In technical colleges, traditional teaching (TT) or the conventional lecture approach to teaching (CLA) is a typical method used by technical teachers to teach Basic Electricity. It is called the "talk and chalk" or "textbook approach" to teaching (Ajemba et al., 2021:118-129); Education Resource Centre [ERC], 2010). The classroom interaction pattern in a conventional teaching or traditional teaching method between teachers-students involves a face-to-face manner.

The conventional lecture method is a teacher-centred model wherein the teacher acts as a repository of knowledge and the learners are passive listeners or dormant recipients of the lessons (Daluba, 2013:1-7; Naboth-Odums, 2014:59-66 & Onah, 2017). It enables the teacher to command the learning environment, manage all power, carry out the role of the instructor, and make decisions (Young, 2016). According to Young (2019:13-15) scholars have complained that the teaching technique does not encourage students' invention, inquiry, or scientific method. It encourages learners to memorise facts that are easily forgotten. Students do not have the option to participate actively in traditional methods. The teachers are the only ones in the room who are actively involved; they supervise all activities, including teaching, asking questions, and strolling between the chalkboard and the students (Adesina, 2013). In this scenario, the teacher initiates classroom discussions and focuses solely on topics from textbooks and notes.The material is passively received by the students, who then repeat what they learned in the examinations (Olatide, 2018:24-36).

Many teachers still use the traditional lecture approach, according to Devinder and Zaitun (2006:26-42). In traditional teaching classes, when the teacher is explaining and writing on the board, students will be repeating the same thing on their notes, some day-dreaming, and others sleeping. The conventional lecture teaching approach extensively used in Nigerian technical colleges, according to Eze, Ezenwafor, and Molokwu (2015:101-108), is more teacher-centred than learner-centred. Teacher-centred instruction strategies prioritises teaching over learning and pays little or no attention to the learning process, obscuring the creative thinking of students, which is crucial in today's profession where engineering is constantly changing as a result of technology innovation.

Although the lecture approach has the advantages of being less taxing and allowing for a broad coverage of the subject in a short amount of time, it also enables the simultaneous instruction of many students (Ibeneme & Emeasoba, 2017:17-28). Many students do not always have positive learning outcomes as a result of it. It would be difficult to prevent pupils from copying notes from the board while also ensuring that every student in the class was paying attention because the teacher was too preoccupied with giving the lesson.

According to an analysis of the present trend, the most common technique is teacher-centered, which emphasises rote learning above meaningful learning. This technique of instruction has failed to produce an actual understanding of Basic Electricity. Furthermore, this strategy does not encourage learners to participate actively or work independently. This approach also causes learners to learn mechanically to solve issues, resulting in poor learning outcomes when they are unable to transfer their mechanical knowledge to other contexts. To shift this paradigm, classroom interaction must be improved, and suitable teaching and learning tactics must be adopted as the teaching and learning circumstance demands. The group, cooperative, competitive, and individualised patterns of interaction are the most common types of interactions encountered in a typical classroom situation.

Lectures as a teaching method have the following advantages:

- They are a simple technique to swiftly transfer knowledge to students.
- Because they are the sole source of knowledge, instructors have more authorityover what is taught in the classroom.
- Auditory learners find lectures to be beneficial to their learning style.
- In terms of logistics, a lecture is usually easier to prepare than other types of instruction.
- Most teachers are familiar with the lecture method because it is how they were taught.

• Students receive familiarity with the most frequent mode of instruction because most college courses are lecture-based.

Lectures as a teaching method have the following disadvantages:

• Lectures will be less engaging for students with learning styles other than auditory learning.

• Students who struggle to take notes will find it difficult to retain what they need to know from lectures.

• Students may find lectures boring and lose interest as a result.

• Students may not feel confident in their ability to ask questions during lectures.

• Because there are few opportunities for exchanges during lectures, teachers may not get a true sense of how much students understand (Raj, 2012).

However, some of its drawbacks, as listed above, show that traditional lecture methods fail to develop students' manipulative skills in Basic Electricity because they are passive listeners, and it ignores individual differences among students, resulting in slow learners and academically weak students being driven along at a rate they cannot handle. As a result, students perform poorly and lose interest in what they are learning. The strategy only appeals to the sense of hearing. According to Maqbool, Ismail, Maqbool& Hassan, (2018:488-505), a child's learning is complete when they use all of their senses in the process. The lecture method's main disadvantage is that it is largely a one-way communication system. In most circumstances, the listening student has little or no knowledge of how the type and rate of information flow might be influenced. One-way communicationprovides little opportunity for interaction and feedback, both of which are critical for learning to take place.Excessive lecture use promotes intellectual inactivity, the polar opposite of learning, and may inhibit students from developing inquiry and problem-solving skills. To mitigate some of these disadvantages, an individualised method of instruction, such as the personalised system of instruction(PSI) may be required.

A discussion follows below on the origin of the PSI, definitions from a different perspective and its usage. The following section will explain the definition of PSI, its characteristics and its superiority over the CLM and evidences of PSI improving students' academic achievement.

2.2 Personalised System of Instruction as an innovative method of teaching

The ideas that underpin the concept of personalised instruction evolved in response to a several issues that the knowledge explosion, knowledge economy, and the rise of modern educational technologies have posed to current educational systems (Alalwneh & Alomari, 2018:81-92), as well as the belief that individuals vary in their learning characteristics and that these variations must be used to plan instruction for each learner (Alalwneh & Alomari, 2018:81-92; Onah, 2017). Individualisation of learning was employed to encourage students to take a more active role in organising educational materials, developing information from it, and integrating it with prior knowledge, resulting in a more robust knowledge structure (Al-Otaibi, 2015:255-268).

Conventionallecture methods, according to Butler, Kohlert, McElrath, Wolfe, and Gross (2015:317-326), may not challenge thebrightest students while the weaker onesare leftbehind. Apersonalised system of instruction (PSI), in their opinion, is designed to adapt to each student's needs in order for all students to grasp the subject. Some definitions of personalised learning include learning that pays attention to individual characteristics in learning (Alalwneh & Alomari, 2018; Davidescu, 2018), differences in learning experiences (Cullhaj, 2017), relevant to information needs and follow-up for individuals (Pardo, 2018), interactive systems and learning material based on students' interests and motivation (Alalwneh & Alomari, 2018; Davidescu, 2018), interactive systems and learning material based on students' interests and (Gaheen, Ewees, Eisa, 2020; Agustinaningsih, 2019; Keller, 2016).

A personalised system of instruction is defined by Al-Zboun et al. (2016:101-117) as a system that aims to teach the learner through activities carried out individually, based on their abilities and needs, to acquire knowledge, attitudes, and skills, as well as self-learning skills, with the least amount of teacher supervision and guidance. PSI, according to Redding (2016:3-18), is a differentiated teaching system that can be tailored to the learners' abilities and competencies, as well as their needs, attitudes, and preferences. It is a way for both students and teachers to have a lot of choice and flexibility (Alalwneh & Alomari, 2018:81-92). For example, students may work through different types of knowledge at different speeds or present different pieces of proof to demonstrate mastery of a specific objective.

According to Bautista (2012:573-583), a personalised system of instruction is an effort to organise the learning environment by taking into consideration individual student traits and needs, as well as flexible instructional approaches. The author observed that teachers are committed to personalising instruction to assist their students in developing personal learning plans, diagnosing their cognitive strengths and weaknesses, and other style characteristics, as well as attempting to provide students with a unique learning experience.It is a model that could assist students in forming lifetime learning habits. PSI, according to Juditya et al. (2018:313-315), allows students to become independent learners while also allowing teachers to use high levels of interactionwith students. The underlying denominator throughout the various PSI definitions is that the PSI is a process that values students' differences; allows students to advance at their own pace, and tailors instruction to the individual learner's needs and abilities. The current study adopts this notion of the PSI.

According to Gaheen, Ewees, Eisa (2021:1165-1181) and Warner (2021:39), Fred Keller invented the personalised system of instruction (PSI) in 1968. It is one of the methods for tailoring instruction. The PSI is a method that enables a student to progress from one unit to the next at his or her speed and capacity until the course is completed. The system is differentiated by activity and efficacy to learn the educational material. He is no longer just a spectator, but rather an active participant in various instructional activities (Keller, 2016:1-15). This approach was introduced in 1962 by four psychologist lecturers at the University of Brasilia, in response to their discontent with the methods used to teach various psychological disciplines, as well as the practical issues that these strategies encountered in the classroom (Azukas, 2019:275-310). Individual differences among students, as well as the traditional learning approach, do not accommodate all students, particularly those with a faster understanding and diverse physical abilities. It also fails to take into account learners' self-pacing during the learning process, resulting in boredom among the students.

Keller Plan was given its name as a result of Keller's special efforts and those of his followers. In 1963, this method was initially used to teach one of Columbia University's psychology courses (Warner, 2021; Keller 2016). Keller was a psychologist who felt that, whether or not a teacher is present, the learning environment had an impact on human learning (Hannon, Holt, & Hatten, 2008:20-33). When Keller released his renowned piece "Goodbye Teacher" in 1968, it sparked widespread interest in the Keller Plan, prompting educationalists to adopt it in a variety of sectors. In addition to the general model, there were a variety of teaching design models. Along with the existence of a wide range of old and new models, as well as their evolution, there is a substantial gap represented by the neglect of the motivation component, which prompted Keller to develop the old model and replace it with the Attention, Relevance, Confidence, and Satisfaction motivational design model (ARCS). Keller's model was one of the few models that emphasised motivating and reinforcing students (Keller, 2016).

Many educational institutions began to feel the same needs as the University of Brasilia and Columbia University, as a result, they began to follow suit, *albeit* in varied ways, such as computer-based PSI or the use of a mobile app. The approach spread and was adopted by institutions all over the world (Allen, 2015). The institutions adopted a veritable pragmatic alternative technique for efficient teaching and learning, which integrates the characteristics of PSI, as a consequence of their quest for a changefrom the old style of teaching. A personalised system of instruction (PSI), according to Kalaivani (2014:28-30), is one of the successful innovations that has been adopted and implemented in higher education to individualise instruction. It is a teaching method that arose from a rise in educational policies aiming at raising all students' academic achievement by supporting and encouraging the development of novel instructional techniques and school models (Bingham, Pane, Steiner, & Hamilton, 2018:454-489). This is a person-centred form of training that places a greater emphasis on individualisation than other methods. The education is tailored to the individual learner's needs and abilities (Kalaivani, 2014). As a result, the present study intended to find out its efficacy in the teaching of Basic Electricity in Nigerian technical colleges.

The use of the PSI approach in primary, secondary, and post-secondary education has been studied, according to the literature (Warner, 2021).The PSI model was applied in technical education in the current study. The PSI method is a learning methodology that allows students to move at their rate through a variety of self-paced tasks in a learning module. Each module provides students with information on task presentation, task structure, performance requirements, and error analysis.The instructor provides all tasks and criteria using prepared materials such as textual instructions. The PSI's basic premise is that if given sufficient time and support to master content, any student can succeed (Keller, 2016:1-15). Bloom in 1971 proposed that instruction included the following elements to provide students with this support: organising concepts and skills into learning units, making use of assessment to educate students, providing learners with corrective feedback, supplying students with individualised improvement activities to further learning and understanding, and making sure that students have mastered a topic before moving on to the next learning unit (Paiva et al., 2017). This teaching technique enables teachers to make significant changes for individual learners, provides learners with several opportunities to learn concepts, and closes the success gap for students who might otherwise fall behind in a typical lecture format (Bloom, 1971; 1976; Kim & Axelrod, 2014:111-120).

The fact that learners will score better than the minimum acceptable standard indiccates an improvement in academic achievement. Knowledge application and problem-solving ability or abilities are the processes through which pupils can analyse their surroundings or natural environment scholastically. Although there are numerous methods of instructional innovation, they all have the potential to improve learning outcomes and student satisfaction in the educational setting (Gardner, 2011:97-102). As far as personalisation in instruction is concerned Ciampa (2014:82-96) and Clark and Mayer (2011:112) argue that individualised environmental stimuli in the classroom are the characteristics that increase learners' motivation to keep ownership of the learning experience. The following are the basic features of PSI as described by Grant and Spencer (2003:1-17):

1. Emphasis on the Written Word
2. Unit Mastery Requirement
3. Self-Pacing of Students
4. Proctors are used as a fourth option.
5. Using Lectures and Demonstrations to Motivate students

In conclusion, the instructor creates the course policy statement. The instructor divides the material into relevant bits or units. For each unit, the instructor creates study guides that include objectives, study techniques, questions, and self-paced, individual work through guidelines. PSI study guides were traditionally printed, but they now come in a variety of formats, including computer-based and internet-based training (Sharifi & Farrokh, 2017:287-315). Unit mastery can be demonstrated by doing a physical demonstrationor taking a quiz. Students who do not pass the initial assessment or physical demonstration will be given another chance to complete the unit.

Mastery is required in the PSI instructional paradigm, but students are allowed to progress at their own speed. The student prescribes the objectives with the support of the instructor in the personalised system of instruction (PSI). In the learning process, students play an active and continual role. Students that need more time to learn are not penalised in PSI. Throughout the module, the teacher spends time with each student, providing one-on-one training and feedback. Students in the PSI technique do not have daily lesson plans; instead, they continue working in their previous class session's workbook.

The PSI has been shown in numerous studies to be more effective than traditional lectures (Allen, 2015; Prewitt, 2014; Young, 2016; Alalwneh & Alomari, 2018:81-92; Juditya, Suherman, Ma'Mun, & Rusdiana, 2018; Tirodkar & Lawrence, 2021). Similarly, data from outcome research comparing the performance of PSI-based courses to conventional lecture approaches show that PSI is unquestionably superior. The mastery requirement, immediate performance feedback, and review units are all important factors that contribute to high-quality student outcomes in the PSI courses according to parametric studies, or component analyses.

The personalised system of instruction is beneficial in stimulating higher-order thinking (Allen, 2015; Prewitt, 2014; Young, 2016). Research has also demonstrated the efficacy of the PSIto be an excellent way of teaching a challenging subject that is commonly faced in secondary schools, allowing pupils to master content at their own pace (Paiva, et al.,2017; Sharifi & Farrokh, 2017). In a study carried out in Nigerian secondary schools, chemistry students were divided into two groups: one received the PSI instruction, while the other received conventional face-to-face training. The students who utilised PSI outperformed the control group because they had to "take a make-up quiz any time their original score fell below 90 percent correct" and complete a preceding lesson unit before taking a quiz on the following lesson." (Salami, 2007:134). Furthermore, a recent study reveals that students value the educational model's time convenience, flexibility, and clear expectations (Butler et al., 2015; Juditya et al., 2018). Finally, learners who were taught using the PSI curriculum outperformed learners who were taught using standard lecture methods on practically every outcome measure (Young, 2019:13-15; Kalaivani, 2014).

In the Nigerian school system, the PSI teaching technique is currently not in vogue. Nigerian teachers, like those elsewhere in the world, believe that traditional teaching methods are ineffective and wasteful when it comes to teaching curricular content (Atsumbe et al., 2018). Students are exposed to a curriculum that is more theoretical than practical (Azukas, 2019:275-310), resulting in teachers using the most traditional method of instruction.The majority of the time, students find themselves memorising to pass exams. Students struggle to comprehend the ideas being taught, let alone the applications, and find it difficult to grasp the concepts being taught (Warner, 2021:1-106).

The government and stakeholders in the Nigerian education system have yet to create an enabling climate for the PSI approach to be implemented. This could be due to a severe dearth of teaching facilities, unavailability of textbooks produced with a PSI focus, orientation, and teachers educated in the PSI pedagogical method, among other things. The government has made some initiatives to remedy ineffective instructional practices in our classrooms.

Two such projects are the Second Primary Education Project (PEP-II) and Teaching and Learning Studies. As part of PEP-II, the Universal Basic Education Programme (UBEP) developed many programmes across the country to promote primary school teaching and learning. To improve the content and management of teacher education and training, two types of research were conducted, they are; teacher surveys and teacher education programmes at the national level, as well as action research and development projects in classrooms and across school clusters (UBEC, 2016). The initiative was designed to use a personalised learning strategy. PSI, on the other hand, accommodates this method and still has other elements that can help with excellent Basic Electricity teaching and learning.Below is a discussion on the advantages and disadvantages of the PSI.

2.2.1 Opportunities and challenges of the PSI

With time, the modes of instruction and education have undergone major modifications. The PSI is one of these unique means of providing knowledge to aspiring students.

Teaching and learning are no longer confined to classroom sessions in which a single person stands in front of a group of students to impart knowledge. (Tirodkar& Lawrence, 2021). Today's education has broadened its horizons to include more practical teaching approaches that empower leaners to take charge of their learning. They are in charge of their future and must learn what they need to meet the state academic norm of experimenting and exploring beyond instructor-led knowledge. PSI is an example of a method of teaching students that enables them to develop the creativity, ingenuity, and critical thinking abilities needed to obtain information on their own and use it in meaningful ways. PSI is more likely to motivate and engage learners to study when they are taught in a way that enables the individual learner to achieve his or her full potential. PSI provides a safe, friendly, and caring environment in which learners are encouraged to experiment and explore their unique interests, abilities, and love of learning.

According to Hall Rivera (2017:79-84), learning goes beyond bookish knowledge and assists students in confronting and overcoming real difficulties. PSI enables students to apply existing knowledge to new challenges, resulting in greater comprehension. When new information is presented in a context that makes sense and contrasts with prior knowledge, learning is boosted. PSI helps children learn to interact and communicate with their classmates, abilities that they will be able to apply in the workplace as adults. PSI also gives children a sense of belonging to a community, which can help them emotionally and physically. As a result, rather than being solely responsible for themselves, team members are responsible for each other. It also provides a simple approach for students to demonstrate mastery of the subject and chances for them to become "content creators." PSI expects courteous interactions between students and teachers (Birnie, 2015:62-65). As a result, with the guidance of the teacher, students can partially select their course of action, increasing the fascination, engagement, and activity-based nature of learning.

Apart from the teaching style used, technical teachers across the Basic Electricity have low moraledue to the low status of the teaching profession, inadequate teacher training, and a lack of enthusiasm among many technical teachers.According to Ogbe and Omenka (2017:21-28), a lack of skills/competence required for teaching, a lack of improvisational talents, and a scarcity of qualified technical graduate teachers are some of the recognised teacher-related causes of ineffective teaching of Basic Electricity subject matter.These are the underpinnings that are likely to jeopardise the positive effectsof any alternative teaching approach used by technical teachers in place of the previously outlined inadequate traditional method. Even among technical educators, this is one of the most serious issues.

Before giving clearance for the deployment of a personalised system of instruction approach, the school administration has to be convinced of its suitability and motivation in terms of job satisfaction. The implementation of the PSI learning was opposed by school administrators for several reasons, including the notion that it hindered technical teachers from covering all of the themes in the scheme for a specific term and the distribution of only two periods per week. Others included the need for teachers to be motivated and satisfied in their jobs, as otherwise the strategy could be handled haphazardly, as well as the concern of school administrators and parents regarding their children's performance on standardised tests. The school administration was concerned about a lack of qualified technical/technology graduate teachers, so they added more Basic Electricity periods in the afternoon when most of the teachers appeared to be exhausted, and a non-periodical review of technical education curricula at the teacher preparation institutions.

Despite the significant body of research supporting the efficacy of PSIs, Warner (2021:71-76) remarked that the following misperception could stymie successful implementation or non-adoption of PSI approaches in schools at all levels:

(i) Teachers may find it challenging to adapt their teaching techniques.

(ii) The assumption among administrators is that instructors do not teach until they are in front of a class.

(iii) Individuals or groups may complete their tasks sooner or later.

(iv) PSI necessitates extensive research and material.

(v) The PSI model is challenging to implement in all classes.

It is beneficial to use this method, which encourages activities that build reasoning abilities and processes through a scientific perspective. A source of resistance against the implementation of the PSI approach includes the inadequate time required to develop the PSI model and the energy required in terms of the teacher who faces an examination-driven Basic Electricity curriculum. Others include the difficulties of adjusting the self-paced/mastery mode to academic schedules, instructor opposition to shifting from a traditional teacher-centred to a student-centred strategy, and administrators' unwillingness to value the model (Allen, 2015). The PSI model may not be adopted by teachers in technical colleges due to the huge changes in the educational scene. Another possibility is that there is not enough research on the concept as it relates to technical education.

Using Bloom's taxonomy of educational objectives and past question papers of the National Business and Technical Education Board (NABTEB) examination body examining students at the technical level in Nigeria, the kind of testing utilised for a subject like Basic Electricity, assesses both cognitive and psychomotor performances. Hence, the focus of this research was solely on cognitive performance. Cognitive performance indicates how effectively a student has met this domain of educational objectives. Achievement tests are used to examine the cognitive domain. When developing achievement tests, it is important to keep gender and school location bias in mind, whether it is a product or process assessment.

Thus, gender and school location are powerful variables; the value of which determines students’ outcomes in Basic Electricity should be thoroughly understood for research to be made meaningful regarding how male and female, rural and urban technical college students performed in Basic Electricity. The following section will explain the concepts of gender and school location and their possible influence on students learning outcomes. In addition, this could reveal if truly there is a gender and school location gap in the achievement of a technical college students in Basic Electricity.

2.3 Students' Gender and Academic Achievement

Gender is a collection of physical, biological, psychological, and behavioural characteristics that differentiate the feminine (female) from the masculine (male) population (Adigun, Onihunwa, Irunokhai, Sada, & Adesina, 2015; Onah, 2017). 'Gender explains the distinct personality traits, attitudes, behaviours, values, relative power, influence, roles, and expectations (femininity and masculinity) that society assigns to the two sexes' (Ezeh, 2013:1-24).

Gender covers personality traits such as role orientation and identity that are dependent on a person's self-concept (Nnamani & Oyibe, 2016b), to the extent of assigning some vocations and professions to men (technology, engineering, arts and crafts, agriculture, etc.) and others assigning to women (catering, typing, nursing etc.). Parents give their sons chores like car washing, grass mowing, bulb replacement, scaling ladders, repairing or removing items, and so on. Females, on the other hand, are assigned jobs such as dishwashing, cooking, and cleaning. In a nutshell, boys are assigned to duties that are considered complex and tough, whilst girls are supposed to do tasks that are comparatively simple and low-demand. As a result of this style of thinking, the general public views girls as a “weaker sex." Consequently, a typical Nigerian girl attends school with these preconceived notions. Because it is believed that a student's gender has an impact on their academic performance, this study will investigate whether or not there is a link between the two.

Gender's influence on learning and performance has proven to be a contentious and hot topic among educators and psychologists. Gender disparities have become a critical issue all around the world. For more than a century, this discovery has piqued academics' interest in gender disparities in intellectual aptitude and academic inclinations (Priess & Hyde, 2010:297-316; Amatobi & Amatobi, 2020:1-8). Gender is a powerful determinant of human behaviour, according to Nnamani and Oyibe (2016b: 72-83), and males and females have a variety of attitudes and behaviours that influence academic achievement. The necessity of analysing gender-related performance stems mostly from the socio-cultural inequalities that exist between girls and boys. The disparity in student achievement due to gender differences has become a critical issue in society, prompting several studies, workshops, seminars, and training sessions for educators resulting in a considerable amount of literature (Adeyemi & Ajibade, 2011; Kyei et al, 2011; Awofala, Adeneye & Nneji, 2011; Amosun, 2011; Apata, 2011; Dania, 2014; Agbaje &Alake, 2014).

The low achievement of students in technical education, especially in Basic Electricity, has been a notable source of concern for everybody, especially those in Nigeria's main stream technology education (Owodunni, 2015). Atsumbe et al. (2018:1-17) found that gender contributes to students' low performance in Basic Electronics. The social qualities and opportunities associated with being male or female, as well as the connections between women and men, girls and boys, and women and men, are all characterised by gender. Through socialisation processes, these characteristics, opportunities, and connections are socially formed and acquired (Yang, 2010:8 & UNICEF, 2017:4).

Several research studies in science, technical, and vocational education have found evidence in favour of males (Aina, 2013:447-452; Adigun et al., 2015:1-7; Amao, Adewuyi, Gbadamosi, Salami & Ogunjinmi, 2016:102-108; Onah, 2017:107-108). According to certain research, there are various disparities in students' cognitive, affective, and psychomotor skill acquisition based on gender (Bamiro, 2015:1-7; Agbetoye et al., 2015:55-62; Adigun et al., 2015:1-7). Differences in male and female children's schooling, ability, interest, and aspirations are explained by the sex stereotype. Despite this, some researchers believe that there are no disparities in theachievement in science, technical, and vocational education between male and female students, while others disagree. The findings of Goni, Yagana Wali, Ali, and

Bularafa (2015:107-114) revealed that there was no significant genderin the academic achievement in Borno State's Colleges of Education. In their study on the influence of gender on self-concept and academic achievement, Kamoru and Ramon (2017:49-52) discovered that male students outperform female students in their academics. Morris (2015:55-71) agrees with Kamoru and Ramon (2017) that boys perform better on Advanced Placement (AP) exams than girls.

Gender differences, according to Ogula, Kisigot, and Munyua (2021:1-10) affect on students' learning outcomes in school. In any classroom teaching activity that involves calculation, male students outperform female students (Lin, Tseng, & Chiang, 2017:741-770). Aina (2013:447-452), in his study on gender analysis of students' academic performance in physics practicals in Colleges of Education, discovered that while there was no relationship between male and female students' performance in physics practicals, male students fared better than female students. In the Agbani Education Zone of Enugu State, Nnenna and Adukwu (2018:45-51) looked at the impact of gender and location of the school on senior high school students' biology achievement. The study made use of four intact senior secondary school III classes from urban and rural schools. A sample of 328 students (164 men and 164 females, respectively) from four co-educational schools was selected. The findings showed that male and female students had a significant mean difference in their achievement scores. In the Biology achievement test, male students outperformed female students. Similarly, Naboth-Odums (2014:59-66) discovered that the gender effect on the mean achievement scores of students is significant.

The work of Agbaje and Alake (2014:1-5)showed that students' variables (study habits, attitude toward, and interest in science subjects) are stronger predictors of students' performance in science subjects, however, student gender has no effect on students' academic performance. On their own, Adesogun, Adekunle, and Adu (2016:255-261) attributed the poor performance to a range of variables, including teacher factors (lack of qualification, experience, low salary and allowances, and poor supervision), student factors (a lack of enthusiasm to learn, and a negative peer group influence, and so on), but not gender influence. The findings of Eze and Osuyi (2018: 666-678), discovered that the impact of problem-based learning on the academic performance of male and female students in electrical installation and maintenance works (EIMW) is not statistically different from the impact of the lecture-demonstration instructional method.

Dania (2014:78-85) looked into the impact of gender on the academic achievement of secondary school Social Studies students. A quasi-experimental design was adopted in this investigation. Six schools and 180 Upper basic II pupils from Delta and Edo states made up the study's sample. According to the findings, gender does not influence on students' achievement in Social Studies. As a result, the study concluded that academic achievement has nothing to do with gender. This conclusion implies that a student's gender has no bearing on their academic performance, whether they are male or female. Amao, Adewuyi, Gbadamosi, Salami, and Ogunjinmi's (2016:102-108) study looked at genderbias and agricultural science achievement in public and private schools. Two hundred (200) students from senior secondary school III were surveyed. The findings demonstrated that male and female performance in agricultural science and other scientific-related courses has a standard level of significance, and males fare better in agricultural science than females.

Adigun, Onihunwa, Irunokhai, Sada, and Adesina (2015:1-7) investigated the association between student gender and academic performance in computer science and found that although male students did slightly better than female students, but the difference was not significant. This demonstrates that there is no significant difference in the performance between male and female students. The outcomes of Nnamani & Oyibe's (2016b:72-83) study on gender and academic achievement of secondary school students in Social Studies found that female students' mean achievement scores were higher than male students' mean achievement scores. The research also found that there are significant differences in secondary school students' mean Social Studies achievement based on gender.

In South-West Nigeria, AbdulRaheem (2017:93-98) explored the effect of gender on the academic achievement of secondary school students. From 2003/2004 to 2007/2008, the results from ten secondary schools in five Nigerian states of the West African School Certificate Examinations (WASCE) in English Language, Mathematics, Biology, Chemistry, Physics, Economics, Geography, Government, Yoruba, Christian Religious Studies, and French were collected. The study included a total of 2,305 students. Two schools from each state were chosen using stratified random sampling. The West Africa Senior Certificate Examination results of the sampled students were collected through purposeful sampling. The five hypotheses were tested using Chi-Square. According to the research, the performance of male and female students are well equally in the English language. Except for Yoruba, males surpassed females in Mathematics, Science, and Social Science, while girls outperformed boys in Arts.

Aina (2013:447-452) conducted a study at Colleges of Education in Nigeriaon a gender analysis of physics practical students' academic achievement. Data was provided by three public colleges of education in Kwara state. The Pearson Moment Correlation Coefficient was used to analyse gender. The results showed that there was no correlation in the achievement of male and female students, however male students outperformed female students in the physics practical. Okorie and Ezeh (2016:309) did a study in which they looked into gender and location effects of senior secondary schools students' achievement in Chemical Bonding in the Nsukka education zone of Enugu State. The study's purpose was to see if students' chemical bonding achievement was influenced by their gender or school location. Three hundred and eleven (311) students took part in the research. According to the findings, female students had a higher mean achievement score than male students. The research found that gender had no significant impact on students' chemical bonding achievement.

A thorough examination of pertinent literature on the gender role in student accomplishment demonstrates that male and female students achieve differently. In some cases, boys outperformed girls in terms of academic achievement (Nnenna & Adwuku, 2018:45-51). However, Nnamani & Oyibe (2016b:72-83) and Okorie & Ezeh (2016:309-310) noted that in some countries, technical and vocational education is seen mostly for boys, following certain traditions, and that efforts are being made to facilitate girls' enrolment at technical and vocational institutions. Nigeria still maintains a sex-biased technical and vocational education tradition (Odede & Adewale, 2013:286-296).

According to Odede & Adewale (2013: 286-296), female enrolment in Basic Electricity and technical education, in general, is quite low. This is in keeping with Robinson's (2017:14-21) study, which found that the number of females studying Basic Electricity in technical colleges is low in comparison to males. Gender inequality in technical education and associated subjects has resulted from the disparity in the number of females and males studying Basic Electricity (Robinson, 2017:14-21). Some programmes are restricted or unavailable to women. In Nigeria, the present trend is for individuals to focus on educating the female child.

Gender differences were originally explored by educational sociologists. At every level of the educational system, the attention was primarily on female underachievement. As a result, there is a need to enhance Basic Electricity teaching and learning at technical colleges, particularly among female students. The following factors, according to Iwu and Azoro (2017: 882-838), contribute to the underrepresentation of women in science and technology education in Africa:

- There is a scarcity of effective guidance and counselling services.
- The association between sex and professional status.
- The impact of education.
- Family history.
- Other elements, such as interest.
- There is not a good orientation programme in place.

• Discrimination in the educational system against women.
• Choosing a profession and adapting to science and technology.

In their contributions, Odede and Adewale (2013: 286-296) stated that the low enrolment of girls in technical education (Basic Electricity) is due to the following factors: negative attitudes of female students toward Basic Electricity, the "calculation" aspect of Basic Electricity, the unfavourable environment, and parental and peer influence. Inadequate opportunities for girls to pursue technical education, a lack of enthusiasm for science and technology, a negative attitude toward science and technology learning, and a lack of knowledge of science's true nature and technology are just a few of them.

Biological theorists maintain the critical belief that gender inequalities are unavoidable and thus unchangeable (Nworgu, Ugwuanyi, & Nworgu, 2013:71-76). Because males and females have different natural inclinations, treating them differently would be appropriate and accurate in school. As a result, hypotheses were advanced that women outshine in language-based disciplines due to their superior reasoning abilities.However, they underperformed in the sciences due to a lack of inherent talent in the shape and form components. (Nworgu, Ugwuanyi, & Nworgu, 2013). Furthermore, unskilled and inexperienced teachers, as well as inadequate teaching methods, have been blamed for students' poor performance in Basic Electricityin Nigeria (Owodunni, 2015; Robinson, 2017; Atsumbe et al., 2018). It would thus be a worthwhile exercise to see if a student's gender has an impact on their achievement when taught Basic Electricity using a personalised system of instruction (PSI) package or a traditional lecture approach (CLA).

Besides gender, learning environments also play an important part in learning and the area where the students' lives can influence their performance in their studies. Reasons for the differences in achievement are geographic location, resources, technologicalavailability, and also teachers'quality (UKEssays, 2018). The discussion follows below on how child immediate environment has affected their achievement. The following section will explain the influence of location on students' performance. This could expose inconsistencies in the delivery of teaching and learning resources to schools in rural and urban areas.

2.4 School location and students' achievement

The location of a school is referred to as the place where a school is situated. It could be in a city or a rural setting. Many studies have been conducted on school locations, and some believe that the location influences the academic achievement of students in such a school. Abamba (2021:56-76) posited that a child's immediate environmenthas a significant influence on his socialisation. According to him, the location of a school can have a significant impact on a student's academic performance. Rural life in Nigeria is more consistent, homogeneous, and less complicated than city life, with cultural diversity that is sometimes believed to be affecting students' achievement. In a similar vein, Essien (2017:72-87) claims that school location is one of the most crucial elements influencing children's academic progress. It is commonly assumed that ruralstudentsreceive a lower quality of education than their counterparts in metropolitan institutions. This is because metropolitan areas are better served in terms of social amenities like piped-borne water, electricity, and healthcare facilities, giving them an advantage in their schooling over rural students.

This provides them with better educational quality, access to information from various sources such as electronic media and mass media, as well as educated families and peer networks, all of which aid them in improving their performance, whereas students in rural areas are less favoured because they are less opportunity to interact with the outside world and a lack of awareness of current events (Anonymous, 2016). In Nigeria, a school in a rural location is frequently confronted with issues including, a shortage of teachers, a lack of laboratories and poorly equipped laboratories, among others (Essien, 2017). These flaws have a severe negative influence on students' motivation as well as their academic attainment. There is ample evidence that students in rural areas have lower educational aspirations than their urban peers (Ella & Ita, 2017;

Tikoko & Omondi, 2022). Abamba (2021:56-76) discovered that students in rural locations place less emphasis on their education, resulting in lower academic achievement.

Essien (2017:72-87) points out that there has been research on the link between a school's location and the academic performance of its students. Students in urban schools outperform those in semi-urban and rural schools (Chianson, 2014; Eraikhuemen, 2014; Onoyase, 2015). Rural students, according to Alordiah, Akpadaka, and Oviogbodu (2015), have lower educational goals, layless emphasis on academics, and have poorer motivation than urban students. The academic performance of students in urban areas and theirrural counterparts differed significantly (Akissani, Muntari, & Ahmed, 2019:410-420). On the other hand, Ntibi & Edoho (2017:76-85) investigated the association between students' achievement and the location of the school and discovered that students' academic achievement in urban and rural schoolsis notsignificant. Abamba (2021:56-76) found no significant differences in achievement between pupils taught with the 5E learning circle in rural and urban locations. Other research (Ezeudu & Obi, 2013; Agbaje & Awodun, 2014), for example, discovered that there was no statistically significant mean difference in the students' academic achievement levels between urban and rural school. Also, contrary to Agbaje and Awodun (2014:1-4), Faisal, Shinwari, and Mateen (2016:317-320) and Nnenna and Adukwu (2018:45-51) believe that there is a considerable variation in the achievement mean scores between students in rural and urban school districts. When gender and school location were taken into account, urban students outperformed ruralstudents.

Consequently, Opoku-Asare and Siaw (2015:1-14), while investigating the discrepancies in educational resources and differences in student achievement in various parts of Ghana, discovered that some parents go to great lengths to enrol their children into urban SHSs, even agreeing to their children being placed in visual arts, a subject thought only suitable for students who are deficient academically. According to the study, urban schools outperform rural and peri-urban schools because junior high school graduates with excellent Basic Education Certificate Examination (BECE) results are attracted and admitted to urban schools, they also have good infrastructure, adequate qualified teachers, prestigious names, and character that encourage their students to succeed.

Ellah and Ita (2017:381-384) investigated the correlation between the location of the school and students' academic achievement in the English language in secondary schools in the Ogoja Local Government Area and discovered that students' academic achievement in the English language differed significantly based on their school location.It was suggested that the government should bridge the gap between rural and urban areas by providing social facilities to rural residents, which would improve pupils' academic performance. The study of Yadav and Chahal (2016:33-36) on the impact of caste region and gender on students' academic achievement in Mahendergarh district in Haryana showed that there is no significant difference between male and female students, urban and rural students, government and private students, or general category students and urban category students. Based on these findings, it can be stated that the impact of caste region, and gender on the differences between male and female students, urban and rural students, and government and privatestudents is no longer relevant. However, students' academic achievement is influenced by their geographic location to some extent.

In a similar vein, Onoyase (2015:123) in his research of students in urban, semi-urban, and rural secondary schools in Oshimili South Local Government Area of Delta State, Nigeria, acknowledged that school location contributed significantly to academic performance, as the results, the study showed a significant variation in academic performance between students in urban, semi-urban, and rural secondary schools in English Language, Mathematics, and Science. Onoyase (2015:124) concluded that the fact that urban students have access to utilities such as piped water, electricity, decent roads, and well-equipped schoolsis the reason why they outperform rural students in academics. Rural schools lack appropriate educational infrastructure for efficient teaching and learning processes, which is one of the reasons. He submits that with the same methods, materials, and qualified teachers, students' achievement can be consistently improved in both rural and urban schools.

When Soliu, Badmus, Akanbi, and Omosewo (nd:1-18) looked at the impact of school location and school type on the academic performanceof students in the West Africa Senior Secondary School Certificate Examination (WASSCE) from 2010 to 2014, they found that students from rural areas do much better in some courses, such as physics than their urban counterparts. This is because the study revealed a statistically significant difference in senior school students' performance in WASSCE physics examinations based on school type. Because rural school students are used to working alone, they may be given greater responsibility for organising their work than urban school students.

Yusuf and Adigun (2010:81-85) also noted that a student's academic achievement is unaffected by whether he attends a rural or urban secondary school. According to Owoeye and Yara (2011:170-175), schooling in Nigeria's rural communities is typically tough because:

1. Qualified teachers dislike being posted to villages.
2. Because their children are involved in farming tasks, villagers prohibit their children from attending school regularly.
3. Parents are wary of entrusting their female children to male teachers.
4. Access to books and teaching materials is challenging due to a lack of roads and communication facilities.

As a result, there is a gap between the quality of teachers in urban and rural schools, which is reflected in students' accomplishment. The effects of school location on academic attainment are not the same as those found in other reviews of literature. Although some argue that urban students outperform their rural counterparts in exams, others have discovered that rural students outperform their urban counterparts (against all odds). Some researchers have presented their results, concluding that no one setting (urban or rural) can claim supremacy over the other because their results are comparable. Alokan (2010:340-345) found out that students' problems are highly connected with poor performance, while sex and location do not affect on the negative relationship between student problems and academic performance. As a result, school location may have no consequences on how students learn in schools. Given these mixed results, it will be a productive exercise to prove or disprove the otherwise perplexing question of the effect of locational interaction (urban/rural dichotomy) on students' achievement in Basic Electricitywhen using a personalised system of instruction.

As a result, the goal of this research is to explore if using the personalised system of instruction (PSI) technique will significantly improve student achievement in bothurbanand rural schools, regardless of the school's location. After determining that students' academic achievement in technical education, particularly in Basic Electricity, is declining, it is critical to developing ways and strategies to reverse this downward trend in student achievement in that subject. After examining the PSI's effectiveness in enhancing students' achievement in other disciplines and observing the low achievement in rural areas, the study looked at the PSI's effect on students' learning outcomes.

The section below discovered that attitudes can be a contributing factor in motivating students to pursue particular disciplines. This viewpoint, which is corroborated by various studies, may provide an answer to a portion of the sub-research questions of this study because it deals, among other things, with how poor academic achievement of students may be affected by attitudes. The solution might be to develop a students-centred learning technique aimed at allowing learners to develop positive attitudes towards the subjects. However, an understanding is needed of students' attitudes toward Basic Electricity. The following discussion on attitudes may aid comprehension of the dynamic influence of attitudes on learning and allow the researcher to link to some of the study's objectives.

2.5 Attitudes and Students' Achievement

For a long time, researchers have studied attitudes. The term "attitude" refers to a person's predisposition to think, feel, or preferences about an object, based on their belief about the object. It is related to likes and dislikes and can be positive or negative. On that basis, attitude can be referred to as a positive or negative assessment of persons, things, events, actions, thoughts, or any other thing in the environment. Similarly, one's attitude toward Basic Electricity might influence whether he or she considers it to be positive or negative, damaging or beneficial, pleasant or unpleasant, significant or inconsequential (Kapici& Akçay, 2016). Attitudes are personal beliefs formed through experience that a person uses automatically to interpret new events and knowledge and to direct their actions (Nja, Orim & Neji, 2022).

According to Bhargava and Pathy (2014:27-36), attitude is an individual's mental state of preparedness, which is influenced by daily events and influences how we respond to a related stimulus. It is a character trait that governs human behaviour and has to do with how people deal with emotions that arise during the learning process. Our attitudes are continuously focused on something or someone. Attitudes are complex, and they can have a wide impact on learning. Attitude has an impact on behaviour, determining what the learner chooses from the environment, as well as how he reacts to teachers, materials, and other pupils (Ntibi & Edoho, 2017:76-85).

The importance of attitude in a student's life is emphasised once morebecause these assumptions form the goal-oriented activity. Human perceptions and behaviour are heavily influenced by one's attitude. Students' attitudes in learning environments may spread the idea of success and ease of learning. The current study looked at the impact of a personalised learning system on students' attitudes. Ekweme (2013:153) reported that students' attitudes toward studies fall under four sub-headings in the science and technology learning process, where Basic Electricity is paramount. These are: students' views about the nature of knowledge; students' views regarding the importance of teachers in their learning; students' views about their role in learning; students' views about the nature and position of assessment.

Several researchers (Attah, Ita & Nchor, 2018:164-167; Ntibi & Edoho, 2017:76-85; Robinson, 2017:14-21; Taale & Mustapha, 2014:16-25) have found that having a positive attitude in life allows us to: make sense of who we are; make sense of the world around us, and make sense of relationships across multiple dimensions. Positive attitudes, on the other hand, have been demonstrated in several studies to be favourable to good performance and that there is a substantial link between attitude and achievement.

In learning Basic Electricity, attitudes are something crucial to be considered because attitude affects the student's performance or achievement. Student attitudes are one of the academic elements that are directly or indirectly associated with educational outcomes (Hinneh, 2017:6-11). Students' attitudes about learning Basic Electricity are taken into account because they have an impact on their grades. According to Njaet al. (2022) student, school-related attitudes are a decisive element that forecasts academic progress. The study concludes that a positive mindset produces positive results, whilst a negative attitude produces negative outcomes. Information, reverence, emotions, stimulation, and self-esteem all contribute to one's attitude toward a certain discipline. Students demonstrate a specific attitude toward Basic Electricity by reacting to it, based on their comprehension as opposed to its current state. A study of secondary school student attitudes toward biology as a school subject in Birnin Kebbi Metropolis, Nigeria, by Hussaini, Foong, and Karmamr's (2015:596-600) found that students who had a more positive attitude toward science had better success ratings.

Attitude in Basic Electricityis the persons' disposition toward the study of Basic Electricity which might be a positive or negative impression about Basic Electricity.

Whether one considers Basic Electricity to be tough or simple depends on one's perspective (Mao, Cai, He, Chen & Fan, 2021). The levels, how easy or difficult it is to do, the intangible character of some concepts, and the instructional methodology and methods used in class during teaching all influence learners' attitudes toward Basic Electricity learning (Petty, 2018). Expression such as "Basic Electricity lessons are not very interesting," "Studying Basic Electricity is a waste of time," "the calculations involved in Basic Electricity are difficult," or "I am always afraid when studying Basic Electricity," are some of the different perspectives that researchers view Basic Electricity. This component of the affective domain represented in words tends to reveal how the direction of the students' attitude toward Basic Electricity; positive or negative towards Basic Electricity as a subject and the related careers. Those who have a positive attitude are more likely to work hard, which is manifested in their examination results.

Researchers in the field of technical education have identified numerous factors that may contribute to students' negative attitudes toward technical subjects. Some of these elements are poor practical skills, the nature and content of the curricula; students' negative perception of technical education and lower enrolment rates of female students in a technical college (Okonkwo, 2014:15-24; Sanni, 2014; Taale & Mustapha, 2014:16-25; Ogundu, et al., 2015; Ogbuanya & Akinduro, 2017:2347-2371; Onah, 2017; Robinson, 2017). The number of students interested in studying Basic Electricity and related career courses at a technical college is steadily decreasing (Odede & Adewale, 2013:286-296; Agbara, Chagbe, & Achi, 2018:7-13). This negative tendency is the outcome of students' poor attitudes regarding technical education.

The attitude of students toward studying science and technology subjects is a critical component of course instruction's goal. In a science lesson, instilling a scientific mentality throughout the learning of science and students' attitudes about science are extremely important (Sakariyu, Taiwo, & Ajagbe, 2016).Hofstein and Mamlok-Naaman (2011), listed the three main aspects that may influence and hence increase students' attitudes to be: material presentation approach, Gender bias, as well as the resources and teaching aids used. Hussaini, Foong & Karmamr, (2015:596-600) discovered an expressive connection between students' attitudes about information technology and their academic achievement, indicating that academic achievement and attitudes are inextricably linked. According to the findings, it is critical to change student attitudes to improve academic achievement. According to a study by Sesen and Tarhan (2010:2625-2630), active learning resulted in a much higher acquisition of scientific concepts. When compared to students who were taught in a standard classroom environment, students who were taught in an active classroom setting had more positive attitudes toward Basic Electricity lessons.

Similarly, Mello and Less (2013:1-8); Momani, Asiri, and Alatawi, (2016:19-35), and Dema and Tshering (2020:1-7) found that an active learning strategy improved student science learning achievement. It was also discovered that active learning increased student motivation, which led to better performance. This is because learners who participated in active learning environments valued their learning experiences more than students who participated in passive learning environments. According to Niemi, Nevgi, and Aksit, (2016:471-490), active learning is essential in the classroom since it makes learning a lifelong process. Learning is one of the goals of Basic Electricity, among other things, to cultivate students' good attitudes toward Basic Electricity. Attitude outcomes in teaching and learning are just as important as cognitive outcomes. It is depressing to realise that the majority of traditional teacher training and learning focuses on the cognitive domain. This demonstrated that students' motivation and attitude toward learning are the most important aspects in mastering any subject (Paramitha, 2017).

2.6 Conceptual Framework for the Study

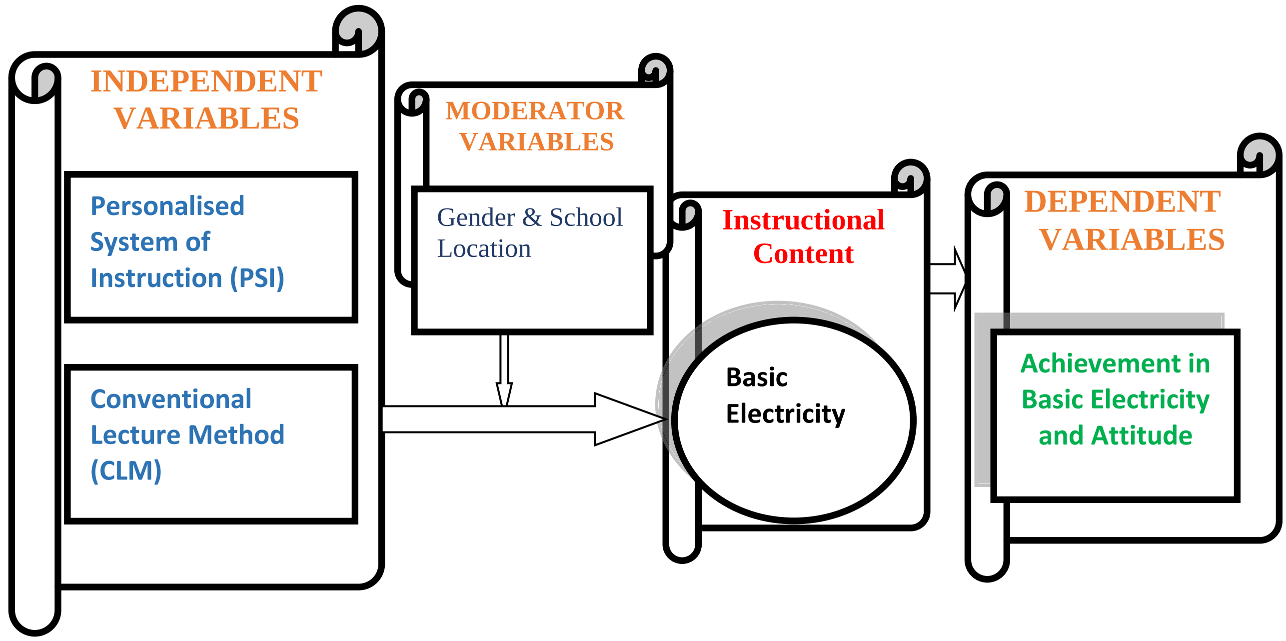

Figure 2.1: Conceptual Framework of Study Variables

Records had shown that technical college students' academic performance in Basic Electricity (BE) in National Business and Technical Examination Board (NABTEB) has been declining in recent years. A critical examination of the National Business and Technical Examination Board (NABTEB) reports shows persistent reports of the students' poor achievement in BE (Sanni, 2014; Taale & Mustapha, 2014:16-25; Atsumbe et al., 2015:380-387; Robinson, 2017:14-21). The reports revealed that approximately 40% of candidates who enrol for Basic Electricity from 2012 to 2017 obtained credit in the examination (NABTEB, 2018). The decline in student performance was traceable to poor instructional approaches and other factors as contained in the NABTEB Chief Examiner's Report.

The personalised system of instruction teaching method is the treatment utilised in this study, which is referred to in the conceptual model as the independent variables manipulated by the researcher to observe its efficiency on the dependent variable.The moderator variables are the elements that influence the effectiveness of the independent variable. They are factors that exists both within and outside the students, for example, gender and location of the school. It is against this background that the researcher decides to combine the instructional strategy (PSI) with gender and school location serving as moderator variables to see if it will improve the teaching and learning situation in technical college Basic Electricity. The students were divided into two groups: experimental and control. The experimental group received the personalised system of instruction (PSI) Package, while the control group received the conventional lecture method (CLM). The PSI Package and CLM were employed in the teaching of the activities that involved capacitor in an alternating circuit; Series R-L, R-C, and R-L-C circuits; Resonance and resonance frequency; Magnetism and Electromagnetism; Mutual inductance; Transformer (losses and how to minimises losses in transformer); Transformer lamination; types of transformer.

Students' cognitive domain (knowledge, understanding, application, analysis, synthesis, and evaluation) and attitude were tested using the Basic Electricity Achievement Test and the Attitude Questionnaire respectively.As a pre-test and post-test, the Basic Electricity achievement test and an attitude questionnaire were used. The data of the pre-test and post-test were utilised to assess students' performance and attitude in the tasks. Mean, standard deviation, bar chart, and analysis of covariance were used to examine the effects of the personalised system of instruction package on students' achievement in Basic Electricity (ANCOVA).

It is necessary to undertake an examination of theories that are relevant to the learning of these models to gain a better knowledge of how learners may learn and the process through which learning occurs.This could indicate how different theories approach content learning using various teaching styles and strategies in various environments. To delineate and determine the efficiency of the personalised system of instruction package on students' achievement in Basic Electricity in technical colleges in Osun State Nigeria, the following section of this chapter unravels three learning theories. The theories could provide insight into how teaching strategies affect students' learning outcomes.That might lead to knowledge and understanding of the reward-able approaches that technical college teachers should adopt to improve the students achievement.

2.7. Theoretical Framework

2.7.1 Behaviourism Theory, Social Cognitive Theory and Mastery Learning Theory

The purpose of this study is to see if the personalised system of instruction (PSI) model has any impact on student academic performance in Basic Electricity at a technical college. A shift in student behaviour and a shift in the teaching environment from a teacher-centred instructional model to a student-centred instructional model, as well as learning for mastery, are at the heart of this study. Behaviourism theory, social cognitive theory, and mastery learning theory are some theories that suggest such a change would affect student learning. Therefore, this study is underpinned by three main theories of learning; these include; behaviourism theory, the social cognitive theory, and mastery learning theory.

A learning theory is aimed at explaining the way people and animals learn; this will in turn help us to comprehend the complexity of learning processes. Illeris (2004:79-89) and Onmrod (1999:44) have defined learning as a process that combines cognitive, emotional, and environmental influences and experiences to acquire, enhance, or modify one's knowledge, skills, values, and worldview. Burns (in UK Essays, 2018:1) equally considers learning to be a relatively permanent change in behaviour, which includes both observable action and internal processes such as thinking, attitudes, and emotions. Learning, according to the aforementioned definitions, is a holistic process involving contextual effects and experiences on learners' behaviour, which may be observed as they interact both within and outside the classroomsettings.

Learning theories are detailed hypotheses that explain how people learn. Learning theories, according to Hill and Rita (2008:14-38), give a conceptual framework for evaluating observable examples and advise where to look for solutions to practical problems in education. They conclude that learning theories do not provide answers to instructional problems, but rather draw stakeholders' attention to the variables that are crucial in finding solutions to the problems.

Cognitive theories explore beyond behaviour to explain brain-based learning, whereas behaviourism focuses on the objective components of learning. When using a behavioural theory of teaching, Carnine (2000:1-12) emphasises the importance of developing specific learning objectives and creating a sequence of learning activities that progress from simple to complex. Mastery learning theory believes that given appropriate time learners can learn to the level of mastery.

The theories are discussed below and their relationship to the PSI teaching approach will be discussed.

2.7.2 Behaviourism Theory

John Watson, who lived from 1878 to 1959, invented the term "behaviourism." Learning is defined by behaviourism theory as an observable change in behaviour. Skinner and Tyler, on the other hand, were the pioneers of the modern behavioural movement, which was later improved upon by Orlich, Harder, Callaham, & Trevisan (2012:84). Three basic assumptions are held to be true about learning. First, learning is manifested by a change in behaviour; second, the environment shapes behaviour; and third, the principles of contiguity (i.e. how close in time two events must be for a bond to be formed) and reinforcement (i.e. any means of increasing the likelihood that an event will be repeated) are central to explain the learning process (Kim & Axelrod, 20:14:111-120).

Behaviourism is a school of thought that concentrates on one type of learning: changing external behaviour by a large amount of repetition of desired activities; rewarding good habits and discouraging bad habits. This approach to learning in the classroom will result in a lot of repetition, praise for good results, and immediate correction of mistakes. Learning, according to behaviourism, is the acquisition of new behaviour through conditioning. Classical conditioning and operant conditioning are two types of conditioning that can be used.

2.7.2.1 Classical conditioning

Classical conditioning (also known as Pavlovian conditioning or responder conditioning) is a significant behaviour-analysis technique that does not need the use of mental or other internal processes. The most well-known example of the classical conditioning process is Pavlov's work with dogs. Simple conditioning involves showing the dog a stimulus, such as a light or sound, and then placing food in the dog's mouth. The light or sound-induced the dog to salivate after a few repeats of this sequence.

It is the type where the behaviour becomes a reflex response to a stimulus as in the case of Pavlov's Dogs. Ivan Pavlov was a scientist who was interested in studying the behaviour of animals and human beings alike. He was interested in reflexes when he noticed that the dogs drooled without the necessary stimulation, even though that there was no food in sight, and that their saliva dribbled. It turned out that the dogs were reacting to lab coats whenever they see the man serving them wearing a lab coat. Pavlov then tried to figure out how these occurrences were linked in a series of tests. For example, he introduced the sound of a bell whenever the dogs were been fed. The dogs learned to associate the sound of the bell with the smell of their food if it was rung near their meal. After a while, the dogs began salivating at the mere ring of the bell.

2.7.2.2 Operant conditioning

B.F. Skinner developed operant conditioning in 1937. It entails the modification of 'voluntary behaviour,' often known as operant behaviour. Operant behaviour is influenced by its surroundings and reinforced by its results.Reinforcement and punishment are the most important tools in operant conditioning; they can be positive (given after a response) or negative (given before a response). It is essential to mention that, punishment is not regarded to be suitable if it does not terminate the behaviour, and so the terms punishment and reinforcement are decided because of the actions. Within this context, behaviourists are specifically concerned with observable behavioural changes. The Skinner box, also known as the operant conditioning chamber, was invented by Skinner to study the effects of the operant conditioning principle on rats.

Skinner designed a box with a lever that puts a food pellet into a rat's tray and automatically records the rat's responses on a time chart. The box's mechanism could be a lever for the rat to press. Food pellets are delivered to rats via the reinforcement delivery system. The mouse scurried around restlessly, unwittingly pressing the bar. A container containing food pellets is linked to the bar so that each time the rat presses it, a pellet of food falls into the dish. The rat consumes the food and presses the bar once again. The food adds to the pressure on the bar. The pressing reaction is in charge of producing the food (reinforcer), which subsequently serves as a response stimulus (bar pressing). Skinner devised a learning system known as Programmed Learning or Programmed Instruction as a result of this and other similar experiments, which is one of the 150 individualised instructional packages or designs in which the PSI Package is included.

Learning, according to Skinner (1984:217-221), is a set of events that alter behaviour in the same manner as conditioning does. When a behaviour works, it is preserved; when it doesn't, it is dropped. It implies that learning takes place through trial and error. It is first meticulously described to bring about the intended learning or style of behaviour. The aim must be set up in the second phase. The learner is rewarded or reinforced when he exhibits this desired behaviour. If the learner is rewarded quickly for any behaviour that approaches what is desired and the reinforcement is of value to the learner, the new learning or behaviour will be maintained. Thus, through the selective use of reinforcement, new learning is acquired.

The PSI is founded on the principle of active interaction of the learner with the environment, therefore the focus is shifted away from the teacher and toward the student executing the work himself. This means that the learner is emphasised as a unique individual. In this case, the instructional package, like the Skinner box, takes centre stage. The students are also allowed to proceed at their own pace. That is, each type of learner (both fast and slow) moves at a rate that allows them to get the most out of the learning experience. The PSI provides the learner with immediate knowledge of the result (IKR), similar to the Skinner box, where the rat obtains the food pellet by operating in the box.This instantaneous knowledge of the result serves as a form of reinforcement for the learner. The student is now in charge of both what s/he learns and how s/he learns the package. Skinners theory is related to PSI as effective use of PSI provides immediate knowledge which acts as reinforcement in skinner's theory.

It is vital to keep in mind that behaviourists perceive the process of learning as a modification in behaviour; the environment is arranged by the educators to bring forth the expected responses through devices like behavioural objectives, skill development and training, and competency-based education (Smith, Cowie & Blades, 2015). This model has spawned educational methodologies such as applied behaviour analysis, curriculum-based measurement, and direct instruction (Kim & Axelrod, 2014).

2.7.3 Social Cognitive Theory

Bandura, Albert in 1977, propounded the theory. The main emphasis of this theory is the gradual development and application of human agency, meaning that human being can exert some control over their activities (Bandura, 1977). A theoretical premise for developing a self-regulated model of learning is provided by social cognitive theory in which interaction exists between personal contextual behavioural factors such that learners are given the avenue to control the learning within this framework. The theory is a development of Montgomery's Social Learning Theory, which postulated that human behaviour is a product of only cognitive processes and was developed in the late 1800s. Human behaviour and knowledge acquisition, on the other hand, according to SCT, are the outcome of the interaction between present behaviour and environmental and psychological factors. (Denler, Wolter, & Benson, 2014). In the school, for instance, the teachers are facing the challenges of enhancing the learning achievement and courage of the students in their charge. Applying social cognitive theory as a framework in this study, teachers can strife to enhance the emotional states of their students and correct their defective attitudes and modes of thinking (personal factors), elevate their academic skills and self-control practices (behaviour), and adjust the school and classroom structure that serves as a threat to students' success (environmental factors) (Bandura, 1977).

2.7.4 The Mastery Learning Theory

According to Davis and Sorrel (1995:1-4), the mastery learning concept was introduced in the American schools in the 1920s with the work of Warshburne (1922) as cited in Block (1971:2-12) and others in the format of the Winnetka Plan. However, in the late 1950s, it was revived in the form of programmed instructions in an attempt to provide students with instructional materials that would allow them to work at their own pace while receiving continuous feedback on their progress. Carroll (1963:723-733) was one of the first to advocate for mastery learning. Benjamin Bloom's learning for mastery, published in the 1960s, drew new attention to the philosophy of mastery learning. Bloom's work from 1968 is now widely regarded as the first theoretical formulation of the mastery learning model. He is widely regarded as the principal theorist and proponent of the mastery learning theory.

According to Garner, Denny, and Luxton-Reilly (2019:1-10), mastery learning is a pedagogical strategy that requires students to demonstrate mastery of the currently assessed unit of material before moving on to the next. It is designed in its various forms; towards making learners perform beautifully well on academic tasks. The subject matter is divided into units with predetermined objectives or unit expectations in the mastery learning method. Students systematically work through each unit, either individually or in groups. Before moving on to a new subject, students must demonstrate mastery on unit tests, which are normally 90 percent. Tutoring, peer monitoring, small group discussions, or additional homework or assignments are used to help students who do not master the material. Those that require remediation are given additional learning time. Students repeat the cycle of learning and testing until they have mastered the material.

According to the proponents of mastery learning, it is most effective with basic skills in slow learners at both the elementary and secondary levels. Instructors frequently give group instruction to the entire class, with individual time for learning provided until mastery is reached. The purpose of mastery learning is for the student to achieve achievement. It is claimed that in the education or learning environment, success in achievement, attitude, and motivation make learning more effective. Mastery learning is an instructional method based on the assumption that all children can learn if they are given the right learning conditions. Students have not proceeded to the next learning target until they have shown mastery of the current one, which is known as mastery learning. The operant conditioning principles of behaviourism are responsible for the concept of mastery learning. Learning happens when a link is formed between a stimulus and a response, according to operant conditioning theory (Skinner, 1984:217-221). Mastery learning is centred on overt behaviours that could be observed and measured, in keeping with behaviour theory (Baum, 2005). The information that will be taught to mastery is divided into small discrete lessons that proceed in a logical progression. To demonstrate mastery over each lesson, students must be able to provide overt evidence of understanding of the material before moving to the next lesson (Anderson, 2000).

According to Bloom, teachers who teach for mastery must divide curriculum content into units and then assess students' progress after each unit. He reasoned that these assessments of learning progress should be used as part of the teaching and learning process to provide feedback on students' learning problems and then prescribe appropriate remediation activities. As a result, teachers are expected to define mastery, plan for mastery, teach for mastery, and grade for mastery. Mastery is defined as a set of behaviours that students must display before they achieve mastery. Breaking down topics, selecting appropriate teaching methods, appropriate instructional materials, and evaluation procedures are all part of mastery planning. Each instructional material must also be evaluated by the teacher to establish its suitability for achieving the instructional objectives.

When delivering lessons for mastery, the instructor must keep in mind the age of the students and the class they are teaching. Students should be graded and assessed with the specified objectives in mind so that critical mass can be determined. When learners are given more favourable learning conditions for mastery learning, it is anticipated that virtually all students (or at least 90%) will be able to fully master academic content (Bloom, 1976; Guskey, 2010:8-31). A large body of research has proved that when compared to students in traditionally taught classes, students in well-implemented mastery learning classes typically achieve higher levels of achievement and build greater confidence in their ability to learn and in themselves as learners (Carmo &Médici, 2018:5-15; Guskey & Gates, 1986:73-80).

In general, mastery learning programmes have been found to lead to higher achievement among all students when compared to more traditional modes of instruction (Anderson, 2000). Despite the empirical evidence, many mastery programmes in schools have been replaced by more traditional forms of instruction due to the level of commitment required by the teacher and the difficulty in managing the classroom when each student is following an individual course of learning (Anderson, 2000). According to Joiner (2015:16-66), mastery learning is a

> concept that has a long history of targeting education and accomplishment to satisfy the individual desires of the entire student body. With so much pressure to meet the criteria of current legislation, mastery learning methodologies are unquestionably being recognised and treated as a strategy used in the classroom.

Mastery learning strategy is a paradigm shift or an invention through which, in its diverse ways articulated towards making learners perform excellently well on academic tasks. He explains further that it is a technique that prompts the teacher to help nearly all students learn equally excellently and quickly with self-confidence (Joiner, 2015:16-66).

Alalwneh and Alomari (2018:81-92) assert that the mastery learning model of Keller is individualised otherwise referred to as a personalised system of instruction (PSI). The model requires learners that do not reach mastery on particular learning tasks to repeat the given instructions by studying the original problem assignment. Learners must work themselves until mastery is attained. He went further to assert that Keller's model is by implication, approximated as the full mastery learning model because it was concerned for individual students to attain a 100% mastery rather than Bloom's which is group based and only recommends a high level of performance at the end.

Moreover, Mitee and Obaitan (2015:34-38) compare the mastery learning strategy with the conventional method of teaching, pointing out that mastery learning is an instructional strategy that principally lead to reducing the myth surrounding the normal curve which holds that only the minority of students are capable of learning what is being taught to them. Rather than accepting this traditional idea, the mastery learning strategy holds that instructional time and resources should be used to bring all learners up to an acceptable level of achievement. Garner, Denny, and Luxton-Reilly (2019) focus on the successful and unsuccessful work that previous researchers recorded in their studies on mastery learning techniques, thus preferring the mastery techniques to the conventional method of teaching. Results of studies using Keller's mastery learning approach have shown that the mastery learning group's mean scores are often at least one standard deviation higher than those receiving traditional teaching (Akinsola, 1999; Mitee & Obaitan, 2015:34-38; Garner, Denny & Luxton-Reilly, 2019). More than 30% of them can attain mastery at the grade 'A' (Akinsola, 1999; Mitee, & Obaitan, 2015:34-38; Garner, Denny & Luxton-Reilly, 2019) as opposed to the conventional group where less than 20% can attain the set standard.

2.7.5 The link between the theoretical construct and this study

The goal of this study is to explore if the personalised system of instruction (PSI) instructional model has an impact on the academic achievement of technical college students in Basic Electricity. A shift in the student environment from a teacher-centred instructional paradigm to a student-centred instructional model is at the core of this study. As previously stated, learning is considered a collection of experiences that influence behaviour in the same manner as conditioning (Skinner, 1984). When a behaviour works, it is preserved; when it doesn't, it is dropped. It means that the process of learning is by trial and error. It is first meticulously described to achieve the desired learning or behaviour style. The second phase involves setting up the goal. The learner is rewarded or reinforced when s/he exhibits this desired behaviour, if the learner is quickly rewarded for any behaviour that matches the desired behaviour, and the reinforcement is valuable to the learner, the new learning or behaviour will be sustained. New learning is obtained as a result of the selective use of reinforcement. The personalised system of instruction is founded on the notion of the student's active interaction with the environment, therefore the attention is shifted from the teacher and toward the learner executing the task.

According to B.F. Skinner's operant conditioning theory, attitudes that are reinforced by the positive outcome are more probably to be repeated than behaviours and attitudes that are reinforced by a negative outcome (Johnston, 2016). According to Skinner's theory, positive reinforcement strengthens a behaviour by offering a gratifying outcome, while negative reinforcement strengthens a behaviour by removing an unpleasant experience. In this regard, teachers must guarantee that students receive a variety of positive and negative reinforcements that will help them build good attitudes toward learning Basic Electricity to ensure a successful and meaningful learning process. Students who are placed in this type of learning environment will employ deduction, applying what they have learned to new situations, examining data, comprehending new ideas, imparting, teaming up, tackling challenges, and determining.

Because this study focuses on the learner as an individual, the behaviourism theory was also used. In this case, the PSI package, like the Skinner box, takes centre stage. PSI enabled students to work at their speed. This means, that each type of learner (both slow and fast) moves at a rate that allows them to get the most out of the learning experience. In the same way that the Skinner box gives the rat immediate knowledge of result (IKR), the personalised system of instruction package offers the learner with immediate knowledge of result (IKR). This instantaneous understanding of the outcome serves as a form of reinforcement for the learner. The student is now in charge of what he or she learns and how they learn it. Skinner's theory is linked to PSI because effective PSI use delivers instant knowledge, which acts as reinforcement in skinner’s theory.

In a similar view, the Social Cognitive Theory (SCT) (Bandura, 1986: 206) asserts that effective learning can occur not only through social interactions but also through modelling or observations in scenarios where individuals are learning with specific resources. Humans can be considered agents of successful learning acquisition in the personalised system ofinstruction learning settings. Learners' cognitive, affective, motivational, and metacognitive processes are influenced by observing people act or, in a broader sense, by obtaining knowledge based on people's experiences. According to Bandura's (2001:43) triadic reciprocal causation, an optimal learning process requires three factors: person, behaviour and environment. Each component can influence the others. As a result, environmental influences such as the general mood depicted in learning materials might influence a person's interest or cognitive engagement (i.e., behaviour). The PSI learning settings, according to Bandura's theory, can act as an environmental component impacting learners' learning processes. After controlling for prior achievement, the study's core hypothesis is that students in a PSI classroom will adjust to their new environment and produce positive, statistically significant results on the Basic Electricity test when compared to students in a traditional lecture classroom.

In addition, to address the issue of a poor method of teaching Basic Electricity, this study looks into the strength of Bloom's (1971, 1976), Keller's (1968), and Guskey's (2010).This study adopted the PSI method as an alternative method of teaching that could potentially enhance students' academic achievement in Basic Electricity. As previously stated, the PSI is an instructional method predicated on the premise that all learners can learn effectively if given sufficient time and teaching opportunities

(Zakariyya, Ndagara, & Yahaya, 2016; Adeniji, Ameen, Dambatta, & Orilonise, 2018). The method's learning for mastery component mandates that the contents of the materials to be studied are separated into discrete units, each with its own set of objectives and assessment. Keller (1968:79-88) advocated a personalised approach to training in which each learner is given one-on-one attention. Under the supervision of the teacher and/or proctors, each learner is free to progress at their own pace (Kalaivani 2014). The focus of PSI is on the student. It takes into account the variances among students and permits each student to progress at his or her speed. Students are also allowed to interact as fast learners are tasked with instructing the slower students. In essence, students are encouraged to participate and are highly driven. Following widespread reports of Mastery Learning's success, this study set out to implement the learning technique in technical colleges in Osun State to teach specific areas of Basic Electricity.

The following section reviewed the empirical studies that have been conducted by some scholars to explore the impact of individualised instruction (i.e. PSI) methods of instruction on students' learning outcomes in various disciplines at various levels of school-based. The empirical studies could reveal that different individualised instructional methods have different effects on students' achievement and attitude. This might necessitate the need for this study, which looked into the effect of the personalised system of instruction (PSI) on achievement and attitude.

2.8 Related Empirical Studies

The researcher looked into the extent to which a personalised system of instruction approach has been applied in teaching students in various disciplines at various levels of school based on the literature. Over the last half-century, a large body of work on PSI has contributed to adaptations, procedural changes, and the identification of feature components that are crucial for student performance and academic achievement.PSI Research conducted on PSI between the early 1970s and the late 1990s, for example, had positive outcomes. The PSI studies at the beginning focused on a variety of topics.

Studies comparing PSI to traditional lecture methods, PSI component analyses, studies addressing procrastination in the PSI courses, studies investigating the efficiency of proctor feedback, and research on the development and efficacy of the PSI are among them. The PSI has been demonstrated to be useful in improving academic performance in a variety of areas, including human growth and development, economics, writing skills, biology, medical school biochemistry, introductory psychology, and applied behaviour analysis (Warner, 2021:56-57). PSI was also discovered to be a successful educational strategy for enhancing socially valid behaviours and vocational skills, such as lowering Navy Training dropout rates and teaching adults checking account skills (Warner, 2021).

However, PSI research has slowed significantly over the last two decades (2000-present). Several researchers have speculated on the causes of the drop (Fox, 2013; Eyre, 2007; Grant & Spencer, 2003). Even though the PSI research has dropped since the early 1970s, scholars continue to provide useful studies today. PSI advancements (Springer & Pear, 2008); improving academic achievement with the use of PSI to teach various course disciplines such as weight training (Pritchard, Penix, Colquitt, McCollum, 2012) and even a behavioural application to higher-order thinking (Svenningsen & Pear, 2011); implementing PSI for teacher job specialist professional training (Mayer, Sulzer-Azaroff, & Wallace, 2014); and finally, implementing PSI for teacher job specialist professional training (Svenningsen & Pear, 2011; Paiva, Ferreira, & Frade, 2017). According to their findings, the PSI creates an environment in which students (a) actively participate in the learning process, (b) accept responsibility for their learning, and (c) improve their time management skills as well as their ability to define topics, access various resources, and evaluate the validity of these resources. They further concluded that the PSI turn out to boosts critical thinking, communication, mutual respect, teamwork, and inter-personal skills, as well as raises students' enthusiasm for a course.

Adeniyi (2019:147-163) investigated the impact of a personalised system of instruction (PSI) on mathematics retention. A total of 86,234 senior high school students from Kwara State were involved in the study, with a sample size of 170 males and 150 females totalling 320 students. A quasi-experimental design was utilised, with a non-randomised, non-equivalent control group.The study used the (PSI) Instructional module on indices and logarithms, the Mathematics Performance Test (MPT), and the Retention Performance Test (RPT) as research instruments (RETEPS). The Cronbach alpha value for MPT was 0.87. Mean and standard deviation was used to determine the difference between post-test and retention scores. Analysis of covariance was used to test the hypotheses. In comparison to students in the control group, students who were taught mathematics using PSI were able to retain the material learned.

The impact of individualised teaching techniques on students' learning outcomes in vocational courses among the students of Irbid University college, a branch of the Balqa' Applied University in the 2017/2018 academic year, was investigated by Alalwneh and Alomari (2018:81-92). To answer the study's research questions, the descriptive-analytical approach was utilised, and a sample of (62) female students was purposefully selected. Participants in the study were split into two groups: the experimental group, which received a personalised system of instruction, and the control group, which received a traditional teaching method. In the post-test, there were statistically significant differences in mean scores between the experimental and control groups, with the experimental group having a mean score of (18.57) and the control group having a mean score of (16.31). Furthermore, when compared to the traditional teaching method utilised with the control group, the independent sample T-Test indicated statistically significant differences, indicating that the PSI approach has successfully enhanced students' achievement. The current study is being conducted against this backdrop to see if PSI can improve learning and modify students' attitudes.

Olatide (2018:24-36) looked into the relative effects of mastery learning and a personalised system of instruction (PSI) approach on students' progress in Kwara State's Social Studies classes. He adopted a quasi-experimental pretest-posttest approach with a control group design. A sample of 180 students from a junior secondary school class II was used. The schools and research participants were chosen using a multi-stage selection approach. The experimental group consisted of two schools, while the control group consisted of three schools. The data was gathered using the Social Studies Achievement Test (SSAT). The reliability of the instrument was determined using the test re-test approach, which yielded a reliability coefficient of 0.84.At the.05 level of significance, Analysis of Variance (ANOVA) and Multiple Classification Analysis was employed to assess the generated hypotheses. Students exposed to mastery learning and the personalised system of instruction did better than students subjected to the traditional method (control group), according to the findings. It was also shown that exposing students to learning for mastery and a personalised system of learning to constitute a veritable tool for effective and better students performance in Social Studies.

Nnamani and Oyibe (2016a:110-120) studied the impact of an individualised (PSI) teaching approach on secondary school students achievement inSocial Studies in Ebonyi State's Onueke educational zone. Two research questions were generated and tested, as well as two null hypotheses. The study was conducted using a quasi-experimental research design. The entire population consists of 2,793 students from public junior secondary school two (JSS II) in the Onueke education zones of Ebonyi State. The data was obtained using the Social Studies Achievement Test (SOSAT), andmean and standard deviation was used to analyse all study questions. At the.05 level of significance, the null hypotheses were tested using analysis of covariance (ANCOVA). The finding shows that secondary school students taught Social Studies using the individualised (PSI) instructional method had higher mean achievement scores than secondary school students taught Social Studies using conventional methods, and that female secondary school students who were taught Social Studies using the individualised instructional method (PSI) had higher mean scores than male secondary school students who were taught Social Studies using the traditional method. The study also discovered that individualised instructional methods had a substantial impact on the mean achievement of students in Social Studies in both urban and rural secondary schools in the Onueke education zone. They concluded that teachers should re-evaluate their Social studies classroom instruction and change from instructional practice that renders learners passive listeners to instructional practice that actively involves learners in the teaching-learning processes.

The work of Wood (2018:1-87) looked at the differences in engagement between students in personalised learning classrooms and students in standard classrooms in the first year of implementation, as well as any gender differences. Teachers' perspectives of student engagement when implementing personalised learning were also investigated. A total of 167 second and third-grade students, as well as eleven educators, were enrolled in the study. In third grade, the study found no significant differences in emotional engagement between genders or method groups, however second-graders in the personalised learning group were much more emotionally engaged than their traditionally instructed classmates. Additionally, qualitative data revealed teacher perceptions of student engagement to be higher when they employed learner-centred strategies that personalised the students' learning.

Ginanjar (2019:32-36) used the personalised system as an instructional model and the direct instruction (DI) learning model to investigate differences in student learning motivation.A randomised post-test control group research design and an experimental research approach were adopted in this investigation. A total of 94 vocational school students took part in the study.The Taro Yamane formula and a simple random selection procedure were used to choose a sample of 48 students for the study. The data was collected using a student motivation questionnaire, and the null hypothesis was tested using an independent-samples t-test. Results revealed that students' learning motivation differed while using the personalised system for instruction learning model and when using the direct instruction learning model. He concludes that using the PSI model of learning improves learning motivation.

The influence of the personalised system for instructions (PSI) on the physical fitness of Senior High School nursing students from Bhakti Kecana at Cimahi was investigated by Friskawati, Ilmawati, and Suherman (2017:2-6). The study used pre-test and post-test control group research designs as experimental methodologies. A total of 233 Senior High School nursing students participated in the study, including a sample of 25 students in the experimental group and 25 students in the control groups drawn using the cluster random sampling technique. The study was conducted in 12 meetings over four weeks, with three meetings per week. The data collection instruments are Tes Kebugaran Jasmani Indonesia (TKJI). The data were analysed using paired samples T-tests, and the results revealed that the Personalised System for Instructions (PSI) has a significant influence on the physical fitness of Senior High School nursing students at .000 alpha levels. The study concludes that the personalised system of instructions (PSI) can be used to increase student physical fitness.

Learning using a digital module-based personalised system instruction (PSI) model can substitute the conventional/traditional learning method (teacher-oriented learning) with student-oriented learning, according to Zakaria, Septiana, and Kurnia (2018:95-107) in their study on mastering the basic motions of basketball using the electronic module-based (E-Module) personalised system of instruction (PSI) model. The goal of the study was to see if implementing the electronic module-based (E-Module) personalised system of instruction (PSI) has any effect on basketball basic motion mastery, particularly among junior high school students. With a sample of forty (40) students, the research conducted a pre-test and post-test on the experimental and control groups, with twenty (20) students each in the experimental and control groups. The basketball game's basic motion control sheet was used, which included items on mastering basic passing, shooting, and dribbling actions. For the treatment, the study used five meetings with a total duration of 3 x 40 minutes per meeting. Resultsrevealed that the PSI model based on digital modules was effective in inducing mastery of students' basic motion in basketball games.

At the University of Zarqa in Jordan, Al-Zaboun, Al-Mawadiah, Al-Mawajdeh, and Al-Mawajdeh (2016:101-117) compared the influence of individualised instruction and cooperative learning methodologies on students' achievement for the course of principles of pedagogy. The study used a sample of (288) students who were studying pedagogy principles in the academic year 2013/2014. The sample was selected as a deliberate sample. The students in the sample were split into three groups. Individualised instruction was used to teach the initial experimental group of 92 students (Claire Plan). The cooperative learning (Jigsaw 2) technique was introduced to the second experimental group (99 students). The control group, which comprised 97 students who were exposed to the traditional manner, was the third group.After the three groups had been taught, the analysis of variance pair (3 x 2) was employed after the three groups had been taught to see how the study factors (method and sex) affected student achievement. The findings revealed that students who were taught through cooperative learning had higher mean achievement scores than those who were taught through personalised teaching and traditional techniques. Students who were taught using a personalised system of instruction had a higher mean than those who were taught in a traditional approach. However, the differences in mean accomplishment ratings across the three groups were not significant; thus, achievement cannot be linked to sex or the interplay of sex and teaching techniques.

The study on the Intelligent tutorial system based on a personalised system of instruction to teach or remind mathematical concepts conducted by Paiva, Ferreira, and Frade (2017:370-381) describes the design, development, implementation, and evaluation of a tutoring system (TS) to improve student engagement in higher mathematics. The TS design is based on the Personalised System of Instruction of the Mastery Learning pedagogical approach and can be utilised in any higher-level mathematics course. The TS is made up of small self-paced modularised instructional information pieces such as tutorial videos, notes, and formative e-assessment with individualised feedback. The TS ensures that the student can only progress to the next unit once the current unit’s mastery criteria have been met. Students gave positive feedback on the TS after it was used in an undergraduate Quantitative Methods course. Learning and participation in the subject were found to be aided by TS. It has also been demonstrated through an experimental research experience that imposing mastery criterion-based constraints on advancement to the next level results in a considerable improvement in student engagement and performance.

Butler et al. (2015:317-326) wanted to see how effective a modified PSI that worked on a typical academic timetable was. Both a modified PSI and a regular lecture-style were used to teach students in two introductory psychology courses. The academic achievement and satisfaction of the students were assessed. The PSI group and the lecture method group showed no statistically significant differences in students' academic achievement, course satisfaction, or motivation. Furthermore, adding more technological gadgets to PSI did not increase students' satisfaction with the programme in any way. According to the findings, altering PSI by incorporating time constraints may undermine its superior performance over conventional lecturing. Although their research found no evidence that PSI is superior to conventional lecture, when students were given the option of choosing a teaching method, 55.2 percent chose PSI.

Prewitt (2014:1-173) examined the fidelity of using PSI to teach HRF content knowledge and resistance training skills in a high school physical education class, as well as the differences in HRF content knowledge and in-class physical activity levels between a PSI-using class and a DI-using class, using a two-study approach. A total of 54 students from a private, urban high school in a large city in the Mountain West region of the United States participated in the 6-week study. The qualifying standards linked with PSI were determined by recording video and audio, conducting interviews, and keeping journals.Knowledge was measured three timestest (pre, post, and 3-week follow-up) usinga standardised HRF knowledge. The two groups' scores were compared, as well as variations within each group. Physical activity during class time was measured with a modified version of the System for Observing Fitness Instruction Time (SOFIT).The study found that three of the four PSI components, as well as ten of the twelve design characteristics, were met, indicating that the PSI-based personal fitness unit was successfully implemented. According to the findings, the PSI group exhibited a significant increase in knowledge evaluation scores from pre to post-test ($p = 0.003$). According to between-group data, HRF knowledge scores from the PSI were significantly higher than those from the control group after the 6-week experiment ($p = 0.03$). The differences in physical activity between the two groups were not statistically significant ($p = 0.79$). He believes the PSI is an excellent instructional paradigm for acquiring HRF knowledge while keeping physical activity levels high.

Allen (2015:1-153) put the Social Cognitive Theory to the test in a large, urban high school in northeast Georgia, comparing the achievement of all-male high school weight training students who were taught using the personalised system of instruction (PSI) model to students who were not taught using the PSI model on the state-mandated Fitnessgram assessments, after controlling for prior Fitnessgram achievement. Data were obtained from archival Fitnessgram pre-and post-tests on a total of 206 students, 103 of whom were taught utilising the PSI instructional technique and 103 who were not. The data was analysed using ANCOVA to see if there was an influence of the instructional model on student accomplishment on the Fitnessgram PACER, ninety-degree push-up, and curl-up assessments after correcting for past Fitnessgram achievement as evidenced by the Fitnessgram pre-test scores. There was no statistically significant difference in student achievement between the groups, and none of the null hypotheses was rejected.

The effect of a personalised system of instruction (PSI) on the performance of senior secondary school students in Mathematics was studied by Owolabi and Aderinto (2010:53-63). With two groups of 25 senior high schools (class one) students participating in the study, the post-test only control group design was used. One group was given the PSI, while the other was given standard teaching as treatment. The effect size was calculated when the post-test scores of participants in Mathematics were subjected to a t-test. The study's findings revealed that the experimental group did considerably better than the control group, witht (48) = 12.33, p< .05, indicating that the experimental group outperformed the control group. Also obtained was a substantial effect size of 0.76. He maintained that PSI is an effective strategy for considerably boosting senior secondary school students' mathematics performance. It is thus suggested that teachers of Mathematics and other school disciplines consider using PSI to help students improve their grades.

The PSI's impact on the learning of basic football abilities among secondary school students was investigated by Abd-Allateef (2011:1-117). The participants in the study were separated into two groups: an experimental group of 21 students who were taught using the PSI approach, and a control group of 21 students who were taught using the traditional method. The results demonstrated significant differences in student performance between the two groups, especially in the experimental group. Al-Mawajdeh’s (2004:1-176) goal was to investigate the impact of PSI and cooperative learning on 7th-grade students' achievement in Islamic education in Jordan. All 7th-grade students in the South Mazar directorate of education in the 2003/2004 academic year (n = 1230) were included in the study. The students in the study were separated into three groups: experimental group one was taught using the PSI technique, experimental group two was taught using the cooperative learning method, and a control group was taught using the traditional method. The cooperative learning technique produced the best outcomes in terms of student achievement, whereas the PSI method produced superior results in terms of student achievement when compared to the traditional method.

Akinsola & Awofala (2009:389-404) investigated how personalisation of instruction affects the achievement and self-efficacy of 320 Nigerian senior secondary students in math word problems. Gender was also looked at as a moderator variable for the independent variable (personalisation) and dependent variables (mathematics achievement in word problems and self-efficacy). The data collected for the research were analysed using the t-test statistic. In terms of mathematical achievement in a word problem and self-efficacy views, the data revealed significant differences between personalised and non-personalised groups, male and female personalised groups, and male and female non-personalised groups.

Hannon, Holt, and Hatten (2008:20-33) looked at how to teach a high school personal post-rehabilitation exercise unit using a personalised system of instruction (PSI). To give students an introduction to the unit, class rules and procedures, learning objectives, and content-based assessment modules, a course workbook was prepared.The PSI unit was successfully implemented in this study, according to the criteria used to verify the effective use of PSI in a physical education setting. One of the key elements of PSI, self-paced mastery learning, was a novel experience for the students, according to their comments. Students loved the structure and material offered as they were more familiar with the concept. According to teacher feedback, after introducing and implementing the PSI approach, very little time was spent on classroom management. The majority of the teaching was devoted to giving students individualised feedback. The PSI provides an alternative approach to teaching and learning in physical education and other subjects.

The moderating influence of gender on students' academic achievement was studied in Salami's (2007:132-137) study on the effects of a personalised system of instruction on students' academic achievement in chemistry. In the study, 189 students from senior secondary school one (SS1) in Oro, Kwara State, Nigeria, were chosen at random from three co-educational secondary schools. The study used a pre-test, post-test, control group, and experimental design with 3 x 2 factorial matrixes. There were two experimental groups: one that received individualised instruction with a target date and the other that did not. The control group was given traditional instruction. The course of treatment lasted six weeks. At the .05 levels of significance, four hypotheses were evaluated. The results of the Analysis of co-variance and Fisher's LSD tests revealed that students in the PSI group improved their academic achievement in chemistry more significantly than those that were exposed to the traditional technique. On the dependent measure, there was also no significant interaction between treatment and gender. The implication of this study to chemistry and other science subject shows that the PSI will be useful in teaching very abstract concepts and principles that are difficult for students.

Alieme (2014:1-183) investigated the impact of the personalised system of instruction (PSI) and direct instruction (DI) on the self-efficacy and mathematics achievement of primary five learners in Oyo state. Solomon's four-group design was used in this investigation. In Oyo state, four local government areas and 16 public primary schools (eight urban and eight rural) were chosen using the purposive sample technique. Three groups of participants were formed (PSI, DI and CM). The data gathering was placed over six weeks. In each of the schools that were chosen, entire classrooms were utilised (397 primary five pupils, 209 males and 188 females). Three measures were used to assess mathematical achievement, self-efficacy in mathematics, and attitude: the Mathematics Achievement Test (r = 0.82), the Mathematics Self-Efficacy Test (r = 0.82), and the Mathematics Aptitude Test (r = 0.82). Mathematics aptitude scale (r = 0.78) and mathematics self-efficacy measure (r = 0.75). These instruments were evaluated using 100 pupils (50 urban and 50 rural).

The independent t-test and ANCOVA were used to analyse the data, and both were tested at the .05 level of significance. The post-test scores showed that participants in PSI (x = 85.2), DI (x = 79.9), had higher scores on pupils' self-efficacy than CM (x = 74.6); and participants in DI (x = 79.8), PSI (x = 50.6), had a higher score on pupils' achievement in mathematics than CM (x = 38.9).The main effect of attitude on students' self-efficacy was significant ($F_{(1.372)}$ = 12.830). The location of the school had a significant main influence on students' mathematical achievement ($F_{(1.372)}$ = 53.830). Students from urban schools outperformed students from rural schools in every category [urban (PSI: x = 69.0) (DI: x = 82.6) (CM: x = 43.3); rural (PSI: x = 38.5) (DI: x = 77.4) (CM: x = 33.3)]. Gender showed a significant main effect on pupils' mathematics achievement ($F_{(1.372)}$ = 9.314), as well as significant interaction effects. When the learners' post-test scores were compared, it was discovered that those who were given a pre-test before treatment fared better than those who were not.

As a novel technique study, Bautista (2012:573-583) looked at the superiority of personalised instruction. It expands on the articulation of current activities in a dynamic classroom setting. It focuses on learning about the history of learners, including their learning styles, as well as the learning environment's collegiality culture. It discusses the role of collaborative learning in developing a sound culture of learning and development in the course; the role of small group discussion (SGD), teacher-coach-adviser, and peer-mentor in a shared culture of active learning experiences; and the implementation of flexible scheduling and pacing using authentic assessment of student learning. It was discovered that students who received personalised instruction fared higher on the post-test mean score. The significant interplay of this methodology with the student’s learning capacity is a corollary to that conclusion. However, the scores attained by the students across their learning capacitiesare not significant.Furthermore, it was discovered that the programme benefited the low and average pupils the most.

Butler et al (2015:317-326) concluded that a personalised system of instruction approaches was less effective in improving academic achievement, course satisfaction, or motivation; their study found no evidence that the PSI is superior to conventional lecture because student achievement across the groupswas not significant statistically, whereas Ginanjar (2019:32-36); Owolabi and Aderinto (2010:53-63), reported that PSI approaches were more beneficial in boosting academic performance, course satisfaction, and motivation. In studies by Alalwneh and Alomari (2018:81-92) and Allen (2015:1-153), the latter concluded that PSI harms both the process and outcomes of learning,' whereas the former concluded that PSI has a positive effect on both the process and outcomes of learning and that it is generally accepted that the PSI produces positive student achievement and attitudes.Students in PSI classes generally report more satisfaction with their experiences than non-PSI students, according to

Zakaria, Septiana, and Kurnia, (2018:95-107), however, Butler et al. (2015) found no benefit in using PSI over more traditional methodologies.

Thus, a review of empirical studies shows that the PSI method has a positive impact on student achievement (Salami, 2007; Akinsola & Awofala, 2009; Owolabi & Aderinto, 2010; Alieme, 2014; Al-Zaboun et al, 2016; Adeniyi, 2019), as well as on students' performative skills (Prewitt, 2014; Allen, 2015; Nnamani & Oyibe, 2016; Friskawati, Ilmawati, Suherman, 2017; Wood, 2018). Some of the studies (Butler et al, 2015) had varied results, which could be attributed to the study's sample characteristics or how the PSI approach was implemented.

2.9 Appraisal of Literature

The review of related literature in this study was done under the conceptual and theoretical framework, review of empirical studies and appraisal of the literature review. The conceptual framework started with expounding technical education in Nigeria, technical education development in Osun state, current assessment practices in technical colleges, teaching approaches in Basic Electricity; students' achievement, gender, school location, attitude and Basic Electricity as a subject in the technical college. The conventional lecture and the personalised system of instruction were also examined, both of which have advantages and disadvantages.

Learning theories related to the personalised system of instruction package were reviewed. The empirical review's lists demonstrated that there are strong opinions about the nature of the difference in learning outcomes between male and female students. As a result, the lack of agreement on the impact of gender on learning outcomes created a gap that necessitates further research. The performance of boys and girls concerning the instructional strategies designed must then be carried out. Nonetheless, a greater majority of research findings in the literature indicated that there seem to be more agreements among researchers that school location (urban and rural) does not seem to favour both urban and rural-based students in the same way. Many of the researchers claimed that rural-based students have more disadvantages and are said to suffer more disabilities than their urban counterparts. So also literature has identified a several factors that may contribute to students' negative attitudes towards studying technical subjects.

The literature contradicting the positive association of the variables under inquiry was significantly fewer and almost non-existent, according to the current researcher. The PSI studies were solely concerned with learning outcomes. It seems that none of these studies appears to look at the interaction of the PSI model of instruction, gender, and school location on achievement and attitude. However, the majority of the literature focused on the positive correlation of variables with learning outcomes or achievement, rather than looking at the interaction effect of variables, as the present research did by combining the effects of the PSI, gender, and school location on students' achievement and attitudes toward Basic Electricity. Also, some research studies have been conducted on the effectiveness of the PSI model of instructional delivery in western countries. Very few research studies have been conducted in Nigeria, particularly in Osun State, to confirm the clients of the personalised system of instruction.

In addition, the literature reviewed so far investigated the effectiveness of PSI, specifically on the use of test-assisted programmed instruction. On the other hand, the majority of the research was done in other subject areas like student engagement, physical education, chemistry, mathematics, physics and vocational studies. Based on the accessible literature to the researcher, research with direct bearing on the impact of the variables under investigation on learning outcomes in Basic Electricity and even in technical colleges are very scarce and almost non-existent. None had been conducted on the effect of the personalised system of instruction package in Basic Electricity in Nigeria. Consequently, the study, therefore, filled this gap by introducing the PSI, which is a learner-centred activity approach to stimulate the students to learn.

In the next chapter, the researcher will describe the research approach, methodology, and design used in the investigation targeted at understanding the effect of the personalised system of instruction (PSI) package on technical college students achievement in Basic Electricity in Osun State, Nigeria.

CHAPTER THREE

RESEARCH METHODOLOGY, PARADIGM AND PROCEDURE FOR DATA COLLECTION AND ANALYSIS

3.1 Introduction

This chapter lays the general plan for carrying out the study. The research strategy for this study was addressed by the stated objectives in chapter 1 to determine possible changes in students' achievement during the personalised system of instruction (PSI) intervention in the teaching of Basic Electricity. It is once more in chapter one section 1.5 where the main and sub-research questions are presented. Whereas chapter two which unpacked the Literature Review also offers both a Conceptual Framework (section 2.5) and Theoretical Framework (section 2.6) that helps to set a stage for addressing the research questions. The data collection instruments were directed by the study questions' aims and objectives, which are summarised in Table 3.4.

Within the post-positivist worldview or paradigm, the research topic demanded a quantitative methodology with a causal study design. The research paradigm, study design, study population, sample and sampling technique, data collection instrument, instrument validation, instrument reliability, data collection procedures and data analysis strategies, ethical considerations, and methodological challenges encountered during the conduct of this study are all covered in this chapter.

3.2 Research paradigm of the study

A research paradigm is a well-established principle based on a fundamental truth that gives rise to a certain worldview (Nieuwenhuis, 2014:55). A research paradigm is referred to as the theoretical or philosophical foundation for research work (Khatri, 2020:1436). The post-positivism paradigm was used for this study because it aimed to determine the influence of the personalised system of instruction (PSI) intervention in the teaching of Basic Electricity. Positivism is a scientific philosophy based on the assumption of universal laws as well as the assertion of objectivity and neutrality. According to Creswell (2014:33), positivism requires a belief founded on the assumption that a drifts generalisation, methods, procedures; cause-and-effect issues are also applicable to the social sciences. Post-positivists embrace a deterministic philosophy that causes control effects or results. Consequently, the problems studied by post-positivists reveal the need to detect and evaluate the causes that influence the results found in experiments (Creswell, 2014:36). The knowledge that develops through a post-positivist lens is built on cautious observation and the dimension of the objective reality that occurs out there in the real world. Therefore, developing numeric measures of observations and studying the conduct of individuals becomes paramount for a post-positivist (Yin, 2012). In post-positivism, the understanding of the laws and theories that govern the world are tested, verified and refined, and research begins with a theory, the collection of data that moreover supports or refutes the theory, and makes essential revisions and conducts further tests (Yin, 2009).

This study was informed by the low achievement of students and their attitude to BE in both internal and external examinations in Nigeria. Many studies have found that students' low achievement in BE is mainly due to teachers' poor methods of instruction and continuous use of the CLM (Atsumbe, et al., 2015; Ogbu, 2015; Amaechi & Thomas, 2016; Robinson, 2017; NABTEB, 2018; Usoro, Akpan & Ikpe, 2018). This study chose to use a PSI technique, in which students worked at their own pace to master skills and progress through defined learning tasks, with the teacher serving as a facilitator, tutor, and motivator rather than the primary source of knowledge.

In this study, a change in participant behaviour and the change in a teaching environment from a teacher-centred instructional model to a student-centred instructional model and learning for mastery provide subjective experiences concerning the reality of the PSI. Participants' performance was afterwards measured to have a better understanding of the PSI intervention's process of changing students' behaviour and attitude. The post-positivist paradigm allowed the researcher to determine any improvement in the achievement and positive change in attitude in the PSI experience. As a quantitative researcher, the researcher should be conscious that the research study must be led by core philosophical positions while articulating the paradigmatic standpoint (Maxwell, 2013). This philosophical belief provides a cohesive framework for understanding knowledge of reality (ontology), the search for knowledge of the truth (epistemology), and the method of attaining this knowledge (methodology).

3.2.1 Ontological assumption

Nieuwenhuis (2014:69-97) described ontology as the study of nature and its form of reality. It is the philosophical study of the nature of existence, reality, being, and becoming, as well as the basic categories of existing things and their relationships. It investigates the basic belief system about the nature of being and existence as a researcher. It is about the assumptions individuals make to believe something makes sense or is genuine, or about the nature or essence of the social phenomenon researchers are looking at. It aids in the conceptualisation of reality's form and nature, as well as what one believes can be known about it. (Kivunja & Kuyini, 2017; Saunders, Lewis, & Thornhill, 2019).

Having taught Basic Electricity for over fifteen years, it is assumed that student perceptions of reality are formed via their interactions with and understanding of the natural and social worlds (in the context of a professional organisation, community, school, or classroom). As a result, this study takes a quantitative approach, assuming that participants form subjective meanings about reality and truth, make sense of their social experiences, and evaluate socially generated knowledge in the context of a personalised system of instruction (Creswell, 2014:41; Nieuwenhuis, 2014: 69-97; Khatri, 2020:1435-1440). The researcher had a one-on-one discussion with the participants to better understand how they construct personal realities based on their experiences. This makes it easier to find different points of view and thoughts on students' subjective discussions and reflections. However, it was expected that thorough interpretations of participants' experiences and reflections could provide insight into how participants generated various realities during this PSI intervention, depending on what they perceived. (Creswell, 2014; Kivunja & Kuyini, 2017).

3.2.2 Epistemological assumption

According to Nieuwenhuis (2014:55), and Rehman and Alharthi, (2016:51-59), "Epistemology examines how one knows reality, the process for understanding the nature of reality, or how one comes to know reality, it assumes a relationship between the knower and the known." Seeking knowledge entails discovering the truth and understanding the phenomenon under investigation, as well as determining what works best in a given situation (Creswell, 2014; Saunders, Lewis, & Thornhill, 2019:133; Khatri, 2020). However, epistemological reflection affirms that people generate meaning for a phenomenon depending on their specific social, economic, political, and cultural experiences (Nieuwenhuis, 2014; Kivunja, & Kuyini, 2017).

To gain a better understanding of students' inner worlds, the researcher used a quasi-experimental design in which students were matched beforehand or after the fact, using statistical methods, to investigate the effects of the PSI on students' achievement in Basic Electricity when crossed with gender, and school location (i.e. students with similar characteristics were placed in PSI and CLM conditions so that any differences between the treatments could be attributable to treatment effects and not to differences between the groups themselves). This method provided a viable option for researchers who could not assign students to different treatments at random but yet needed some degree of control to make statistical statements about their findings.

3.3 Research design

The conduct of this research was guided by quantitative research methods and based on a causal research design. The reason for the quantitative research approach in the study is to look into the interaction between variables to test objective theories. It is used to generate numerical data to quantify attitudes, views, actions, and other defined variables and generalise results from a wider sample population.The variables can be measured using instruments, and the data can then be numbered and statistically analysed. When the goals of the research are evaluation, exploration, or description, quantitative approaches are frequently used (Schutt, 2018:22; Coy, 2019:71-77; Mohajan, 2020:50-79). The quantitative approach is justified since it measures causal links between independent and dependent variables. In the quantitative methodology, researchers uses the scientific method that begins with the specific theory and hypotheses for research procedures (Mohajan, 2020). They attempt to achieve rich, real, deep, and valid data. In other to answer research questions or test hypotheses, the quantitative approach investigates behaviour under controlled conditions and gathers data based on accurate measurement using validated collection instruments (Creswell, 2014:36).

This study is causal-comparative because it aimed at determining the influence of the PSI on technical college students'achievement in Basic Electricity in Osun State, Nigeria. A quantitative approach was used in gathering data, analysing and statistical presenting data in this study. The quantitative technique is associated with numerical data and is based on numerical evidence to make a conclusion or to analyse the hypotheses (Veal, 2018). In quantitative research, questionnaires, surveys and experiments are the major instruments used for data collection, which is numerically adjusted and tabulated, which permits the data to be described by employing statistical analysis (Antwi, & Hamza, 2015:217-225; Schutt 2018:22).

Brannen (2016:1-57) submits that the attention of quantitative researchers is focused largely on the testing of theory; they control variables on a sample of subjects and reveal the association among variables using the effect statistics like correlations, relative frequencies, or mean difference. Therefore, the researcher used questionnaire and achievement test to find and analyse statistical information about learner performance, mean difference in the students' achievement scores, mean difference in the gender scores of students, mean difference in the school location scores of students, mean attitude scores of students, effect of gender and school location on students' attitude when taught Basic Electricity using the personalised system of instruction method and the conventional lecture method.

The causal study is aimed at establishing the cause and effect relationship among variables (Sreejesh, Mohapatra, & Anusree, 2014:82-93). Sreejesh, Mohapatra, & Anusree (2014:82-93) further explain that causal study is the technique of ascertaining if a variation in one variable is accounted for by the variation in another variable, for instance, the effect of the PSI on students' achievement and attitude to Basic Electricity in a technical college. The design enables the investigator to establish and develop evidence to understand the causal relationship that student-centred methods of teaching (cause) leads to high student achievement and positive attitude (Brendon, 2019:87). Therefore, this study adopted a pre-test/post-test non-equivalent control group design, the non-randomised, quasi-experimental design in which the treatment operates at two levels (PSI and CLM) crossed with gender (male and female) and school location (urban and rural).

The researcher used a quasi-experimental design because it does not allow the independent variable to be fully manipulated but provide flexibility in assigning the treatments randomly to experimental groups. The quasi-experimental design has the advantage of being often easier to set up than true experimental designs (Singh, 2021:17), however, participants are not randomly assigned to treatment conditions (Bell, 2008). Nworgu (2015:88-102) agreed that in a situation where there is no randomisation in the assignment of individual participants to treatment conditions, the quasi-experimental method is most suitable. Because it was not essential to randomly assemble students for any intervention during school hours to avoid artificial conditions, this study used a quasi-experimental approach, which allowed intact groups to be investigated in real classroom situations. Students in both the control and experimental groups took part in the study in their regular classroom conditions.

Furthermore, utilising quasi-experimental designs reduces the risk of external validity (Brendon, 2019:85-89), because natural environments do not have the same artificiality problems as compared to a well-controlled laboratory setting (McKnight, Magid, Murphy & McKnight, 2000). Quasi-experimental designs, on the other hand, may be ineffective at controlling threats to internal validity (Robson, Shannon, Goldenhar & Hale, 2001:29-

42). The term "external validity" refers to how well a study's findings can be generalised to the population from whom a sample was drawn (Wimmer & Dominic, 2011:26-31).Internal validity refers to a study's ability to control the variables that create possible (plausible) but incorrect explanations of results.

Threats to external validity include interaction effects of selection, interaction effects of setting, interaction effects of history, and effects of testing (Creswell, 2014:224). The interaction effects of selection were addressed in this study by employing homogeneous samples. In terms of age, school, course, class, and school location, students in both the experimental and control groups were similar. Furthermore, students in both groups were exposed to the same Basic Electricity curriculum developed by the National Board for Technical Education (NBTE, 2016) and had equal cognitive abilities based on pre-tests scores. The technical college curriculum is modularised into trade-related and trade courses. These are; electrical/electronic trade, auto-electrical work trade, mechanical engineering trade, building trade, fabrication and welding trade, computer trade, as well as related trade courses. The NBTE curriculum for Basic Electricity and the National Policy on Education of Nigeria (FRN, 2013) made Basic Electricity a mandatory subject for all students who want to study engineering and related courses. This requirement was met by students in both the experimental and control groups in this study.

Students in both the control and experimental groups were pre-tested on the same day and within the same period, and the post-test was equally administered on the same day (the last day of the intervention) and within the same period, reducing the interaction effects of history as a potential threat to external validity. The research was carried out in technical colleges in the Osun State, Nigeria. The interaction effects of the setting were controlled by doing the study in the same state. Finally, the six-week time lag between the administration of the pre-test and the administration of the post-test in this study ruled out the interaction effects of testing, because the time lag between the pre-test and the post-test is long enough to minimise item familiarity.

Internal validity threats such as history, maturation, statistical regression, selection, experimental mortality, testing, instrumentation, and design contamination (Wimmer & Dominic, 2011:26-31) were addressed in the following way in this study. First, there was no Basic Electricity curriculum review and no nationwide strike that could have affected the dependent variables of Basic Electricity Achievements (BEAT) and Students' Attitudes toward Basic Electricity (SABEQ). As a result, the researcher ensured that both the experimental and control groups had the same steady educational environment throughout the treatment period, effectively eliminating the impact of history. Second, the period of intervention was the second term of the 2019/2020 academic session where there were no evident vacation/coaching classes for pupils outside of regular school hours, such as during the holidays that could have resulted in the acquisition of any academic knowledge to the benefit of either group of students. Because the students in both groups grew up in the same society, they experienced similar social, cultural, and physiological development, which could have influenced the dependent variables, thereby controlling any maturation effects.

Third, students in both groups came from the same socio-economic background, were taught by the same teacher, and did not have extreme scores as entry criteria, indicating that statistical regression had no influence. Fourth, students were not given the option of choosing which group they would be assigned to (experimental or control), which could have influenced the achievement dependent variables. Students were able to participate in the study because the schools were chosen because they shared similar features in terms of age, school location, and exposure to national curriculum, class, and language.

Fifth, the researcher ensured that no students in either group dropped out during the treatments. Attendance during the study period, neither the control nor the experimental schools had a single student drop out. The effects of experimental mortality were thus ruled out. Sixth, the six-week time interval between pre-tests and post-tests was sufficient in ruling out the effects of testing in the study and preventing hallo-effects that could arise from transferring pre-test instrument familiarity to the post-test instrument.

Seventh, to control the threat of instrumentation in the study, the researcher made sure that the pre-test and post-test of the Basic Electricity Achievement Test (BEAT) and Students' Attitude to Basic Electricity Questionnaire (SABEQ) measurement methods remained the same throughout the experiment since both groups used the same instruments to collect data. Finally, the control and experimental groups were separated by a large distance, preventing students from interacting with one another, and the teachers at the control school did not know the experimental schools. Furthermore, neither group had any motivation to desire the study to succeed or fail, obviating the possibility of design contamination in the study.

The following is the schematic layout of the design:

Experimental Group I	0_1	X_1	0_2
Control Group II	0_1	$\sim X_2$	0_2

0_1 - Represents pre-test for experimental groups 1 and 2

0_2 - Represents post-test for experimental groups 1 and 2

X_1 - experimental group one (PSI method)

X_2 - Control group (conventional lecture method).

A 2 X 2 X 2 factorial matrix was used in the design, which allowed the effect of each independent variable to be determined as well as the combined effect of the independent and moderating variables on the dependent variable to be determined.

Table 3.1: The 2 x 2 x 2 Factorial Matrixes

Treatment groups	Gender	School Location	
		Urban	Rural
Personalised System of Instruction	Male		
	Female		
Conventional Lecture Method	Male		
	Female		

The study Variables

The Variables that were considered are as follows:

Independent Variables:

The independent variable is the teaching method. This was manipulated at two levels:

i. Personalised System of Instruction (PSI) (experimental)
ii. Conventional Lecture Method (control)

Moderator Variables: These are:

Gender	-	Male/Female
School Location	-	Rural/Urban

Dependent Variable:

Students' Achievement in Basic Electricity

Attitude to Basic Electricity

3.4 Population

The study population comprised all year two students of engineering-related trade in all the technical colleges in Osun State, Nigeria. Basic Electricity is an essential trade-related course required for the study of these trades. There are ten (10) National Board for Technical Education (NBTE) approved technical colleges in Osun State, out of which nine (9) are owned by the state government and one (1) by the federal government. They are; Government Technical College Osogbo, Government Technical College Ile-Ife, Government Technical College Gbongan, Government Technical College Iwo, Government Technical College Ara, Government Technical College Inisa, Government Technical College Otan-Ayegbaju, Government Technical College Ijebu-Jesa, Government Technical College Osu and Federal Science and Technical College Ilesha. Only state-owned technical colleges were chosen for the study. Based on the listed criteria: to ensure homogeneity of the sample concerning curriculum content used and school type; the researcher's proximity to his base, acquaintance with the state's geographic location, and access to information at the State Board for Vocational and Technical Education.

3.5 Sampling Technique and Sample

Purposive sampling was used to choose the study's sample because it relies on the researcher's judgement in which the units to be observed are chosen based on the researcher's judgement about which ones will be the most useful or representative (Babbie, 2011:193). The small number of technical colleges in Osun State was one of the purposive sampling technique's criteria. There are nine (9) state-owned technical colleges in Osun state. These technical colleges were sparsely distributed in both rural and urban areas in the thirty-two (32) local governments and one (1) area office in the three (3) senatorial districts of the state.

Four (4) technical colleges were chosen using the purposive sampling technique (two urban and two rural). The experimental group (PSI) consisted of two schools (one urban and one rural), while the control group consisted of two schools (one urban and one rural). The experimental and control groups for the urban and rural schools were chosen using a simple random sampling procedure. However, only one arm exists in each of the selected schools. The affected arm was used for the study. The subject teacher and the students automatically qualify to participate. To be considered for participation in the study, the school must: be far apart in terms of distance to avoid undue interaction among the participants of one school and the other; and have easy access to reaching the location.

Table 3.2: Sampling Distribution

School Name	School Location	No. of selected students
Government Technical College Osogbo	Urban	57
Government Technical College Ile-Ife	Urban	39
Government Technical College Gbongan	Rural	26
Government Technical College Inisa	Rural	30
Total		**152**

3.6 Data Collection Instruments

The questionnaire and achievement test were used as a data collection instrument in this study. According to Sreejesh, Mohapatra and Anusree (2014:143-159), questionnaires are used in survey and experimental research. Patel and Joseph (2015:255) simply define a questionnaire as a 'device' for gathering and documenting information regarding a subject of concern. The questionnaire majorly consists of a poll of predetermined questions to collect data and which includes unambiguous instructions on how to answer the questions and a portion for answers or administration particulars (Bolarinwa, 2015:195-201). A questionnaire helps gathers original information and data concerning people, their behaviours, knowledge, attitudes, perception, facts, experiences and social interactions, and awareness of events (Bolarinwa, 2015; McGuirk, & O'Neill, 2016:246-273; Bhattacharyya, Kaur, Kaur, & Ali, 2017:16-32). Therefore, using the questionnaire in this study provide insights into trends, processes, values, attitudes, and interpretations of the variables of the study. A questionnaire is also cost-effective, enabling research over a large geographical dispersed population.

Therefore, the researcher made use of the following instruments:

1. Basic Electricity Achievement Test (BEAT)
2. Students' Attitude to Basic Electricity Questionnaire (SABEQ)

Instructional Packages

1. Unified Instructional Guide for PSI (UIG)-(for teachers)
2. Lesson Guide for Conventional Instructional Method for Basic Electricity
3. Teachers Marking Guide for Basic Electricity (TMGBE)-(for teachers).

3.6.1 Basic Electricity Achievement Test (BEAT)

The Basic Electricity Achievement Test (BEAT) which contained two sections, (sections A & B) was developed by the researcher. Section A captured the background information of the respondents concerning their age, school location and gender. Section B, which contains the achievement test questions, was used to assess the learner's cognitive level of achievement. Section A addressed the research question 1 which is the participants' profile, while section B of the BEAT was used to determine the mean difference in the achievement scores, the gender scores, and the school location scores of students exposed to the personalised system of instruction method and those that were exposed to the conventional lecture method in the research questions 2 to 4 and research hypotheses 1a, 2a, 3a, 4a, 5a, 6a, and 7a.

The items of BEAT were constructed along with participants' exposure to the Basic Electricity topics. These topics were selected from the year II second term Basic Electricity syllabus for technical colleges. The content area covered were; an alternating circuit; Series R-L, R-C, and R-L-C circuits; Resonance and resonance frequency; Magnetism and Electromagnetism; Transformer (losses and how to minimise losses in transformer); Transformer lamination; types of transformer. A table of the specification was developed in such a way that it showed Bloom's Taxonomy of educational objectives' first three cognitive domains of Knowledge, Comprehension, and Application. It contained (50) objectives test items of multiple-choice types with four alternatives, letters of A to D of one correct answer and three distracters. These items were picked from standardised NATBEB 2015-2018 past questions. From the lists of the alternatives that were provided in the questions, students were required to select the correct option. The correct answer to each of the items was awarded a score of “1” while the incorrect answer was awarded a score of “0”. (Appendix 14).

Table 3.3: Table of Specification for Basic Electricity Achievement Test (BEAT)

Content/Objectives	Knowledge (40%)	Comprehension (32.5%)	Application (27.5%)	Total (100%)
An alternating circuit; Series R-L, R-C, Series R-L-C circuits; Resonance and resonance frequency	1,2,3,9,10,15,18, 24,25,26,27 (11)	4,5,7,12,13,14,16, 19,20,21 (10)	6,8,11,17, 22,23 (6)	27
Magnetism and Electromagnetism;	28,29,30,31,32 (5)	36,42,43 (3)	nil	8
Transformer (lamination, losses, types and uses);	33,35,39,44,45,46, 47,49 (8)	34,37,38,50 (4)	40,41,48 (3)	15
Total	24 (48%)	17 (34%)	09 (18%)	50 (100%)

3.6.2 Students' Attitude to Basic Electricity Questionnaire (SABEQ)

Students' Attitude to Basic Electricity Questionnaire (SABEQ) was designed by the researcher and was used as a pre-test and post-test in both the experimental and control groups in this research. SABEQ was made up of two parts (Sections, A & B). Section A captured the respondents' backgrounds, such as the location of the school, age and gender of the respondent. Section B contains the responses to the statements in the questionnaire items in six domains of students' factors, teacher factors, home factors, school factors, prestige factors and government factors and has forty-five (45) items. The response format ranged from Not True of Me (NTM), Fairly True of Me (FTM), Much True of Me (MTM) and Very True of Me (VTM) (See Appendix 15). Section A addressed the research question 1 which is the participants' profile, while section B of the SABEQ was used to determine the mean attitude scores, the effect of gender on students' attitude, and the effect of school location on students' attitude when exposed to the Personalised System of Instruction method and the conventional lecture method in the research questions 5 to 7 and research hypotheses 1b, 2b, 3b, 4b, 5b, 6b, and 7b.

3.7 Validity of the instrument

The validity of the Basic Electricity Achievement Test (BEAT) and the Students' Attitude to Basic Electricity Questionnaire (SABEQ) were determined. The degree to which an instrument measures what it purports to measure is referred to as validity (Bhattacharyya, Kaur, Kaur & Ali, 2017:16-32). The validity of a questionnaire can be established by a panel of experts to explore the theoretical construct of the questionnaire. Therefore, the Basic Electricity Achievement Test (BEAT) and the Students' Attitude to Basic Electricity Questionnaire (SABEQ) was subjected to expert review for face, content, and constructs validation. This involves going through the (BEAT) items one by one for arrangement and logical sequence. The content validation of BEAT items entails checking through the BEAT items, and whether it corresponds to the lesson plan's content and topic.

Experts in the Science and Technology Education Department and Institute for science and technology education, University of South Africa (UNISA), most especially the researcher's supervisor did the face and content validation of BEAT items and the construct validation of SABEQ. They were required to view the plausibility of the distracter and the appropriateness of the choice of options for the objective questions. They also checked the accuracy and quality of the questions raised and the language level of the items. Based on the suggestions of these experts, the number of items in the BEAT was reduced to fifty (50) and forty-five (45) items in SABEQ, which form the final draft that was used for this study.

3.8 Reliability of the instrument

The instrument's reliability was also established. Reliability is seen as the extent to which an instrument, be it a questionnaire, test, observation or whatever procedure adopted to take measurement when used consistently, measures what is purporting to measure or give similar results on repeated trials (Bolarinwa, 2015:195-201; Patel & Joseph, 2016:255; Bhattacharyya et al., 2017). Pavot (2018:1-11) refers to it as the degree of consistent and dependable results produced by an assessment instrument. According to Wells and Wollack (2003), "reliability supplies a measure of the degree to which a test item repeatedly measures the information concerning the mastery of the domain by the students". Therefore, Kuder-Richardson's (K-R) 20 formula was used to determine the psychometric property of BEAT and gave a value of 0.937 (Appendix 18). The number of items in the BEAT was reduced to fifty (50) after the psychometric properties have been established. Also, Cronbach-alpha was used to establish the reliability of the six portions in SABEQ. The following are the scores for each of the positive items: 1, 2, 3, and 4 for Not True of Me (NTM), Fairly True of Me (FTM), Much True of Me (MTM), and Very True of Me (VTM). Negative items were reversed oppositely. The reliability of the six sections gave 0.872, 0.852, 0.928, 0.973, 0.890 and 0.856 respectively, while the overall reliability determination of the scale was also computed, and this gave a value of 0.952. (Appendix 17)

3.9 Procedure for data collection

Table 3.4 below summarises the data collection methods and procedure which include the research questions, data source, theoretical framework aspects addressed, methods of collecting data and expected information.

Table 3.4.Summary of data collection methods

Research Question	**Data Source**	**Theoretical framework**	**Method(s) of collecting data**	**Expected information**
What is the mean difference in the achievement scores of students exposed to the Personalised System of Instruction method and those that were exposed to the conventional lecture method?	Learners taught with PSI & CLM	Mastery Learning theory (MLT) and Social Cognitive Theory (SCT), Behaviourism theory.	The use of achievement tests (pre & post)	Determining the level of performance of learners when the innovative approach is used. Establishing the effectiveness/ efficacy of PSI over CLM in the teaching of basic electricity Establishing mastering of the content while using PSI
What is the mean difference in the gender scores of students exposed to the Personalised System of Instruction method and those that were exposed to the conventional lecture method?	Learners taught with PSI & CLM	Mastery Learning theory (MLT) and Social Cognitive Theory (SCT), Behaviourism theory.	The use of achievement tests (pre & post)	Ascertaining the male and female learners' performance. Determining which sex is more favoured using PSI and CLM
What is the mean difference in the school location scores of students exposed to the Personalised System of Instruction method and those that were exposed to the conventional lecture method?	Learners taught with PSI & CLM	Mastery Learning theory (MLT) and Social Cognitive Theory (SCT), Behaviourism theory.	The use of achievement tests (pre & post)	Determining the performance of students in urban and rural schools. Gathering information on the influence of the PSI approach based on school location
What are the mean attitude scores of students exposed to the Personalised System of Instruction method and those that were exposed to the conventional method?	Learners taught with PSI & CLM	Mastery Learning theory (MLT), Social Cognitive Theory (SCT) and Behaviourism theory.	Questionnaire(SABEQ)	Establishing the learners' attitude to basic electricity when an innovative strategy is used in the teaching. Investigate

				attitudinal change in learners
What is the effect of gender on students' attitude when taught Basic Electricity using the Personalised System of Instruction method and the conventional lecture method?	Learners taught with PSI & CLM	Mastery Learning theory (MLT), Social Cognitive Theory (SCT) and Behaviourism theory.	Questionnaire(SABEQ)	Determining the influence of gender on students' attitudes when using an innovative strategy Establishing change in attitude based on gender
What is the effect of school location on students' attitudes when exposed to the Personalised System of Instruction method and the conventional lecture method?	Learners taught with PSI & CLM	Mastery Learning theory (MLT), Social Cognitive Theory (SCT) and Behaviourism theory.	Questionnaire(SABEQ)	Determining the attitude of the learner in the rural and urban schools before and after the intervention. Establishing locational influence on learners' attitudes before and after the intervention.

The procedure for collecting data was broken down into stages along the following:

Stage 1: Trial testing of the instrument

Stage 2: Selection of schools and arms of classes

Stage 3: Training of research assistants (class teachers) on the technicalities of how the data will be collected

Stage 4: Pre-testing

Stage 5: Treatment

Stage 6: Post-testing

3.9.1 Stage 1: Trial testing of the instrument

Trial testing of an instrument is another important element in the process of developing the instrument. The process involved administering the questionnaire to the representative of the population to which it is meant (Patel & Joseph, 2016). The instrument was trial-tested in two equivalent technical colleges which were not part of the study but share similar characteristics with the study area, they are Government Technical College Iwo (Urban) and Government Technical College Ara (rural). At the initial stage, eighty (80) items (BEAT) and forty-five (45) (SABEQ) were generated for the study. However, the BEAT was reduced to twenty fifty (50) items, and SABEQ still maintains its 45 items after the validating exercise respectively. This helped the researcher to ascertain the psychometric properties of both instruments which aided in ensuring that the instruments were valid and reliable. The main study was conducted in four (4) technical colleges that were purposively selected.

3.9.2 Stage 2: Selection of schools and arms of classes

Four (4) technical colleges were included in this research, two (2) urban and two (2) rural. Only one arm exists in each of the selected schools and the affected arm was used for the study.

3.9.3 Stage 3: Training of research assistants (i.e. class teachers)

The researcher trained the research assistants (Basic Electricity teachers) who were involved in the experiment using the PSI treatment package for one week. Training manuals were given to all the research assistants. The researcher looked for a central venue for the training and picked the government technical college Osogbo which is situated in the state capital; this was to cater for convenience. The trained subject teachers automatically formed the research assistants. Throughout the training, they were provided with proper explanations of each of the stages employed in the treatment package, as well as the instructional plan or guide for the treatment, as well as how to administer the instruments (BEAT and SABEQ). Every essential modification and amendment was made at this point. The research assistants (Basic Electricity teachers) then proceeded to teach the students utilising the treatment package as it was applied to the experimental group after the training. To ensure equivalence concerning the chosen teachers, the researcher selected the teachers based on their years of experience, qualifications and gender.

3.9.4 Stage 4: Pre-testing

The data collection procedure began with the administration of the pre-test (pre-SABEQ and BEAT) to all subjects in all groups before the start of the treatment by the research assistants (regular Basic Electricity teachers) under the supervision of the researcher.

The researcher marked and scored the scripts and recorded the results for future reference. The pre-test was used as a covariate to assess students' entry behaviour of the materials they would be exposed to later; used to compare the two groups (experimental and control) concerning their achievement in the pre-test scores and to determine students' prior attitude to Basic Electricity.

3.9.5 Treatment procedure

The treatment began immediately after the pre-test has been administered. The study's primary treatment was teaching the five sub-topics of Alternating current (A.C) circuit, Magnetism and Electromagnetism and Transformer to technical college two (Trade II) Basic Electricity Students, using the two methods of teaching (the PSI and the CLM Approach). For five weeks, the experimental group was taught using the PSI treatment package provided by the researcher while the control group was taught using the traditional lecture approach. The researcher went around all the colleges to monitor and observe the research assistants to ensure compliance with the training. Each of the research assistants was responsible for teaching the assigned topics concerning the treatment (PSI and CLM).

3.9.5.1 Participating teachers and students in Experimental Group

Teachers in the experimental group were trained by the researcher in respect to this study. They were taught by the researcher using the treatment package for a personalised system of instruction (PSI) as the basis of their training and helped them develop their knowledge of creativity in teaching Basic Electricity concepts. The experimental group consisted of two groups of schools (one urban and one rural), where the teacher used the personalised system of Instruction (PSI) package. The students were taught the topics selected in the test blueprint using the PSI. Adequate tasks were given to them to carry out, both in the classroom and as a take-home assignment. The students in the PSI group were given special individual attention by the teacher, allowing them more time to work and corrective measures were given individually to ascertain their level of mastery.

3.9.5.2 Participating teachers and students in Control Group

The teachers in the control group were not trained in respect to this study. They taught the Basic Electricity concepts using the conventional classroom practice existing in the schools that were used. Two groups of schools also formed the control group (one urban and one rural). Students in this group were not exposed to any treatment package. The selected topics were taught by the participating teachers in the control group using the conventional classroom practice existing within the schools. They were given adequate tasks to carry out in the form of classwork and homework as the teacher deemed fit.

3.9.5.3 Operational Manual for the PSI

The manual for the PSI was designed for both the teachers and learners. It provides a systematic direction on how to implement the strategy. The roles of the teacher as a proctor are explicitly highlighted and the activities of the students were given for easy implementation.

The steps are: Teacher's activities

i. The topic is broken down into small learning units' modules, each with its specific objectives and assessments.
ii. State the objectives representing the purposes of the topic.
iii. Develop study procedures
iv. Identify learning materials and instructional strategies
v. Develop questions on each unit
vi. Teach learners and allow them to practice at their pace
vii. As learners complete a unit, test them for immediate feedback
viii. Provide an opportunity for interaction and motivation
ix. Provide an opportunity for review and retest before allowing pupils to move on to new units after they master previous and prerequisite units
x. Identify slow learners and provide them with one-to-one support
xi. Lectures are limited in PSI courses

Students' activities:

i. Listen attentively to the teacher's instruction
ii. Take note of the teacher's explanation of the concept of PSI and the procedure for its use.
iii. Listen to the lesson introduction
iv. Identify key areas of the topic
v. Follow further instructions from the teacher
vi. Prepare your mind to work at your pace
vii. Ask questions on aspects that need help from the teacher
viii. After completing a given task, show your work to the teacher for marking.
ix. If you are successful on the task you will be allowed to move to the next unit otherwise you will have to repeat the task once more.
x. You will not be allowed to attempt a new unit unless you have mastered the previous unit.

3.9.5.4 Operational Manual of Instruction on the CLM

The conventional teaching approach is commonly used by the teachers to impart knowledge to learners which are also termed the traditional lecture method. It involves talk and chalks with an occasional demonstration. The following steps were followed:

Teachers do the following activities

- ♦ Ask questions on the entry behaviour or previous knowledge to gain a better picture of the situation and lay the groundwork for the new topic.
- ♦ Explains the relationship that exists between the previous knowledge and the new topic by providing further explanations.
- ♦ Introduces and develops the topic for the day as well as writing it on the board.
- ♦ Writes the note to be copied by the learners immediately after the teaching.
- ♦ Administers oral or written tests based on the day's lesson or assigns homework as he desires.
- ♦ Marks and award scores based on the class-work notes.

Students' activities

- ♦ Listens to the teacher's explanations.
- ♦ Answers teacher's questions if allowed to do so.
- ♦ Asks any adjoining questions where opportunity is given.
- ♦ Copy the notes religiously, with or without asking the teacher any question till the end of the lesson.
- ♦ Do the class test or copy assignment.

3.9.5.5 PSI Instructional Guide

The experimental group's (PSI) guide was prepared with both teachers and students in consideration. Both the students and teachers were orientiated regarding their expected classroom behaviour during the PSI teaching method. The topic to teach is divided into a module. Each module consists of; an introduction, objectives, procedures, study questions, a written text supplement and a self-test. The introduction contains the researcher's comments on the relevant portion of the textbook and/or provides a summary or synopsis of the text and informs the students about the importance of the unit. The objectives tell the students what they should be able to do because of studying the unit. The procedure specified the activities which proved adequate for the students to accomplish the unit objectives. Study questions help the students to amplify the objectives and self-test whether they had leant the objectives fully or not. Written text supplement gives further (recent) information on the objectives of the topic. Self-test ensured the mastery of the unit to the learner before he/she could proceed to take the unit-end test. The unit-end test would be a short test of 5-10 minutes duration which requires 4-5 minutes for its correction. The questions in the test are of essay type and cover all the objectives of the unit. The students are eligible to take the unit-end test more than once till they could pass out with mastery of a unit. Regarding the arrangement of the class, the regular traditional classroom situation was used. In this study, the research assistants or subject teachers serve as the proctors.

At the beginning of the module, the first lesson was dedicated to explaining and establishing the system. Students were given a workbook and instructed to use it every day. To enable collaboration, the model was slightly adjusted. For example, students could work with a partner for certain types of tasks especially tasks that involve practical work. This collaboration was required to perform some of the pre-screening procedures and exercise prescription implementation required during some modules. Students worked at their own pace but were urged to complete as many courses in the correct order as feasible. They worked on module learning exercises when they had mastered the workbook materials to their satisfaction. Before moving on to the next module, each module's prerequisites have to be met. Students were required to consult with the teacher first to ensure that their work was comprehensive and accurate.

3.9.6 Post-testing

The teachers in the conventional lecture method teach the same topics as those in the experimental group. Each topic was divided into two periods per week. After the lesson, the teacher is expected to give a chalkboard summary. The (post-BEAT and post-SABEQ) tests were administered in the final week after the entire module had been completed. The experimental and control groups' scores were recorded in the same way. In both the pre-test and post-test, each test item received one mark. BEAT had a maximum score of 50 and a minimum score of zero.

3.10 Procedure for data analysis

The data collected in research can be made meaningful through data analysis (Wimmer & Dominic, 2011). Therefore, research can make meaning to its data by analysing the data. The frequency count, percentages, means, and bar chart were used to analyse the quantitative data gathered using the BEAT and SABEQ, which is a significant stage before conducting inferential statistical analysis of the ANCOVA. Questionnaires and achievement test was used as a means of collecting data in this research. The data were analysed using the Statistical Package for Social Sciences (SPSS) software version 23. Each item of the questionnaire was coded and keyed into the computer. The resulting means score was explained following this study response format. Means ($\bar{X}$)

and standard deviations (SD) were calculated to find the mean gain. The mean gain is the difference between two means that can be used to explain whether the two means have changed positively or negatively. The difference between the pre-test and post-test Mean scores is the Mean gain difference in this study.

When differences in pre-test scores were controlled, Analysis of Covariance (ANCOVA) was used to see if there was a statistically significant difference between the group means of BEAT and SABEQ for the experimental and control groups. ANCOVA was used to control the errors of initial non-equivalence arising from the use of intact classes as subjects of the study. The pre-test results are used as a covariate of the post-test results when using ANCOVA. Scores obtained from this design were analysed to find out the main effects of all the involved variables (pre-testing, post-testing, intervening events, etc., and their interactions). Besides, where there exists among the group a significant main effect; the Post Hoc test was carried out to demonstrate how the groups performed and the differences between them. Bonferroni Post Hoc analysis also explains the source of significant differences among the groups and where they exist. At the .05 alpha level, all hypotheses were tested and the decision whether to reject or not reject the hypotheses was taken.

3.11 Permission to conduct research

Permission of all relevant participants is required for credible research. Adequate protection for all the participants protects the confidentiality and secrecy of the participants and ensures that the well-being of participants is well-taking care of. As an element of the preconditions and qualifications to conduct any research at the University of South Africa, the researcher obtained official permission from the Osun State Board for Technical and Vocational Education (OSBTVE) (Appendix 1) to carry out research in all her technical colleges in the state which was granted (Appendix 2). After receiving permission from OSBTVE, letters were sent to the principals of the selected technical colleges to inform them about the study that was going to be carried out in their schools and to seek their utmost cooperation (Appendix 3 & 4a-d). The schools were to be kept anonymous about the conduct of the research and to let them be aware that their normal school calandar and time-table are not going to be disturbed by the research. While visiting the selected technical colleges, the researcher gave the consent and assent forms to the students and teachers to gain their permission in respect of the research (Appendix 5, 6 & 7). Where the students were younger than 18 years, a consent letter was sent to their parents/guardians to seek their permission. It was found out that the subject of this study was composed of students that are 18 years and above.

3.12 Ethical Consideration/Issues

Ethical considerations should be followed in all research that involves human participants (Alshenqeeti, 2014:39-45). This research was carried out per the University of South Africa's Ethics Regulations. As a result, the University of South Africa's Research Ethics Review Committee granted research approval and ethical clearance (Appendix 8). Participants in this study were neither forced nor limited from participating, but rather granted their consent to do so voluntarily. Knowing fully the general ethical principles that guided conducting research, the researcher assured the participant adequate protection of their rights, meaning that they could withdraw at any moment and that their decisions would be respected at all times; participants were guaranteed confidence, secrecy, and anonymity in their responses. The subjects were fully notified concerning all processes and purposes of the research and requested their agreement to take part in the study. The participants were assured that they would not be put in any danger or harm and that all photographs and records collected throughout the study would be maintained in a secure location. The researcher promised the participants his integrity, transparency and accountability and will be honest about his limitations, competence, beliefs system, values and needs.

3.13 Risk identification and Mitigation strategy

Researchers normally face challenges when carrying out a research study. This study faced some methodological challenges when statistical data were to be collected. The researcher faced the problem of data collection from the schools selected for this study, anxiety posed a problem to the researcher, research assistants (teachers to be used), and the students. To overcome this problem, the researcher visited the schools before the actual observation such that the teachers and students got a bit familiar with their presence. The researcher familiarised himself with the authority of the schools selected in a non-threatening manner so that the teachers and the students did not feel any pressure to give what might be considered genuine or fake responses.

Another challenge is the reluctance on the part of some of the school administration in allowing access to the use of the school claiming that the exercise will disrupt the teaching and learning programme of their students. This issue was solved by formally requesting permission from the State Board for Technical and Vocational Education. Finally, the selected schools felt that the research study would expose the inadequacies of their schools and the class teachers whose class lessons were to be observed and that the observations would lead to passing summative judgments on the teaching and learning activities in their classes. To overcome this, the researcher convened a quick meeting with the teachers and students to reassure them of the confidentiality of their responses; he also explained to them that the study was purely an academic exercise.

CHAPTER FOUR

DATA PRESENTATION, RESULTS AND DISCUSSION OF FINDINGS

4.1 Introduction

The effect of a personalised system of instruction on technical college students' academic progress and attitudes toward basic electricity in Osun state was explored in this study. Gender and school location were also used as moderator variables in the study. This chapter contains the findings and discussions from the data analysis. The presentations were organised into figures, charts and tables based on the study's research questions and hypotheses.

4.2 *Research Question 1*

What is the profile of the respondents in terms of age, gender and school location?

Figures 4.1a to 4.1c below present the data to answer this research question.

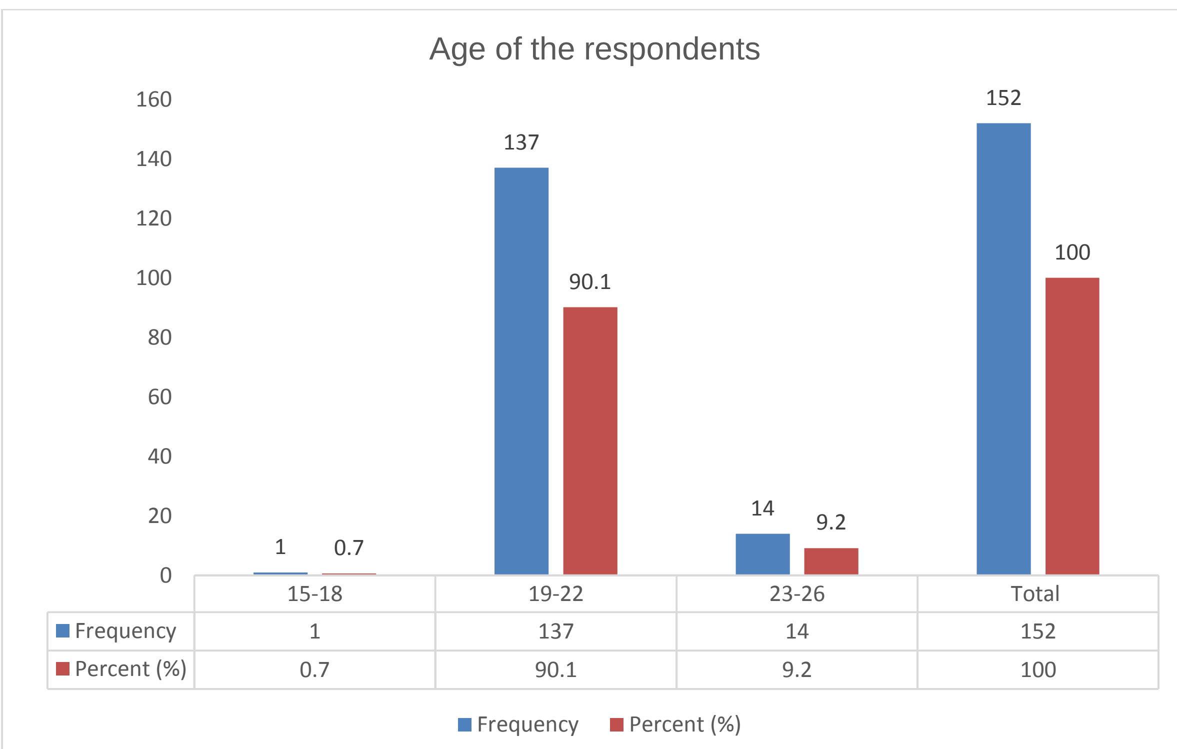

Figure 4.1a: Bar chart showing the mean age of the respondents.

The result presented in Figure 4.1a reveals the respondents' ages. The figure shows that 1 (0.7%) are between the ages of 15 and 18 years. Likewise, 137 (90.1%) were between the ages of 19 and 22 years, and last, 14 (9.2%) were between the ages of 23 and 26 years. The result shows that the respondents are homogeneous in their age. It revealed that, based on the average age, over 90% of the respondents fall between the ages of 19 and 22 years. This indicates that the vast majority of those surveyed are regular students.

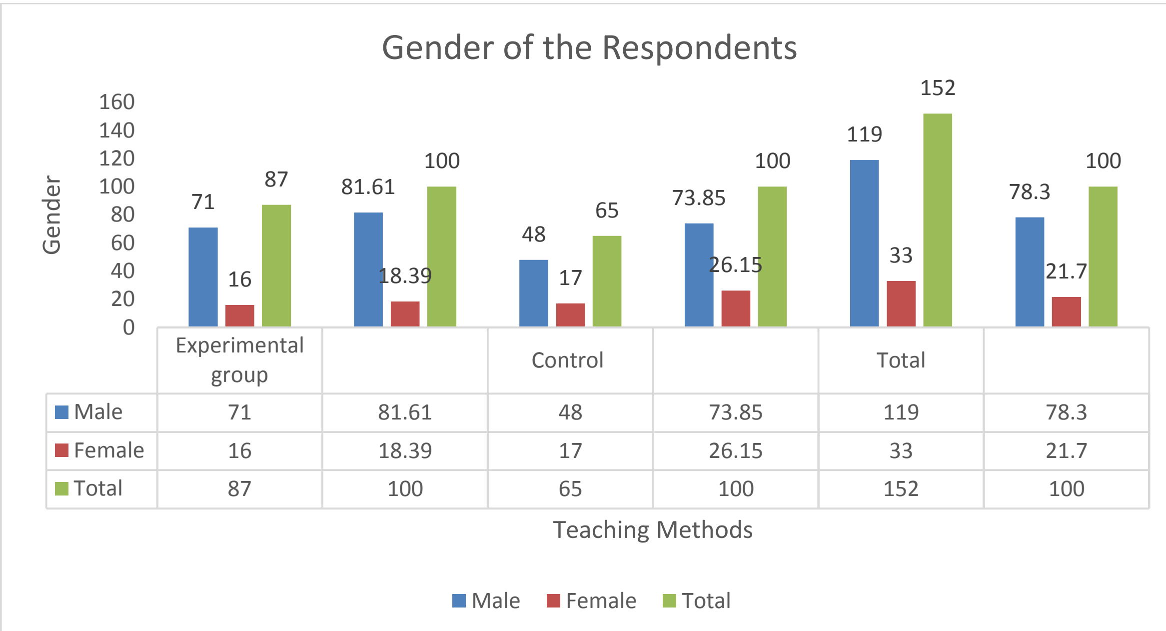

Figure 4.1b: Bar chart showing the gender of the respondents.

The data presented in Figure 4.1b show that there are one hundred and fifty-two (152) respondents, out of which 87 (57.24%) belong to the experimental group and 65 (42.76%) are in the control group. It also shows that the vast majority of those who responded 119 (78.3%) are male, while 33 (21.7%) are female. This revealed that both sexes engaged in the study, although the bulk of the participants are male. From this result, it emerges that majority of the technical college students enrolled in Basic Electricity class are males. It implies that gender disparity still abounds in technical education.

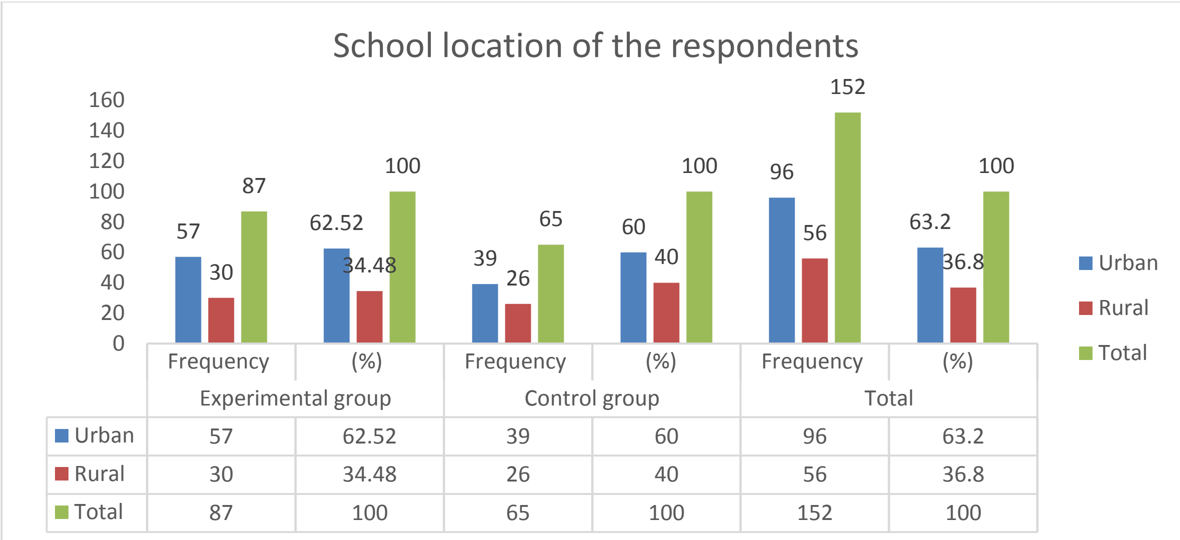

Figure 4.1c: Bar chart showing the school location of the respondents

As shown in Figure 4.1c, out of 152 respondents, 96 (63.2%) are from urban schools 56 (36.8%) are from schools located in the rural area. 87 (57.24%) are from the experimental group and, 65 or 42.76% are from the control group. This result revealed that technical colleges in urban areas have a higher enrolment rate than those in rural areas.

4.3 *Research Question 2*

What is the mean difference in the achievement scores of students exposed to the personalised system of instruction method and those that were exposed to the conventional lecture method?

Figure 4.2 below presents the data to answer this research question.

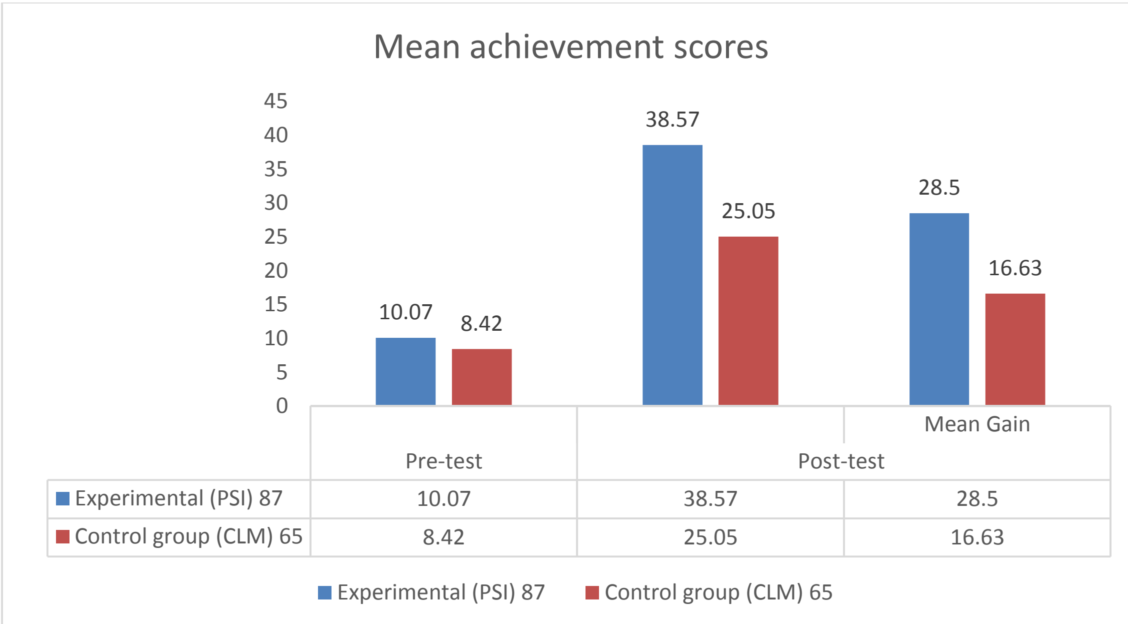

Figure 4.2: Bar chart showing the mean difference in the achievement scores of students exposed to the PSI and those that were exposed to CLM.

Results in Figure 4.2 reveal that the experimental group taught Basic Electricity utilising the personalised system of instruction (PSI) scored 10.07 on the pre-test and 38.57 on the post-test. The experimental group had a mean gain of 28.50 between pre-test and post-test. The control group, who were taught Basic Electricity using the traditional lecture technique (CLM), had a pre-test mean score of 8.42 and a post-test mean of 25.05, for a total pre-test and post-test mean gain of 16.63. However, the result shows that the post-test mean scores were higher than the pre-test mean scores for each of the groups, with the experimental group exposed to the personalised system of instruction (PSI) package having the higher mean in the post-test and thus having a highest mean gain. With this result, Basic Electricity students who were taught using the personalised system of instruction outperformed students who were taught using the conventional lecture method on the achievement test (CLM).This indicates that the personalised system of instruction method had a greater impact on students' learning outcomes in Basic Electricity.

4.4 *Research Question 3*

What is the mean difference in the gender scores of students exposed to the personalised system of instruction method and those that were exposed to the conventional lecture method?

Table 4.1 below presents the data to answer the research question.

Table 4.1: Mean difference in the gender scores of students exposed to PSI and those that were exposed to CLM

Method of Teaching	Gender	N	Pre-test $\bar{X}$	Post-test $\bar{X}$	Mean gain $\bar{X}$
Personalised System of Instruction (PSI)	Male	71	10.52	40.21	29.69
	Female	16	8.06	31.31	23.25
Conventional Lecture Method (CLM)	Male	48	9.23	27.17	17.94
	Female	17	6.12	19.06	12.94

Table 4.1 shows the average gender scores of students who were taught Basic Electricity using the PSI and CLM. The result indicates that male students exposed to BE using the PSI had a pre-test mean score of 10.52 and a post-test mean score of 40.21. The mean gain for male students taught BE using PSI was 29.69. Female students who were exposed to BE utilising PSI had a pre-test mean score of 8.06 and a post-test mean score of 31.31.Female students had a pre-test and post-test mean difference of 23.25, whereas male students taught Basic Electricity using the conventional lecture method (CLM) had pre-test and post-test mean scores of 9.23 and 27.17, respectively, resulting in a pre-test and post-test mean gain of 17.94, also female students taught Basic Electricity using CLM had a pre and post-tests of 6.12 and 19.06 respectively. The mean gain of students taught using CLM was 12.94. However, with these results, both male and female groups had higher post-test mean scores than pre-

test means, with the male group exposed to BE utilising PSI having a higher mean in the post-test and thus a higher mean gain. This indicates that gender may affect student's achievement. As a result, there is an influence associated with gender and students' learning outcome in Basic Electricity.

4.5 *Research Question 4*

What is the mean difference in the school location scores of students exposed to the personalised system of instruction method and those that were exposed to the conventional lecture method?

Table 4.2 below gives the information needed to respond to the research question.

Table 4.2: Mean difference in the school location scores of students exposed to the personalised system of instruction method and those that were exposed to the conventional method

	School location	N	Pre-test $\bar{X}$	Post-test $\bar{X}$	Mean gain $\bar{X}$
Personalised System of Instruction (PSI)	Urban	57	10.67	40.61	29.94
	Rural	30	8.93	34.70	25.77
Conventional Lecture Method (CLM)	Urban	39	9.23	27.10	17.94
	Rural	26	7.19	21.96	14.77

Table 4.2 demonstrates that urban students exposed to Basic Electricity using the PSI had a mean pre-test score of 10.67 and a mean post-test score of 40.61, resulting in a mean gain of 29.94. Students at rural schools who were taught using the PSI had a pre-test mean score of 8.93 and a post-test mean score of 34.70, resulting in a pre-test and post-test mean gain of 25.77 for the rural schools.Meanwhile, urban students taught using CLM had a pre-test mean score of 9.23 and a post-test mean score of 27.10 given a mean gain of students in the urban schools taught using CLM to be 17.96. So

also, pre- and post-test mean scores for rural students taught Basic Electricity using CLM were 7.19 and 21.96, respectively.

For rural schools, the difference between pre-and post-test mean scores was 14.77. The results demonstrate that for students from both urban and rural schools, the post-test mean scores were higher than the pre-test mean scores, with students from urban schools taught Basic Electricity using the PSI having a higher mean in the post-test and higher mean gain. This indicates that the location of schools may have an impact on students' academic performance. Thus, there is an effect associated with the location of schools on technical college students' achievement in Basic Electricity.

4.6 *Research Question 5*

What are the mean attitude scores of students exposed to the personalised system of instruction method and those that were exposed to the conventional method?

Table 4.3 below presents the data to answer this research question

Table 4.3: Mean of pre-test and post-test attitude scores of students exposed to the PSI and those that were exposed to CLM

Teaching method	N	Pre-Attitude test	Post-Attitude test	Mean gain
		$\bar{X}$	$\bar{X}$	$\bar{X}$
PSI	87	85.15	104.03	18.88
CLM	65	75.68	88.11	12.43

The result in Table 4.3 shows that the experimental group taught using the PSI had a pre-attitude mean score of 85.15 and a post-attitude mean score of 104.03, resulting in an 18.88 pre-test and post-test attitude mean gain for the experimental group. The control group, who were taught using CLM, had a pre-test mean score of 75.68 and a post-test mean score of 88.11. The control group's mean gain between pre-test and post-test mean attitude was 12.43. As a result, each of the groups' post-test means attitude scores were higher than their pre-test means.The experimental group that was taught utilising a personalised system of instruction, on the other hand, had a higher post-test attitude mean and a larger mean gain. This suggests that PSI had a greater favourable impact on students' attitudes than CLM.

4.7 *Research Question 6*

What is the effect of gender on technical college students' attitude when exposed to Basic Electricity using PSI and CLM?

Table 4.4 below presents the data to answer this research question

Table 4.4: Mean of pre-test and post-test on the effect of gender on students' attitude when taught Basic Electricity using PSI and CLM

Method of Teaching	Gender	N	Pre-test $\bar{X}$	Post-test $\bar{X}$	Mean gain $\bar{X}$
Personalised System of Instruction (PSI)	Male	71	86.44	101.94	15.50
	Female	16	79.44	113.31	33.87
Conventional Lecture Method (CLM)	Male	48	73.96	87.25	13.29
	Female	17	80.53	90.53	10.00

Table 4.4 show the influence of gender on students' attitude. Result reveals that male students who were exposed to Basic Electricity via the PSI had a pre-test attitude mean score of 86.44 and a post-test attitude mean score of 101.94, resulting in a mean gain of 15.50. The attitude mean scores for female students taught Basic Electricity utilising PSI were 79.44 in the pre-test and 113.31 in the post-test, respectively. Female students gained 33.87 percent on average. The pre-attitude mean score for male students taught with CLM was 73.96, and the post-attitude mean score was 87.25. For male students, the difference between the pre-test and post-test mean was 13.29. In the same vein, female students exposed to Basic Electricity using CLM obtained pre-test and post-test attitude mean scores of 80.53 and 90.53, respectively, having a mean gain of 10.00. As a result of these findings, both male and female students have a higher post-test mean score with female students exposed to Basic Electricity utilising

the PSI having a higher mean score on the attitude scale than male students.This is an indication that gender may have an attributable effect on technical college students' attitudes toward basic electricity.

4.8 *Research Question 7*

What is the influence of school location on technical college students' attitudes when exposed to PSI and CLM?

Table 4.5 below presents the data to answer this research question

Table 4.5: Mean difference of the influence of school location on technical college students' attitude when exposed to PSI and CLM

Method of Teaching	School location	N	Pre-test $\bar{X}$	Post-test $\bar{X}$	Mean gain $\bar{X}$
Personalised System of Instruction (PSI)	Urban	57	84.63	105.42	20.79
	Rural	30	86.13	101.40	15.27
Conventional Lecture Method (CLM)	Urban	39	72.85	88.95	16.20
	Rural	26	79.92	86.85	6.93

Table 4.5 shows the impact of the school's location on students' attitudes. From the obtained data, the students from the urban schools who were taught Basic Electricity using the PSI had a pre-attitude mean score of 84.63 and a post-attitude mean score of 105.42, resulting in an attitude mean gain of 20.79 for the urban students. Students from rural schools who were taught BE using the PSI received a mean score of 86.13 in the pre-test and a mean score of 101.40 in the post-test, resulting in a 15.27 mean gain. The mean pre-test score for urban students taught Basic Electricity using the conventional lecture technique was 72.85, and the mean post-test score was 88.95, resulting in a 16.10 mean gain. Rural students taught with CLM, on the other hand, had a pre-attitude mean score of 79.92 and a post-attitude mean score of 86.85. For students from rural schools, the mean gain in attitude between pre-test and post-test

was 6.93. With these results, the post-attitude mean scores for students from urban and rural schools in both groups were higher than pre-attitude mean scores, with students from PSI-taught urban schools experiencing a higher mean gain. This is an indication that there is an effect associated with school location on the technical college students' attitude to Basic Electricity.

4.9 Testing of Hypotheses

4.9.1 ***Hypothesis 1a:***

There is no significant main effect of treatment (PSI) on technical college students' achievement (pre and post-tests scores) in Basic Electricity.

Table 4.6 below presents the result of this hypothesis

Table 4.6: Summary of Analysis of Covariance (ANCOVA) of the Significant Main and Interaction Effects of Treatment (PSI), Gender and School Location on Technical College Students in Basic Electricity

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	9779.985[a]	8	1222.498	83.275	.000	.823
Intercept	2632.771	1	2632.771	179.341	.000	.556
PreAchievement Test	239.779	1	239.779	16.333	.000	.103
Main Effect:						
Treatment Group	2524.088	1	2524.088	171.937	.000	.546
Gender	645.092	1	645.092	43.943	.000	.235
School location	258.096	1	258.096	17.581	.000	.109
2-way Interactions:						
Treatment * Gender	24.279	1	24.279	1.654	.201	.011
Treatment * Sch. Loc.	61.518	1	61.518	4.191	.042	.028
Gender * Sch. Loc.	.962	1	.962	.066	.798	.000
3-way Interactions:						
Treatment * Gender * School Location	39.319	1	39.319	2.678	.104	.018
Error	2099.278	143	14.680			
Total	175302.000	152				
Corrected Total	11879.263	151				

a. R Squared = .823 (Adjusted R Squared = .813)

The significant main effect of treatment (PSI), gender, and school location on technical college students' achievement in Basic Electricity is summarised in Table 4.6. It demonstrates that there is a statistically significant main effect of treatment (PSI) on students' accomplishment in Basic Electricity after adjusting for the covariate, Basic Electricity achievement scores [$F_{(1,143)} = 171.937$, $P < .05$, $\eta^2 = .546$]. Since the related precise probability value (.000) was less than the .05 alpha level, the null hypothesis that there is no significant main effect of treatment (PSI) on technical college students' achievement in Basic Electricity was consequently rejected. The partial eta squared estimate was .546. According to the result the treatment accounted for 54.6 percent of the variation experienced in students' Basic Electricity achievement.

Since the result shows that the difference between the adjusted means of PSI and CLM is significant, and to determine which group differs significantly among the treatment and control groups, Bonferroni Post-hoc analysis was done. The analysis of the data is displayed in Tables 4.7 and 4.8

Table 4.7: Estimated Marginal Means Score and Standard Error from the Main Effect of Treatment on Students' Achievement

Treatment Group	Mean	Std Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Experimental	35.110[a]	.552	34.019	36.202
Control	24.192[a]	.654	22.899	25.486

(a)Covariates appearing in the model are evaluated at the following values PreAch=9.36

Table 4.8: Bonferroni Pairwise Comparisons of Students' Achievement in Basic Electricity by Treatment

(I) Treatment	(J) Treatment	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Internal for Difference	
					Lower Bound	Upper Bound
Exp.	Control	10.937*	.834	.000	9.288	12.586
Control	Exp	-10.937*	.834	.000	-12.586	-9.288

Based on estimated marginal means

** The mean difference is significant at the .05 level*

b. Adjustment for multiple comparisons; Bonferroni

Tables 4.7 and 4.8 show the estimated marginal scores from the main effect of the PSI on technical college students' achievement and the multiple comparisons with the use of the Bonferroni pairwise post-hoc test. The tables confirmed a significant difference in achievement test scores in Basic Electricity between students in the PSI group ($\bar{X}$ = 35.110), and students in the control group (CLM) ($\bar{X}$ = 24.192), with the mean difference of 10.937, which is significant at .05 alpha level. This simply means that having removed the effect of covariate statistically, students in the experimental group can be said to have a better performance in Basic Electricity than their colleagues in the CLM group.

4.9.2 *Hypothesis 2a:*

There is no significant main effect of gender on technical college students' achievement (pre-test and post-test scores) in Basic Electricity.

The results in Table 4.6 showed that a considerable difference exists in the mean achievement scores between male and female students exposed to Basic Electricity utilising the personalised system of instruction (PSI) and conventional lecture method (CLM) differ significantly [$F_{(1,143)} = 43.943$, $P < .05$, $\eta^2 = .235$]. An F-ratio of 43.943 was generated with a corresponding exact probability value (.000) and was less than the .05 alpha level. As a result of this finding, hypothesis 2a was refuted. According to the estimated Eta square value, gender accounted for 23.5 percent of the variance seen in students' achievement in Basic Electricity.

Table 4.9: Estimated Marginal Means Scores from the Main Effect of Gender on Students' Achievement

Gender	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Male	32.687[a]	.382	31.932	33.441
Female	25.599[a]	.812	24.995	28.204

a. *Covariates appearing in the model are evaluated at the following value: PreAch =9.36*

Table 4.10: Bonferroni Pairwise Comparisons of Students' Achievement in Basic Electricity by Gender

(I) Gender (J) Gender	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference	
				Lower Bound	Upper Bound
Male Female	6.087*	.918	.000	4.212	7.903
Female Male	-6.087*	.918	.000	-7.903	-4.272

Based on estimated marginal means
* The mean difference is significant at the .05 level
b. Adjustment for multiple comparisons: Bonferroni

Tables 4.9 and 4.10 show the estimated marginal scores from the main effect of gender and the multiple comparisons using Bonferroni pairwise analysis. The tables reveal that male students received a higher mean score of 32.687, whereas female students received a mean score of 25.599. At .05 alpha levels, the mean difference between males and females is 6.087, which is significant. This suggests that the mean achievement scores of male and female students are significantly different. This, therefore, implies that male students outperformed female students.

4.9.3 Hypothesis 3a:

There is no significant main effect of school location on technical college students' achievement (pre-test and post-test scores) in Basic Electricity.

Table 4.6 also reveals a substantial main influence of school location on students' Basic Electricity achievement. After controlling for the covariate, the results show that school location has a statistically significant main effect on students' achievement in Basic Electricity [$F_{(1,143)} = 17.581$, $P < .05$, $\eta^2 = .109$]. Since the related exact probability value (.000) was less than .05 alpha levels, the null hypothesis which stated there is no significant main effect of school location on technical college students' achievement was rejected. The partial Eta squared estimate was .109. This means that school location contributed to 10.9 percent of the variance observed in the students' achievement scores in Basic Electricity after the post-test. To identify which group of students differed significantly between the schools located in the urban and rural areas, tables 4.11 and 4.12 present the data on Bonferroni's Post-Hoc analysis.

Table 4.11: Estimated Marginal Means Scores from the Main Effect ofSchool Location on Students' Achievement

School Location	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Urban	31.371[a]	.525	30.333	32.408
Rural	27.915[a]	.669	26.593	29.237

a. Covariates appearing in the model are evaluated at the following value: PreAch =9.36

Table 4.12: Bonferroni Pairwise Comparisons of Students' Achievement in Basic Electricity by School Location

(I) Location of school	(J) Location of school	Mean difference (I-J)	Std. Error	Sig. [b]	95% Confidence Internal for Difference	
					Lower Bound	Upper Bound
Urban	Rural	3.455	.824	.000	1.826	5.084
Rural	Urban	-3.455	.824	.000	-5.084	-1.826

Based on estimated marginal means

* The mean difference is significant at the .05 level

b. Adjustment for multiple comparisons: Bonferroni

Tables 4.11 and 4.12 above show the estimated marginal scores from the main impact of a school's location on a student's academic achievement. The tables reveal that the students from the urban school had a higher mean score ($\bar{X}$ = 31.371), whereasthe mean score of students from schools located in the rural area is $\bar{X}$ = 27.915. The difference in mean between urban students and rural students is 6.087, which is statistically significant at the .05 alpha level. This implies that the achievement mean scores between students from urban and rural schools differ significantly. It means that students in urban schools performed much better than those in rural schools.

4.9.4 ***Hypothesis 4a:***

There is no significant interaction effect of treatment (PSI and CLM) and gender on technical college students' achievement (pre-test and post-test scores) in Basic Electricity

Table 4.6indicates the interaction effect of treatment (PSI and CLM) and gender on technical college students' learning outcome in Basic Electricity [$F_{(1,143)} = 1.654$, $P > .05$, $\eta^2 = .011$]. Since P (.201) is greater than alpha (α) levels, therefore, it is inferred that the interaction effect of treatment and gender on students' learning outcomes in Basic Electricity is not significant. This implies that applyingthe PSI model and CLM crossed with students' gender does not affect Basic Electricity learning outcomes. The null hypothesis 4a was not rejected as a result of this discovery.

4.9.5 ***Hypothesis 5a:***

There is no significant interaction effect of treatment (PSI and CLM) and school location on technical college students' achievement (pre-test and post-test scores) in Basic Electricity.

The ANCOVA summary Table 4.6 reveals the combine effect of treatment (PSI and CLM) and school location on technical college students' achievement in Basic Electricity [$F_{(1,143)} = 4.191$, $P < .05$, $\eta^2 = .028$]. Since P-value (.042) is less than .05 alpha levels. According to the estimated partial eta squared, the interaction of treatment and school location contributed 2.8 percent of the variance perceived in students' Basic Electricity achievement.

As a result, it was concluded that the interaction effect of treatment and school location on technical college students' Basic Electricity learning outcome was significant. As a result, hypothesis 5a was rejected.

Table 4.13: Estimated Marginal Means Scores from the Interaction Effect Treatment Group andSchool Location on Students' Achievement

TreatmentGroups	School Location	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
	Urban	37.639[a]	.671	36.313	38.966
Experimental	Rural	32.583[a]	.892	30.820	34.346
	Urban	25.102[a]	.825	23.470	26.733
Control	Rural	23.247[a]	.909	21.451	25.043

a. Covariates appearing in the model are evaluated at the following values: preAch = 9.36

The result of the post-test mean is analysed in Table 4.13 using the pre-test covariate of 9.36. It demonstrates that students in urban schools did better (37.639) than students in rural schools (32.583) when using the personalised system of instruction (PSI) package. In a similar vein, students in urban schoolsperformed better (25.102) than those who are in schools located in rural areas (23.247) taught using the conventional lecture method (control group). A line graph was plotted to disentangle the interaction, as shown in figure 4.3, to study the nature of the interaction.

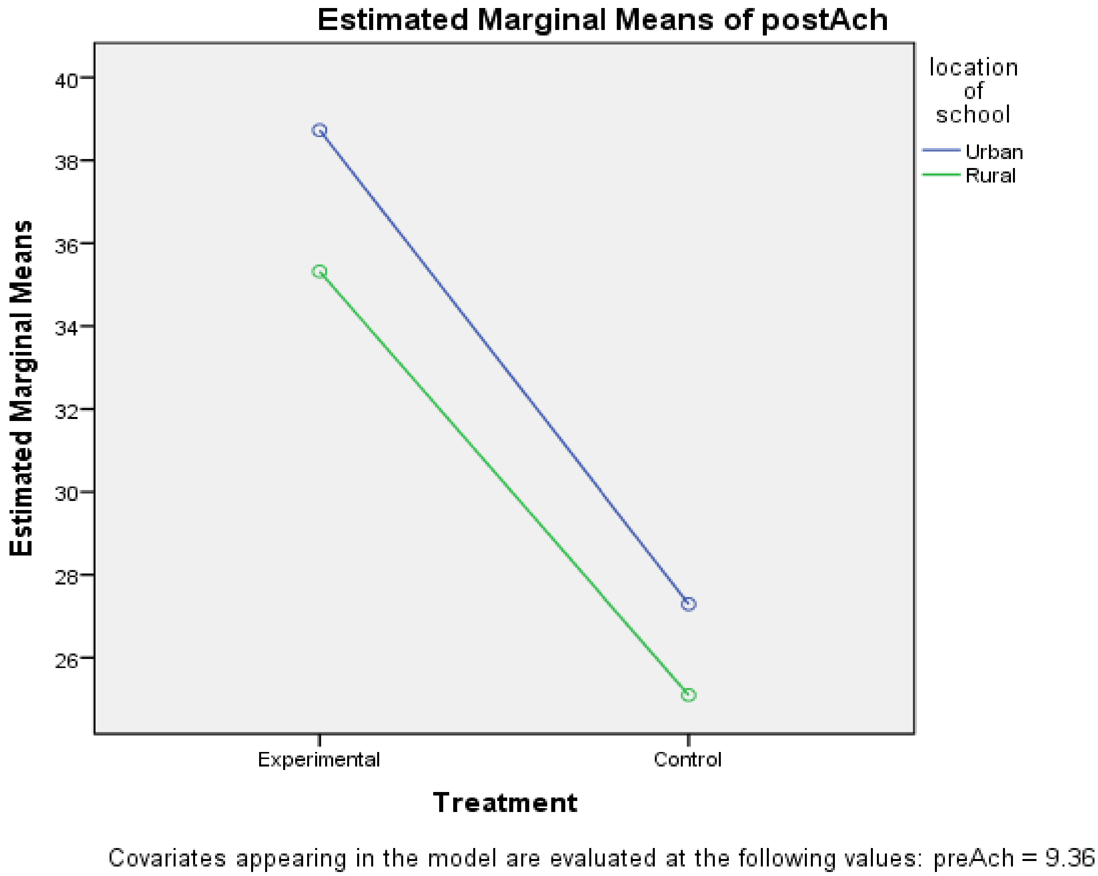

Figure 4.3: *Line graph showing the interaction effect of treatment and school location on technical college students' achievement*

The profile plot in figure 4.3 reveals that the treatment and school location interaction effect followed the same pattern in the sense thatstudents in the control group in schools located in both urban and rural areas obtained lower mean scores, meaning that in all cases, students in the PSI group outperformed those in the control group. Results also revealed that there was an interaction between urban and rural school students' achievement. Observing the nature of interaction critically, from the above figure, one can conclude that the nature of the interaction is ordinal. This indicates that thestudents who were taught with the personalised system of instruction method (experimental) had a stronger statistical difference than those that were exposed to BE using the conventional lecture method (control group).

4.9.6 ***Hypothesis 6a:***

There is no significant interaction effect of gender and school location on technical college students' achievement (pre-test and post-test scores) in Basic Electricity.

Table 4.6 indicates an insignificant interaction effect of gender and school location on technical college students' learning outcome in Basic Electricity [$F_{(1,143)}$ = .066, P >.05]. Because the P-value (.798) is greater than the .05 alpha level, it means that gender and school locationdo not have any effect on students' achievement in Basic Electricity; consequently, hypothesis 6a was not rejected.

4.9.7 ***Hypothesis 7a:***

There is no significant interaction effect of treatment (PSI and CLM), gender and school location on technical college students' achievement in Basic Electricity.

Results in Table 4.6 also revealed that there was no significant interaction effect of treatment, gender and school location on technical college students' achievement in Basic Electricity [$F_{(1,143)}$ = 2.678, P >.05]. Since P-value (.104) is greater than .05 alpha levels. The combined interaction effect of PSI, gender, and school location on technical college students' learning outcomes in basic electricity is not significant, according to the findings. This means that students' achievement in Basic Electricity was unaffected by treatment, gender, or school location. As a result, we do not reject null hypothesis 7a.

4.9.8 ***Hypothesis 1b***:

There is no significant main effect of treatment (PSI) on technical college students' attitude toward Basic Electricity.

Table 4.14 presents the results to answer this hypothesis 1b to 7b

Table 4.14: Analysis of Covariance (ANCOVA) Table Showing the Significant Main and Interaction Effects of Treatment, Gender and School Location on Attitude to Basic Electricity.

Source	**Type III Sum of Squares**	**Df**	**Mean Square**	**F**	**Sig.**	**Partial Eta Squared**
Corrected Model	15929.681[a]	8	1991.210	2.903	.005	.140
Intercept	92371.286	1	92371.286	134.651	.000	.485
Pretest Attitude	1687.761	1	1687.761	2.460	.119	.017
Main Effect:						
Treatment Group	8138.302	1	8138.302	11.863	.001	.077
Gender	1151.151	1	1151.151	1.678	.197	.012
LocSch	206.805	1	206.805	.301	.584	.002
2-way Interactions:						
Treatment * Gender	389.353	1	389.353	.568	.452	.004
Treatment * LocSch	630.156	1	630.156	.919	.339	.006
Gender * LocSch	336.242	1	336.242	.490	.485	.003
3-way Interactions:						
Treatment * Gender * LocSch	2173.630	1	2173.630	3.169	.077	.022
Error	98098.713	143	686.005			
Total	1550800.000	152				
Corrected Total	114028.395	151				

a. R Squared = .140 (Adjusted R Squared = .092)

The result of the main and interaction effects of treatment (PSI and CLM), gender, and school location on technical college students' attitudes to Basic Electricity are summarised in Table 4.14. After adjusting for the covariate Basic Electricity attitude scores, the Table shows that the treatment group (personalised system of instruction) had a significant main effect on technical college students' attitudes toward Basic Electricity. [$F_{(1,143)} = 11.863$, $P < .05$, $\eta^2 = .077$]. Since P (.001), then the F-critical ratio's value is significant, hence, hypothesis 1b was rejected, which indicated that there is no significant main effect of treatment (PSI) on technical college students' attitudes toward Basic Electricity. The estimated partial Eta squared was .077. The result is an indication that 7.7percent of the variation experienced in the post-test scores of students' attitude to Basic Electricity is accounted for by the treatment.

Table 4.15: Estimated Marginal Means Score and Standard Error from the Main Effect of Treatment on Students' Attitude

Treatment Group	Mean	Std Error	95% Confidence Interval Lower Bound	Upper Bound
Experimental	106.326[a]	3.768	98.877	113.775
Control	87.796[a]	3.815	80.254	95.338

a. Covariates appearing in the model are evaluated at the following values: Pre_Att = 81.0987

Table 4.16: Bonferroni Pairwise Comparisons of Students' Attitude to Basic Electricity

(I) Location of school	(J) Location of school	Mean difference (I-J)	Std. Error	Sig. [b]	95% Confidence Interval for Difference Lower Bound	Upper Bound
Exp.	Control	18.530	5.380	.001	7.896	29.164
Control	Exp.	-18.530	5.380	.001	-29.164	-7.896

Based on estimated marginal means
* The mean difference is significant at the .05 level
b. Adjustment for multiple comparisons: Bonferroni

To trace the sources of significant difference among the treatment and control groups' attitudes to Basic Electricity, Tables 4.15 and 4.16 show the estimated marginal means and Bonferroni pairwise comparisons respectively. The results presented in Tables 4.15 and 4.16 indicates that after adjustment for multiple comparisons using Bonferroni pairwise post-hoc analysis, students' attitude scores in Basic Electricity were significant, PSI ($\bar{X}$ = 106.326), and CLM ($\bar{X}$ = 87.796). The means difference in the attitude between the experimental and control group is 18.530, which is significant at .05 alpha levels. This signifies that there was a statistically significant difference in the Basic Electricity attitude score between PSI and CLM participants. This, therefore, infers those students exposed to Basic Electricity using the PSI approach had a more positive attitude than students exposed to Basic Electricity using the CLM method.

4.9.9 *Hypothesis 2b:*

There is no significant main effect of gender on technical college students' attitude toward Basic Electricity.

Results in Table 4.14, after adjustment for covariate, revealed that the main influence of gender on students' attitude to Basic Electrify is not significant [$F_{(1,143)}$ = 1.678; $P > .05$, η^2 = .012]. Since P-value (.197) is greater than .05 alpha levels; therefore, we do not reject the null hypothesis 2b. The findings also revealed that the estimated partial eta squared was .012. This deduces that gender contributed 1.2% of the variance observed in the attitude of students to Basic Electricity.

4.9.10 *Hypothesis 3b:*

There is no significant main effect of school location on technical college students' attitude to Basic Electricity.

The finding shown in Table 4.14 revealed that after adjusting the Basic Electricity pre-test for the covariate [$F_{(1,143)}$ = 0.301, $P > .05$, η^2 = .002]. Since P-value (.584) is greater than .05 alpha levels, it was discovered that the main effect of school location on technical college students’ attitude to Basic Electricitywas not significant. As a result, we do not rejectthe null hypothesis 3b. It thus implies that the students’ attitude to Basic Electricity is not sensitive to school location. The partial eta squared estimate was .002. This reveals that school location contributed 0.2 percent of the variance detected in the students’ attitude to Basic Electricity.

4.9.11 *Hypothesis 4b:*

There is no significant interaction effect of treatment (PSI) and gender on technical college students’ attitudes to Basic Electricity.

Table 4.14 further presents the interaction effect of treatment (PSI) and gender on students’ attitude toward Basic Electricity [$F_{(1,143)} = .568$, $P > .05$, $\eta^2 = .004$]. As the P-value (.452) is greater than the .05 alpha levels, it can be concluded that the interaction effect of treatment and gender on students’ attitude to Basic Electricity is not significant. Therefore, we do not reject null hypothesis 4b. Consequently, the effect of PSI on the students’ attitude toward Basic Electricity is not gendered sensitive.

4.9.12 *Hypothesis 5b:*

There is no significant interaction effect of treatment (PSI) and school location on technical college students’ attitudes to Basic Electricity.

Table 4.14 presents the interaction effect of treatment (PSI) and school location on technical college students’ attitudes toward Basic Electricity. The Table reveals that [$F_{(1,143)} = .919$, $P > .05$, $\eta^2 = .006$]. Since P (.339) is greater than .05 alpha levels, it could be concluded that the interaction effect of treatment and school location on technical college students’ attitude to Basic Electricity is not significant; hence null hypothesis 5b was not rejected. As a result, school location has no bearing on the effect of treatment on students' attitudes toward Basic Electricity.

4.9.13 *Hypothesis 6b:*

There is no significant interaction effect of gender and school location on technical college students' attitude to Basic Electricity.

Table 4.14 also shows the interaction effect of gender and school location on technical college students' attitudes toward Basic Electricity (pre-test and post-test) [$F_{(1,143)}$ = .490, P > .05, η^2 = .003]. The interaction effect of gender and school location on technical college students' attitudes toward Basic Electricity is not significant, as P (.485) is greater than 0.05 alpha values. This means that students' attitudes toward Basic Electricity were unaffected by gender or school location. Null hypothesis 6b was not rejected as a result of this discovery.

4.9.14 *Hypothesis 7b:*

There is no significant interaction effect of treatment (PSI), gender and school location on technical college students' attitude to Basic Electricity.

Table 4.14 reveals that the interaction impact of treatment (PSI), gender, and school location on technical college students' attitudes toward Basic Electricity is not significant [$F_{(1,143)}$ = 3.169, P > .05, η^2 = .022]. Since P (.077) is greater than .05 alpha levels, it may be stated that there was no significant interaction effect of treatment, gender, or school location on technical college students' attitudes toward Basic Electricity. The conclusion was that hypothesis 7b was not rejected, indicating that the treatment, gender, and school location had no interaction effect on technical college students' attitudes toward Basic Electricity.

4.10 Discussion of results

4.10.1a: The main effect of treatment (PSI) on technical college students' achievement in Basic Electricity.

After controlling for covariance and Basic Electricity pre-test scores, the study finds that there is a significant main effect of treatment (personalised system of instruction) on technical college students' Basic Electricity achievement. The findings of the study reveal that students who were taught using the PSI recorded a significantly higher mean score of 35.11 on their academic achievement than the students who were exposed tothe conventional lecture method who obtained a post-test mean score of 24.192.

In the comparisons of the treatment, the significant differences were in support of the personalised system of instruction (PSI) strategies over the control group. The results demonstrated the superiority of the PSI over traditional lecture methods. This could be due to the effectiveness of the teaching method that was adopted. This was confirmed by the studies of Juditya, Suherman, Ma'Mun and Rusdiana (2018), Al-Zaboun, Al-Mawadiah, Al-Mawajdeh and Al-Mawajdeh *(*2016), Alalwneh and Alomari (2018), Allen (2016), Wood (2018), Young (2016), Prewitt (2014), and Zakaria, Adha and Dedi (2018) who in their separate studies found that PSI significantly improved the students' academic achievement in different school subjects. Their findings show a statistically significant difference between the students' pre-test and post-test scores. They concluded that, when properly applied, the PSI model was effective in boosting achievement levels.

One of the learning theory embraced by this study is mastery learning theory. Various proponents of the personalised system of learning and mastery learning such as Bautista (2012); Keller (1968); Kulik and Bengert-Downs (1990), Al-Otaibi (2015); Prewitt (2014) claimed that learners' active involvement in the process of learning, not only foster the subject content mastery but also allow learners to organise the instructional materials, which were used to construct knowledge and link it to previous knowledge, resulting in a more solid knowledge structure. As cited by Murphy, Redding and Twyman (2016) there is convicting evidence that PSI allows the individual students can progress through their various learning modules at their own pace while receiving support, guidance, and feedback from their peers who have already completed the units and tasks before them. Moreover, the relative effectiveness of PSI over CLM in improving student achievement can be associated with the fact that PSI unlike the lecture method is a student-centred and activity-based technique that permits learners to actively participate in teaching and learning (Juditya, et al*.,* 2018).

The results of this study support Keller's Mastery learning Theory. Mastery learning can be attributed to the behaviourism principles of operant conditioning which posits learning occurs when an association is formed between a stimulus and a response (Skinner, 1984:217-221). In line with the behaviour theory, mastery learning focused on overt behaviours that can be observed and measured (Baum, 2005). The material that was taught to mastery was broken down into small discrete lessons that follow a logical progression. As applied to this study, one might interpret the theory to suggest the existing conditions through which methods of teaching were handled in the classrooms, it is not accidental that the students taught using the PSI performed better academically than those who were taught using CLM.

Results from this study also supports the findings of Salami (2007) and Alaxandre and Enslin (2017) who asserted that the effectiveness of the PSI is due to its self-pacing nature and the procedure of obtaining feedback through testing and applying corrective measures through instruction and retesting with other remediation. They further discovered that students taught using PSI can understand the principal concepts and formulas involved in the topics taught and interact with the proctors on the lively interchange of ideas, interests and importance common to each other, which fostered meaningful learning thereby accounted for the marked improvement of their academic attainment.

The results of this study also agreed with the findings of Owolabi and Aderinto (2010) in a study titled "Effectiveness of personalised system of instruction on the performance senior secondary school students" found that the performance of students exposed to the PSI was significantly different from that of those exposed to conventional lecture method with t (48) = 12.33; p-value = .000, and reported the effects sizes of 0.761 a value which implies that PSI accounted for about 75 per cent of the variability observed in the student performance. The study disclosed that the PSI pays direct attention to each learner. It pursues their needs to master the contents of instruction, motivates the learners to put in greater efforts to ensure success and adopt a more positive attitude toward learning. It was concluded that the PSI could be possibly adopted for the improvement of learners' performances (Owolabi & Aderinto, 2010).

The findings of this study conform to the observation of Bingham et al. (2018) that the PSI is an instructional model that is directed towards the needs and capability of individual students. This means that using PSI to teach Basic Electricity at technical colleges helps teachers to visualise individual students as distinct beings/entities with unique traits, potentials, and capacities. Alalwneh et al. (2018) found that the correct use of the PSI instructional model in the teaching and learning of vocational courses encourages the acquisition of self-learning skills with the least amount of teacher supervision and guidance.

A report from the study by Ginanja (2019) which aimed at determining the differences between the PSI and DI learning models in terms of student motivation to learn found that there are variations in students learning motivation using PSI and DI learning models. The study concludes that the use of the PSI learning model increases student learning motivation. However, the results contradict the findings of Butler et al. (2015) whoaimed to assess the efficacy of a modified PSI that was proposed to fit into a traditional academic calendar. Results of their study revealed thatbetween PSI and a conventional lecture method, there were no significant differences in academic performance, course satisfaction, or motivation. The authors suggest adjusting PSI by including time constraints may be harmful to its improved performance over the conventional lecture method.

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Romiro (2012) who looked at the superiority of PSI as an innovative method of teaching established that the students who were taught using the PSI model performed better in their post-test mean score. He also found out there is significant interaction of PSI with the learning abilities of the students. Alieme (2014) revealed that participants in PSI had higher post-test mean mathematical achievement scores than those in the control group, which validates the findings of this study. The work of Friskawati, Ilmawati, and

Suherman (2017) investigated the influence of a personalised system for instructions (PSI) on the physical fitness of senior high school nursing students and discovered that PSI had a significant influence on the physical fitness of senior high school nursing students with the alpha value of .000. The implications of which show that PSI can be utilised to improve students' learning outcome.

4.10.2a: The main effect of gender on technical college students' achievement in Basic Electricity.

Considering the main effect of gender on the achievement of technical college students in Basic Electricity; this study found that gender has a significant main effect on technical college students' academic achievement in Basic Electricity. This result reveals that gender accounted for 23.5 percent of the difference in post-test achievement scores in Basic Electricity. This means that 23.5 percent of the variance observed in the post-achievement test marks in Basic Electricity is attributable to gender differences. The findings of this investigation are consistent with the outcomes of some researchers on the gender difference in science, technical and vocational education even the subject of Basic Electricity in technical colleges which shows some results with significant gender differences in favour of males (Aina, 2013; Onah, 2017; Amao, Adewuyi, Gbadamosi, Salami & Ogunjinmi, 2016; Sani (2014); and Atsumbe, Raymond & Ajuwon, 2015).

The findings of Nnenna and Achukwu (2018) on the influence of gender and school location on students' achievement revealed a significant mean difference in the achievement score of male and female students at a senior secondary school in the Agbani Education zone of Enugu State. Male students outperformed their female counterparts. Naboth-Odums (2014) also established that gender has a considerable impact on students' mean achievement scores. The findings of this study are also in conformity with the research of Amao et al (2016) which focused on gender bias and agricultural science achievement at public and private schools. Their findings revealed that there is a standard level of significance in the performance of male and female in agricultural science and other related subjects and that male performs better than female in agricultural science. The conclusions of this investigation are also in agreement with the findings of some researchers but in favour of females, such as that of Nnamani and Oyibe (2016), whose study revealed thatthe average achievement score of female students was better than the average achievement score of male students. Their findings further revealed a statistically significant difference in gender-based mean achievement scores.

The review of the literature and the findings of this study shows that there exists a disparity between the achievements of male and female students. On several occasions boys had an edge most especially in science, technical and vocational education over the girls in students' achievement, this may be due to the agreement with established traditions that technical and vocational education is considered to be predominantly for boys.bThe tradition of gender-biased in technical education especially in technical colleges in Nigeria still exists. This may be affecting the female performances in a school subject. The study by Bamiro (2015); Agbetoye, Aleburu, Olugbaike & Ogunjimi (2015); Adigun et al (2015) showed varying gender differences in the student's cognitive, emotional, and psychomotor abilities. They concluded that sex stereotype is responsible for the differences between male and female students' educational abilities, interests, and aspirations.

However, this finding negates the earlier studies of Okorie and Ezeh (2016), whose study discovered that there is no significant main effect of gender on students' chemical bonding achievement. Adigun et al (2015), found out that despite the performance of male students being somewhat better when matched with female students, it was not significant. They confirmed that there was no discernible difference in performance between male and female students. In a similar vein, Dania (2014) examined gender influence on secondary school students' social studies academic achievement. The result revealed no significant influence of gender on students' learning outcomes. The research concluded that students'academic attainment is not attributed to gender. The study of Agbaje and Alake (2014) indicated that other variables such as study pattern, students' interest in science subjects and attitude are better predictors of academic performance, whereas student gender has no bearing on academic performance. Adesogun, Adekunle and Adu (2016) attributed students' performance to several factors but not to gender influence.

4.10.3a: The main effect of school location on technical college students' achievement in Basic Electricity.

The research further affirmed that the main effect of school location on the students' achievement in Basic Electricity is significant. The result also indicated that school location accounted for 10.9 percent of the variance observed in the students' achievement post-test scores in Basic Electricity. This is a shred of evidence asthe mean scores of urban students in the PSI group are higher than the mean scores of students in rural schools, indicating that students' learning outcomes in Basic Electricity are influenced by their school location. Similarly, the mean scores of students in urban schools in the control group are higher than the mean scores of students from the schools located in rural areas. The findings of this study corroborated the conclusions of Owoeye and Yara (2011); Alordiah, Akpadaka and Oviogbodu (2015); Akissani, Muntari, and Ahmed (2019) who established that school location had a significant main effect on students' perfomance in senior high school certificate examinations. The results revealed a marked difference in the academic performance among students in the urban and rural schools, with impressive mean scores obtained by students from the urban schools than rural school students.

This finding backs up the previous results of Agbaje and Awodun (2014) on the impact of school location on science students' performance in the SSCE examination. The findings showed that there is a large disparity in the average performance scores of students in rural and urban schools. Faisal, Shinwari and Mateen (2016), and Nnenna and Adukwu (2018) holds a similar view as Agbaje and Awodun that students from urban schools outperformed their counterpart from rural schools. They found that there is a considerable variation in the achievement mean scores of students in a rural and urban school located areas. When gender and school location were considered, urban students outperformed rural students.

In the same vein, Onoyase (2015) acceded that school location makes a significant contribution to academic performance, as the results of his investigation revealed, there was a considerable difference in academic performance between pupils in urban, semi-urban, and rural secondary schools. He argued that the rationale behind urban students' outstanding academic performance than students from rural schools are because urban areas do fascinate or entice amenities such as pipe-borne water, electricity, good roads and well-equipped schools. The rationale is justifiable because for effective teaching and learning to take place, adequate educational facilities are required, the ones which schools in rural areas are lacking. He submitted that by employing the same methods, materials, and qualified teachers, student achievement may improve consistently in both rural and urban schools. Abamba (2021) posited that the location of a school can have an impact on a student's academic performance. Tikoko and Omondi, (2022) discovered that students in rural areas have lower educational aspirations than their urban peers, hence placing less emphasis on their education, resulting in lower academic achievement.

Consequently, Owoeye and Yara (2011); and Ellah and Ita (2017) suggested as appropriate that a link between rural and urban locations should be closed by governments at all levels of education by equipping the schools in the rural area with the state-of-the-art infrastructures and providing social amenities which will improve the better academic performance of students for the rural dwellers. Teachers in rural areas should also be given ample stimulus in the form of incentives to encourage them to do their best to stay behind in their job stations. This, nonetheless, negates some research that claims that the location of a school has no significant effect on a student's academic achievement (Ntibi & Edoho, 2017; Yadav & Chahal, 2016). Also, Alokan (2010) established that students' difficulties are inextricably related to low performance; and that, as a result, school location may have little consequence on how students learn in schools.

4.10.4a: Interaction effect of treatment and gender on technical college students' achievement in Basic Electricity.

The results of this research establishes that there is no significant interaction effect of treatment and gender on the learning outcomes of technical college students in Basic Electricity. As a result, the PSI's influence on technical college students' achievement in Basic Electricity is not gender-sensitive. This signifies that the treatment's effectiveness on participants' achievement is the same whether they are male or female. The result when examined against the background of the insignificance of the main effect of gender suggests that gender cannot be biased in the learning of Basic Electricity. The reason for no interaction effects of gender could be a result of behaviourists' nature of strategies employed by the researcher, which guaranteed high facilitative learning that brings about a high level of achievement to both sexes (male and female). Another reason for the finding could be a result of the students' orientation or counsel given before to the start of treatment. They were made to understand that Basic Electricity is not just for men and that women can excel in the subject as well. Students were also shown examples of the types of jobs that people who have taken Basic Electricity related courses are suited for.

The results of this study affirm similar findings in recent research by Sanni (2014) and Alieme (2014), who found no significant difference among gender. The findings of this investigation also corroborate the findings of the previous study by Alieme (2014), who reported that pupils' achievement in mathematics is not gendered sensitive but at variance with others and Sanni (2014) and Salami (2007) also reported that the interaction effect of the PSI and gender on participants' achievement and interest to Basic Electricity is not significant. It implies that the effectiveness of the treatment (PSI) in improving students' academic achievement is not gender dependent. Both female and male students showed marked improvement in academic achievement due to their exposure to the PSI model of teaching.

4.10.5a: Interaction effect of treatment and school location on technical college students' achievement in Basic Electricity.

The findings of this research further demonstrated that the treatment (PSI) and school location had a significant interaction effect on technical college student achievement in Basic Electricity. Because this study found a significant interaction effect between treatment and school location, the effect of a personalised system of instruction on cognitive learning achievement could be a function of the school location. This result conformed to the findings of Amusan (2013), who found a moderately significant relationship between school location, pedagogical skills, attitude, classroom interaction and the criterion variable basic science and technology achievement. He went on to add that the location of a school has a direct significant impact on students' achievement in basic science and technology.

This result also concedes with Agbaje and Awodun (2014) who asserts that school location has a significant impact on the academic achievement of students. In the same vein, Ellah and Ita (2017) found that learners in schools located in urban areas manifest more brilliant performance than their counterparts from schools located in rural areas. Also, Opoku-Asare and Sraw (2015); Owoeye and Yara (2011); and Onoyase (2015) reported that students in urban schools outperformed students in rural and peri-urban schools, because of the disparities in educational resources, inadequate infrastructural facilities; less qualified teachers; and lack of the character to motivate their students to excel. This finding, on the other hand, opposes the previous findings of Yadav and Chahai (2016) and Ntibi and Edoho (2017) whose findings revealed that the school's location had no significant influence on students' learning outcomes.

4.10.6a: Interaction effect of gender and school location on technical college students' achievement in Basic Electricity.

In another finding, the study revealed that there is no significant interaction effect of gender and school location on technical college students' achievement in Basic Electricity. This shows that gender and school location did not affect technical college students' achievement in Basic Electricity. This result conforms to Okorie and Ezeh (2016) who explored the effect of sex and school location on students' performance in chemical bonding and found that there is no gender-related influence. The findings also corroborate the assertion of Adigun et al (2015) who discovered that despite the male students achieving marginally higher performance when matched with their female counterparts, yet it was not significant.

Amatobi and Amatobi, (2020) found that the disparity in mathematics achievement between boys and girls was in favour of the boys but was not statistically significant, which means that when boys and girls are taught under the same condition, gender will not exert any form of influence on their performance. This finding is in contrast with Ogula, Kisigot, and Munyua, (2021) who believed that in any subject requiring quantitative ability, such as science, boys outperformed the girls. They said boys show an upper hand in science, statistics and accounting. Morris (2015) equally observed that men score exceptionally above women in advance placement examinations. This assertion seems to be valid irrespective of the students' gender and location. However, most females have been discovered to undervalue their academic performance and believe that men are more capable of tackling challenging science courses. Based on the aforementioned, the outcomes of this research vary, with some in favour of males and urban locations and others in favour of females and rural locations.

4.10.7a: Interaction effect of treatment, gender and school location on technical college students' achievement in Basic Electricity.

On the significant interaction effect of treatment, gender, and school location on the learning outcomes of technical college students in Basic Electricity; the finding shows no significant interaction effect. The three-way interaction effect of treatment (PSI), gender, and school location on students' learning outcomes were not significant. This means that the interaction of treatment, gender, and school location does not affect students' performance. This shows that individuals in the PSI outperformed the control group (CLM) regardless of the combination of the three variables (treatment, gender, and school location). As a result, the study's findings provided additional empirical support for PSI's superiority over conventional lecture methods.

4.10.1b: The main effect of treatment (PSI) on technical college students' attitude to Basic Electricity.

The results of the main effect of treatment (PSI) on students' attitude reveal that, after adjustment for the covariate, Basic Electricity attitude scores, the main effect of teaching methods (PSI and CLM) on students' attitude to Basic Electricity was not significant [$F_{(1,143)} = 11.863$, $P < .05$, $\eta^2 = .077$]. Hypothesis 1b on the significant main effect of treatment (PSI) on technical college students' attitude to Basic Electricity was rejected. The estimated Partial Eta Squared was .077. This evidence that treatment accounted for 7.7 percent of the variance noticedin the students' attitude post-test scores.

In the comparisons of the teaching method (PSI) as regard student attitudes, the significant differences were in favour of a personalised system of instruction (PSI). The PSI documented a higher mean score of 106.326, while the control group had 87.796. This agrees with the finding of Alieme (2014), and Onah (2017) that the personalised system of instruction in addition to content learning, improves students' interest and self-efficacy towards mathematics and science. This also corroborates the findings of previous researchers (Bandura, 2001; Salami, 2007; Bautista, 2012; Nnamani and Oyibe, 2016a; Stockinger, Rinas, and Daumiller, 2021) who reported that the nature of the learning environment and method of teaching can enhance self-efficacy in the classroom and that the influence of various teaching strategies on the classroom climate and self-efficacy creates a significant positive effect of climate in the classroom.

Bautista (2012) pointed out that in the organisation of a learning environment, the PSI takes into cognisance individual student's characteristics and needs, and flexible instructional practices. Ciampa (2014); and Clark and Mayer (2011) reported that the personalised environment set up in the classroom settings are the characteristics that boost learners' motivation to take control of their learning experience. This corresponds to the results of Friskawati, Ilmawati and Suherman (2017) that students, who have been trained in PSI technique, can apply it to improve their physical fitness. Furthermore, an attitude survey revealed that students who took part in their research were positive about the PSI model's effectiveness. In addition, Ginanjar (2019) discovered that utilising the PSI learning model to determine differences in student learning motivation increased motivation in learning. The finding of this study negates the study of Butler et al. (2015), who appraised the effect of a modified personalised system of instruction proposed to fit within a traditional academic calendar. Their result showed that between PSI and lecture approaches, academic performance, course satisfaction, and motivation were not significantly different.

4.10.2b: The main effect of gender on technical college students' attitude to Basic Electricity.

This study established that there was no significant main effect of gender on students' attitudes toward Basic Electricity when considering the main influence of gender on technical college students' attitudes toward Basic Electricity. The result of this study supports the findings of Alieme (2014), who do not observe any significant difference in the learners' attitude in Mathematics based on gender. Wosu (2016) noted no discernible variation in the attitude of boys and girls to business studies when taught using brainstorming and field trip teaching methods. Further, Akinbobola (2010) in his study on enhancing students' attitudes towards Nigerian senior secondary school physicsusing cooperative, competitive and individualistic learning strategies, discovered an insignificant gender difference in students' attitudes toward physics. Adebanjo and Otiegede (2020) finding also revealed that there were no significant differences in the learning attitudes of male and female senior secondary school students towards the learning of mathematics.The existence of no difference in the attitude of male and female students to Basic Electricity may be attributed to the fact that no treatment was exceptionallypreferred to the other for any group of gender. This implies that each of the treatments could be applied effectively across learners' gender.

The findings of this study contradict those of Oyekan (2014), who showed a substantial difference in middle school students' attitudes towards social studies. The findings of Imasuen & Omorogbe (2016) confirmed that there is a difference in male and female students' attitudes, and that the male and female dichotomy contributes significantly to influencing students' success. Breakwell (2012) also found that boys had a higher positive attitude toward science than girls.

4.10.3b: The main effect of school location of technical college students' attitude to Basic Electricity.

The result further revealed that the main influence of school location on the attitudes of technical college students to Basic Electricity is not significant. This is an indication that students' attitude to Basic Electricity is not sensitive to the location of the school as the mean scores of students' attitudes were not statistically different. This finding is in contrast with the work of Sanni (2014), who asserted that the context of school location has a significant influence in shaping students' attitudes toward Basic Electricity. He submitted that learners' poor performance is attributed to attending school in a rural area.

4.10.4b: Interaction effect of treatment and gender on technical college students' attitude to Basic Electricity.

On the significant interaction effect of treatment (PSI) and gender on attitudes of students to Basic Electricity, the results of this study reveal that the PSI effect on students' attitudes toward Basic Electricity is not gendered sensitive. This research backs up Breakwell's (2012) findings, which found no significant differences in male and female students' attitudes toward physics in the experimental group before and after the intervention. In other words, it implies that, regardless of gender, all students can perform equally well in a particular task. In her research, Wosu (2016) found no indication that gender had an impact on student attitudes. This contradicts the findings of Nnamani and Oyibe (2016b), who found that gender composition had a substantial impact on student attitudes. Based on this statement, it is likely that both male and female learners will perform equally well if Basic Electricity instructions are provided in a more relevant and exciting way through proper access and thought-provoking techniques.

4.10.5b: Interaction effect of treatment and school location on technical college students' attitude to Basic Electricity.

The findings went further to reveal that there is no significant interaction effect of the intervention (PSI) and school location on technical college students' attitudes toward Basic Electricity. It thus, implies that the impact of the personalised system of instruction (PSI) on students' attitudes toward Basic Electricity is unaffected by where they attend school. This could be an outcome of the pre-treatment orientation provided to the students.This finding is consistent with Ntibi and Edoho (2017), and Yadav and Chahai (2016), who in separate studies found that rural-urban schools' student dichotomy; government and private schools' student dichotomy has no significant effect on students' attitudes.However, student academic achievement is influenced by their geographic location to some extent. This finding contradicts the findings of Mehara (2004), who said a conducive learning atmosphere and positive attitude towards mathematics in urban school students was found to be much higher than the rural school students, and that no gender wise difference was found in the students' achievement.

However, Faisal, Shinwari and Mateen (2016); Nnenna and Adukwu (2018) and Agbaje and Awodun (2014) reported thatthere is a huge gap in student performance between urban and rural schools. Also, Onoyase (2015) acceded that school location makes a significant contribution to achievement, as urban school students showed an excellent performance than their semi-urban and rural counterparts. In summary, research has not provided a shred of distinct evidence that rural schools are substandard to urban and semi-urban schools. According to Reeves and Byhund in Alieme (2014), one notable study established that learners in rural schools performed lesser than their urban counterparts, but other studies using the same national data set have arrived at contrary conclusions (Amusan, 2013).

4.10.6b: Interaction effect of gender and school location on technical college students' attitude to Basic Electricity.

The result further found no significant interaction effect of gender and school location on technical college students' attitude to Basic Electricity. Available literature has not been able to establish a distinctive variation between the performance of male and female students in Basic Electricity, dependent on the inequalities in their physiological structure (Essien, 2017). Although most researchers have found males perform better than females (Nnenna & Adukwu, 2018; Amao et al., 2016; Abdulraheem, 2017; Ania, 2013) especially in science, mathematics and engineering-related course, a few others (Nnamani & Oyibe, 2016b) saw females surpassing males while some others confirmed no significant difference. Following the conclusions of this research, it implies that students' attitude to Basic Electricity is not influenced by the interaction effect of gender and school location. This means that in bothurban and rural areas, male and female students exhibit equal feelings and dispositions toward the study of Basic Electricity.

4.10.7b: Interaction effect of treatment, gender and school location on technical college students' attitude to Basic Electricity.

On the interaction effect of treatment, gender and school location on technical college students' attitude to Basic Electricity. It follows that the impact of the personalised system of instruction on students' attitudes toward Basic Electricity is unaffected by gender or school location. This means the interaction effect encompassing the three variables (PSI, gender and school location) is not mutually influenced by attitude to produce a combined effect. This means that regardless of how the three variables (PSI, gender, and school location) were combined to produce a cumulative effect, the finding of the study has revealed that the PSI group achieved higher than the CLM group, hence,the findings of this study have provided more empirical support for the efficacy of PSI strategies over CLM strategies.

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter gave a summary of the study's major findings, which were detailed in chapter 4 based on the study's findings, conclusions and recommendations were formed. The chapter concludes by providing suggestions for further research on the personalised system of instruction.

5.2 Summary

The low achievement of technical college students and their attitude toward Basic Electricity in Nigeria both internal and external examinations prompted this research. As a result, the effect of a personalised system of instruction method on technical college students' learning outcomes and attitudes toward Basic Electricity in Osun state was explored in this study. The study also looked at the moderating influence of the participants' gender and school location on their performance and attitudes toward the concept of Basic Electricity. The study was guided by the post-positivist paradigm, which allowed the researcher to see if there was any gain in achievement or a positive change in attitude as a result of the PSI experience.

Quantitative research methodologies of pre-test and post-test control groups, quasi-experimental design, using a 2 x 2 x 2 factorial matrix were utilised in the study. The study included 152 trade II Basic Electricity students (119 males and 33 females) from four purposively selected intact classes from both rural and urban schools.Three Basic Electricity topics were selected by the researcher. They are an alternating circuit, Magnetism and Electromagnetism, and Transformer.

Two instruments and three instructional guides were employed to collect data for the study. They are as follows:

1. Basic Electricity Achievement Test (BEAT)
2. Students' Attitude to Basic Electricity Questionnaire (SABEQ)
3. Unified Instructional Guide for PSI (UIG)-(for teachers)
4. Lesson Guide for Conventional Instructional Method for Basic Electricity

5. Teachers Marking Guide for Basic Electricity (TMGBE)-(for teachers).

The study made use of the following work schedule:

The research assistants were trained, and the pre-test was administered over one (1) week. The treatment and administration of the post-test took place over five-week with the help of the research assistants who delivered the strategies to the students. All the schools that were chosen received treatment at the same time.

The research took six weeks in total. At the .05 level of significance, seven research questions and seven null hypotheses were posed, answered, and tested. For data generated from the research questions, mean, percentage and bar chart were used to analyse the data, and for the hypotheses, an Analysis of Covariance (ANCOVA), Estimated Marginal Mean (EMM), and Bonferroni post-hoc analysis were used.

From the data analysed and the result presented the following findings emerged and are summarised as follows:

1. A large percentage of the participants are between the ages of 19 and 22 years with 137 representing 90.1%, this shows, they are regular students;
2. The majority of the respondents are male, with 119 or 78.3%;
3. The majority of the students are from the schools located in the urban area, 96 or 63.2%;
4. The students in the experimental group who were taught Basic Electricity utilising a personalised system of instruction outperformed students in the control group in terms of mean achievement scores, as manifested by their post-test means score of 38.57 versus 25.05 with the mean gain of 28.50 (experimental group) versus 28.50 (control group).
5. Male students taught Basic Electricity using PSI and CLM performed better than their female counterparts, as evidenced in their post-test mean score of 40.21 versus 31.31 and mean gain of 29.69 versus 23.25. The finding shows that gender has an impact on students' academic performance.

6. Students from schools located in the urban area taught Basic Electricity using PSI and CLM had higher mean achievement scores than students from rural schools, as evidenced in their post-test mean score of 40.61 versus 34.70 and a mean gain of 29.94 versus 25.77. The finding also indicates that the location of the school had an impact on students' achievement.
7. In the post-test, the experimental group taught Basic Electricity using the PSI model had a higher mean attitude score and a higher mean gain than the CLM group. The finding shows PSI had a more positive influence on students' attitudes than CLM.
8. Female students who were taught Basic Electricity using the PSI model had a higher mean attitude score than male students, as shown by a post-test mean attitude score of 113.31 versus 101.94. This implies that gender affects student attitudes.
9. Students in urban schools who were taught Basic Electricity with PSI had a higher mean attitude score than their counterparts in rural schools, as evidenced in their post-test mean attitude score of 105.42 versus 101.40 with 20.79 and 15.27 means gain. This implies that there is an effect attributable to the school location on the students' attitude.
10. The main effect of treatment (PSI) on student achievement in Basic Electricity was highly statistically significant [$F_{(1,143)} = 17.937$, $P < .05$]. Therefore, hypothesis 1a was rejected. This indicates that the personalised system of instruction is an effective technique for intensifying classroom efficiency. In this respect, passive learners merit peculiar attention and therefore should be assisted to develop more active learning strategies. As applied to this study, one might interpret the mastery learning theory to suggest the existing conditions through which methods of teaching were handled in the classrooms, it is not accidental that the students taught using the PSI performed better academically than those who were taught using CLM.
11. There existed a statistically significant main effect of gender on technical college students' learning outcome in Basic Electricity [$F_{(1,143)} = 43.943$, $P < .05$]. This

means that male students performed significantly better than their female counterparts.

12. There existed a statistically significant main influence of school location on technical college students' learning outcome in Basic Electricity; [$F_{(1,143)}$ = 17.581, P < .05]. This means that urban students outperformed rural students.
13. On the achievement of technical college students in Basic Electricity, there was no statistically significant interaction effect of treatment (PSI) and gender. As a result, null hypothesis 4a is not rejected.
14. There is a statistically significant interaction effect of the personalised system of instruction and school location on technical college students' learning outcome in Basic Electricity, [$F_{(1,143)}$ = 4,191; P = .042] and the interaction is ordinal; showing that the interaction effect was stronger with students taught Basic Electricity using PSI. Therefore, hypothesis 5a is rejected. This indicated that PSI is a strong mechanism for rejuvenating the academic learning environment across school locations.
15. Gender and school location had no statistically significant interaction effect on technical college students' achievement in Basic Electricity [$F_{(1,143)}$ = .066, P-value is .798] which is greater than .05 alpha levels, hence, hypothesis 6a was not rejected.
16. On the achievement of technical college students, there was no significant interaction effect of the treatment (PSI), gender, or school location on Basic Electricity. Therefore, we do not reject null hypothesis 7a.
17. There is a statistically significant main effect of the personalised system of instruction model on the attitude of students toward Basic Electricity, [$F_{(1,143)}$ = 11.863, P < .05]. As a result, null hypothesis 1b was rejected. This indicates that the personalised system of instruction is an effective tool for improving the attitude of students towards learning a particular subject.
18. There was no statistically significant difference in gender-related post-test mean attitude scores among students, p-value = .197. This reflects that the

respondents do not differ in their attitude to Basic Electricity. As a result, null hypothesis 2b is not rejected.

19. There is no substantial effect of school location on technical college students' attitudes toward Basic Electricity. This suggests that the location of the school does not influence students' attitudes on Basic Electricity. As a result, null hypothesis 3b is not rejected.
20. There is no significant interaction effect of treatment and gender on technical college students' attitudes toward Basic Electricity; p-value = .452. This implies that the impact of the approach on students' attitudes is unaffected by gender. As a result, null hypothesis 4b is not rejected
21. The interaction effect of treatment and school location on technical college students' attitude to Basic Electricity is not significant; P-value = .339, which is greater than .05 alpha levels, hence, we do not reject null hypothesis 5b.
22. The interaction effect of gender and school location on technical college students' attitudes is not significant; P-value = .485, which is higher than .05 alpha levels. This means that gender and school location do not have a combined influence on the attitude of the student. Thus, null hypothesis 6b was not rejected.
23. There was no significant interaction effect of treatment, gender and school location on technical college students' attitude to Basic Electricity; P-value = .077, which is higher than the.05 alpha level. As a result, null hypothesis 7b was not rejected.

Summary based on theoretical framework

The learning theory embraced by this study is behaviourism theory, the social cognitive theory, and mastery learning theory as discussed in sections 2.7.1 to 2.7.4. Here learning is the acquisition of new behaviour through conditioning, here the PSI is based on upon the principle of active interaction of the learner with the environment, here in this study the subject matter is divided into units that have predetermined objectives or unit expectations where students alone or in groups, work through each unit in an organised fashion as revealed by the findings from this study.

The results of this study support Social Cognitive Theory of Bandura which posits that a part of an individual's knowledge acquisition is an outcome from the interactions between psychological and environmental factors working in a reciprocal manner (Denler, Wolter, & Benson, 2014). As applied to this study, one might interpret the theory to suggest that environmental factors, such as the instructional model (PSI) used in the classroom, to influence student learning and achievement because the instructional model is a form of environmental change that the theory postulates would "automatically lead to changes in the students' learning and behaviour. Continuing on this line of reasoning, it can is concluded that the statistically significant results found for some of the null hypotheses corroborate or to a large extent, support the claims of the theory.

In reviewing the results of the study, the effect size of the groups, as measured by the partial eta squared, ranged from .109 to .546, meaning that the PSI instructional model received by a student accounted for between 10.9% and 54.6% of their post-test achievement score. In the same vein, the effect size of the groups, as measured by the partial eta squared, ranged from .002 to .077, indicating that the PSI instructional model received by a student accounted for between 2 percent and 7.7 percent of their post-test attitude score. This increase in achievement is significant. The findings thus suggest that environment, or in this case instructional method used play a very substantial part in student achievement and change of attitude in the study. Along with these findings, this study supports Bandura's (1977) claim that personal factors, such as attitude and modes of thinking, and behavioral factors, such as academic skills and self-control practices, does impact student learning and achievement.

5.3 Conclusion

The findings of this study show that the personalised system of instruction technique has a substantial significant effect on student learning outcomes and attitudes toward Basic Electricity. The major goal of using the effective instructional approach is for students to succeed, acquire a positive attitude toward their subjects, and modify their behaviour. The present study asserted that the personalised system of instruction as a self-paced instructional method is more responsive to the teaching of Basic Electricity. To this end, passive learners need to be given or require special attention and should be assisted to cultivate a more active learning approach. Thus, teaching approaches that are rightly efficient in developing critical thinking skills and improving students' learning outcomes need to be employed. This is an indication that effective teaching and learning could be achieved when diverse student-centred, mind-on, hands-on and activity-based innovative teaching methods are employed, like the personalised system of instruction in this research.

Evidence from this study showed that the personalised system of instruction strategy made students more creative, act purposefully, think rationally and relate effectively with their peers in the Basic Electricity classroom. In this regard, the use of appropriate teaching methods for lessons delivery had a greater impact than the content covered in course of study. There is, therefore, a need for Basic Electricity teachers to expose the students to the teaching of concepts and principles of Basic Electricity using the personalised system of instruction. To this effect, teachers should determine in advance how best to present a given task. The quality of instruction can affect both learners' learning rate and achievement level. Thus, so far, the objective of enhancing the quality of students' achievement in Basic Electricity in technical colleges is concerned, the drastic change of the personalised system of instruction model of teaching Basic Electricity should, therefore, be at the helm of all the teachers teaching this subject in all the technical colleges. In all, the result revealed that the personalised system of instruction (PSI) is more effective than thebconventional lecture method (CLM); the finding revealed that those students that were taught using CLM had a lower mean score in their achievement. Therefore, the personalised system of instruction model should be embraced as a practicable, feasible and workable model for reinforcing the students' achievement and attitude toward Basic Electricity in technical colleges.

5.4 Implications of the Findings

In this study, the low performance of students in the control group was evidence of the latent deficiencies of the conventional lecture method as a means of improving learning in Basic Electricity. The application of the CLM teaching strategy is a common characteristic of regular Basic Electricity classes in Nigeria, and the low students' achievement is due to over-dependence on this method. The PSI's efficacy in this study was based on the fact that it improved student learning and stimulated students' levels and modes of thinking. The methods enabled learners to go at their own pace and be more active in organising the educational materials. It is a model that tries to teach the learner to gain knowledge, attitudes, and skills by engaging him in activities tailored to his abilities and requirements. With the least amount of supervision and guidance from the teacher, the method emphasises self-learning skills. Therefore, the findings of the study have implications for students, teachers, school administrators and researchers.

Students

Teaching strategies employed by the teacher can facilitate the students' understanding of Basic Electricity concepts. This study revealed that the PSI model of teaching helps raise student success and attitude to Basic Electricity and is also quite effective in improving their confidence judgements of their abilities to reach academic goals. Technical college students should cultivate a good attitude toward the learning of Basic Electricity. A student with a positive attitude can quickly boost his or her academic performance. When PSI was employed, students who had a negative attitude thought they would not be able to do well in Basic Electricity class. The findings have opened the possibility of using PSI to improve Basic Electricity learning. Students with a negative attitude about basic electricity may benefit from the findings.

When using the PSI strategy allows students to work at their own pace and learning can take place anywhere at any time. PSI fosters the development of critical thinking; recognising the need to improve Basic Electricity learning outcomes, technical college students should work hard to guarantee that the ability to excel in their studies inculcated in them. According to various studies that suggest that attitude influences academic progress, technical college students should be encouraged to acquire a positive attitude toward Basic Electricity.

Teachers

The findings from this research have shown that a specific learning approach did influence outcome domains of attitude and Basic Electricity achievement. In that wise, teachers are to determine which particular learning approach is more appropriate for several ability levels. Individual differences among students should be considered by Basic Electricity teachers. This required additional responsibility on the part of the teachers, as a result, the class interaction shifts away from telling, dictating, and drilling, which is seen to be less stimulating, and unsuitable to more activity-based, which are student-centred to enable students to be involved fully rather than merely listen to the teachers. Many studies reviewed in this study stressed that if the goal of instruction is to improve students' performance, it is desirable to improve the instructional strategy adopted in the classroom. Therefore, it becomes necessary to embrace the PSI model of teaching and include it in the curriculum of Basic Electricity. This will assist the subject teachers to work with low-achieving learners to improve their achievement.

In addition, it is suggested that Basic Electricity teachers should use moderately difficult tasks for struggling students so as not to frustrate their efforts. In cases where students fail a particular task, they should be made to realise that they failed because they did not follow the instructions, but not because they are weak, or maybe they did not spend enough time on the task or they did not adhere to the learning strategy. It is also suggested that seminars and workshops for Basic Electricity teachers be held regularly to profit more from different learning strategies.

School Administrators

Considerable efforts are required by teachers and school administrators before success can be achieved using the personalised system of instruction learning strategy. Much understanding is required from the administrator of the school to implement the PSI model. There is also the need to encourage and motivate the teachers to overcome the resistance of being transit from a traditional teacher-centred to a student-centred approach. Students should also be motivated and encourage staying focused when a method is being used. The administrator should try as much as possible to adapt the self-paced/mastery mode to academic calendars. Also, they should change their disposition not to value the model. School administrators should encourage the students to have a positive attitude toward Basic Electricity, and they should be informed that PSI will help them learn better and faster if they follow their teachers' recommendations.

Researchers:

Meta-analyses of PSI based learning strategy can be carried out with time. This will provide an empirical foundation for ascertaining the significance of learning methodology in terms of the magnitude of the effect sizes. This would serve as the basis for suggesting such learning methodologies for inclusion in school curricula and will also provide an avenue for technical/technology educators to ascertain the difficulties inherent in using such learning strategies.

5.5 Limitations of the study

This study was limited to four (4) state own technical colleges in Osun State, Nigeria. Two from the urban area and two from the rural area, only year two students of engineering and the related courses participated in the study.The study made use of the personalised system of instruction (PSI) teaching strategy crossed with the conventional lecture method of teaching. This study was also limited to students' gender and school location acting as moderator variables. Even though the findings of this study are unmistakable, broad generalisations about other curricular and geographic areas should be avoided. PSI is beneficial for teaching skills in other areas, however, this study only looked at content knowledge in Basic Electricity when compared to the conventional lecture class. Further studies investigate the distinction between PSI and other models in other subject areas.

Another limitation was that a comparatively few samples were used for the study, despite being done in state-owned technical colleges, which are public institutions, the class sizes were generally between 26 and 57 per school. The study also lacks randomisation, as the classes enlisted, were intact classes to ensure students' schedules are sustained. Finally, only a few females participated in this study (n = 33) because few females enrol in technical colleges in Nigeria particularly engineering related courses.

5.6 Suggestions for Further Studies

The study investigated the possible effect of the personalised system of instruction (PSI) model on technical college students' learning outcomes and attitudes toward Basic Electricity. It is suggested that replication of the study is needed with students from Federal Science and Technical Colleges. The study should be reproduced in technical and vocational schools for learning other courses. The impact of several variables on PSI, such as academic self-efficacy, personality traits, and motivation, should be investigated further. Other moderator variables, such as school types, mental ability, numerical ability, parents' socio-economic status, parental background, cognitive style, and many others, could be included in future research. Another suggestion is that replication can be conducted in other states so that comparisons can be made. This study also suggests that future studies should not just look at how PSI is used in Basic Electricity but incorporate the application of computer-assisted instruction into PSI teaching. This will give empirical evidence for determining their importance, as well as a benchmark for suggesting PSI for usage in technical and vocational school curricula.

5.7 Recommendations

Based on the outcomes of this investigation, the following recommendations were made:

1. Basic Electricity teachers should re-examine their classroom instructional practice to accommodate a change from teaching in a way that makes students passive listeners to teaching in a way that involves students actively in the learning process.

2. Technical teachers should also be exposed to different enhancement strategies that will assist them in taking care of individual differences among students in the classroom. This will help develop positive attitudes towards Basic Electricity have self-confidence and be more positively disposed towards obtaining good results in Basic Electricity.
3. PSI could also significantly influence the technical college students' attitude toward Basic Electricity. BE teachers have to be well-informed about the personalised system of instruction learning strategy before it can be implemented in the classrooms and therefore, should attend conferences, workshops and seminars regularly, where they would learn the requisite skills and knowledge to administer this model of teaching within and outside their classrooms.
4. If the PSI approach is to be adopted, the school system and programmes, such as school curriculum, timetable, and assessment orientation should be conditioned to facilitate mastery in the acquisition of life skills and other cognitive, affective and psychomotor learning outcomes.
5. There should be adequate provision of essential infrastructure required for efficient PSI implementation in teaching and learning Basic Electricity.
6. Educational agencies with the directive from the government should place a greater focus on the use of PSI teaching approaches by technical colleges teachers to teach Basic Electricity; and
7. Further research should be sponsored and published on the efficacies of PSI teaching strategy in improving students' academic achievement in Basic Electricity by the Nigerian Educational Research and Development Council (NERDC) and Technology Education Practitioners Association of Nigeria (TEPAN)

5.8 Contributions to Knowledge

Though various investigations on the effectiveness of the PSI model of instructional delivery have been conducted, the majority of these studies, to the best of the researcher's knowledge, have been conducted in western countries in subject areas like students' engagement, physical education, chemistry, mathematics, physics and vocational studies, using primary school, senior secondary schools or higher institutions students. This study is unique in the sense that the study's sample consists of technical college students. Based on the findings, these strategies could be used to improve the teaching and learning of Basic Electricity.

Finally, the research has demonstrated the effectiveness of a personalised system of instruction (PSI) learning strategies as means of improving students' learning outcome in Basic Electricity and attitude. The strategies employed have proved that when low achieving students are equipped with appropriate teaching strategies, coupled with enough time for learning, their academic achievement could be improved.

REFERENCES

Abamba, E.I. (2021). The effects of school location on students' academic achievement in senior secondary physics based on the 5E learning cycle in Delta State, Nigeria. *LUMAT International Journal on Mathematics, Science and Technology Education*. 9(1), 56-76. https://doi.org/10.31129/

Abd-allateef, A. (2011). *The impact of PSI method and the use of Multiple Devices on the learning of Football skills among the Secondary Stage Students*. Thesis, Zaqazek University, Egypt

Abdullahi, A. (2010). Laboratory Instruction and Safety in Science Teaching. *Journal of Science Teachers Association of Nigeria,* 8(1), 17-22.

AbdulRaheem, B.O. (2017). The Influence of Gender on Secondary School Students' Academic Performance in South-West, Nigeria. 31(1), 93-98. Retrieved November 7, 2019, from https://doi.org/10.1080/09718923.2012.11893018

Ackermn, P., & Heggestad, E. (2017). Intelligence, personality, and interests: evidence for overlapping traits. *Psychological Bulletin.* 121, 219–245.

Adebanjo, A.A. & Otiegede, S.O. (2020). Assessment of male and female students attitudetowards mathematics in selected public and private schools in Eti-Osa, Lagos. *SapientiaFoundation Journal of Education, Sciences and Gender Studies*, 2(3), 201-210.

Adebule, S.O. (2016). Self-Assessment in mathematics as a correlate of performance of students in junior secondary school basic science in Ondo State, Nigeria. *European Journal of Education Studies,* 2(10), 35-42. Retrieved January 28, 2020, from www.oapub.org/edu

Adebule, S.O. & Adebule, H.T. (2014). Self-Assessment of secondary school performance in south-west Nigeria, *International Journal of Educational Research and Technology (IJERT*), 5(1), 5-11. Retrieved September 13, 2019, from http://soeagra.com/ijert/ ijertmarch2018/2.pdf

Adegbola, F.F. (2019). Teachers' pedagogical competence as determinants of students' attitude towards basic science in South-West Nigeria. *Educational Research and Reviews,* 14(18), 655-660. Retrieved June 20, 2020, from http://www.academic journal.org/ERR

Adeniji, S.M., Ameen, S.K., Dambatta, B.U., & Orilonise, R. (2018). Effect of MasteryLearning Approach on Senior School Students' Academic Performance and Retention in CircleGeometry. *International Journal of Instruction*, 11(4), 951-962.https://doi.org/10.12973/iji.2018.11460a

Adeniyi, C.O. (2019). Effectiveness of personalized system of instruction on students' retention ability in mathematics in Kwara state, Nigeria. Retrieved January 12, 2022, from https://www.researchgate.net/publication/335188946_Effectiveness _of_personalized_system_of_instruction_on_students%27_retention_ability_in_ mathematics_in_Kwara_state_Nigeria

Adepoju, T.L., & Oluchukwu, E.E. (2011). A study of secondary school students' academic performance at the senior school certificate examinations and implications for educational planning and policy in Nigeria. *African Research Review;* 5(6): 314-333.http://dx.doi.org/10.4314/afrrev.v5i6.26

Adetula C.A., & Salman, M.F. (2017). Effects of Mathematical Language on errors committed by Senior School Students in Bearing Problems in Omuo-Ekiti, Nigeria, ABACUS, *Journal of Mathematical Association of Nigeria. 39, Mathematical EducationSeries*

Adesina, A.D.O. (2013). Assessment of the social studies curriculum of secondary school in Southern Nigeria. *International Educational Journal Research,* 4 (4), 345 – 351.

Adesogun, B.T., Adekunle, B.D., & Adu, O.E (2016). School location and gender as correlates of students' academic achievement in economics. *International Journal of Education Science*. 13(3): 255-261. *Faculty of Education, University of Fort Hare, South Africa.*

Adeyemi, B.A. & Ajibade, Y.A. (2011). The Comparative Effects of Simulation Games & Brainstorming Instructional Strategies. *African Journals Online* 5(3), 64-80.

Adigun, J., Onihunwa, J., Irunokhai, E., Sada, Y., & Adesina, O. (2015). Effect of gender on students' academic performance in computer studies in secondary schools in New Bussa, Borgu Local Government of Niger State. *Journal of Education and Practice*. 6(33) 1-7. Retrieved June 20, 2020, from https://files.eric.ed.gov/fulltext/ EJ1083613.pdf

Aduloju, M., Adikwu, O. & Agi, C. (2016). School-Based Assessment: Implication for National Development. *Open Access Library Journal*, 3, 1-8. http://doi: 10.4236/oalib.1102392. Retrieved September 10, 2019, from https://www.scirp .org/journal/paperinformation.aspx?paperid=69079

Agbaje, R.O., & Alake, E.M., (2014). Students' variables as a predictor of secondary school students' academic achievement in science subjects. *International Journal of Scientific and Research Publications*, 4(9), 1-5. Retrieved September 17, 2019, from http://www.ijsrp.org/research-paper-0914/ijsrp-p3375.pdf.

Agbaje, R.O., & Awodun, A.O. (2014). Impact of school location on academic achievement of science students in senior secondary school certificate examination. *International Journal of Scientific and Research Publications*, 4(9), 1-4. Retrieved September 17, 2019, from https://www.academia.edu/8702791/In

Agbara, W., Chagbe M.B. & Achi, T.T. (2018). Challenges of women in technical and vocational education: A case study of federal college of education (technical), Gusau. *International Journal of Vocational and Technical Education, 10*(1), 7-13, Retrieved November 26, 2018 from www.academicjournals.org/journal/IJVTE/ how-to-cite.../ B0B219F55719

Agbetoye, S.J., Aleburu, J.O., Olugbaike, J.K., & Ogunjimi, A.D. (2015). Effects of students' gender, school environment, and teachers on the students' learning outcomes in basic technology in secondary schools in Lagos State in Nigeria. *International Journal of Contemporary Issues in Education*, 55–62.

Agustinaningsih, W. (2019). Personalized learning modelling for the control of student creativity in physics learning media. *Proceedings of the International Conference on Learning Innovation 2019* (ICLI 2019) Atlantis Press SARL, Antasari State Islamic University, Banjarmasin, South Kalimantan, Indonesia*. Ret*rieved January 26th, 2022, from http://creativecommons.org/licenses/by-nc/4.0/.

Aina, J.K. (2013). Gender analysis of students' academic performance in Physics Practical in Colleges of Education in Nigeria. *Advances in Arts, Social Sciences and Education Research.* 3(5), 447-452. Retrieved December 12, 2019, from https://www.ejournal.sedinst.com

Aiyedun, T.G. (2020). Effect of animation teaching strategy on secondary school students' achievement, retention and interest in climate change in Lokoja, Kogi State. *International Journal of Trend inScientific Research and Development* (IJTSRD), 4 (3), 944-949. https://www.ijtsrd.com/papers/ijtsrd30740.pdf

Ajemba, H.E., Ahmed, F.M., Ogunode, N.J., & Olatunde-Aiyedun, T.G. (2021). Problems facing science teachers in public secondary schools in Nigeria and way forward. *International Journal of Discoveries and Innovations in Applied Sciences*. 1(5), 118-129.www.openaccessjournals.eu

Akinbobola, A.O. (2010) "Enhancing Students' Attitude Towards Nigerian Senior Secondary School PhysicsThrough the Use of Cooperative, Competitive and Individualistic Learning Strategies," *Australian Journal of Teacher Education*: 34(1),1-9.Retrieved December 14, 2020, from http://ro.ecu.edu.au/ajte/vol34/iss1/1

Akinsola, M.K. & Awofala, A.O.A., (2009). Effect of personalization of instruction on students' achievement and self-efficacy in mathematics word problems, *International Journal of Mathematical Education in Science and Technology*, 40(3), 389-404, http://doi:10.1080/00207390802643169

Akinsola, M.K. (1999). *Comparative Effects of Mastery Learning and Enhanced Mastery Learning Strategies on Students' Achievement and self-concept in Mathematics.* Unpublished PhD Thesis, University of Ibadan.

Akissani, I., Muntari, I. & Ahmed, M. (2019). Mathematics achievement of senior secondary school students in Katsina educational zone,Katsina State, Nigeria. *Abacus (Mathematics Education Series)*. 44(1), 410-420. Retrieved August 18, 2021 from https:/man-nigeria.org.ng/ issues/ABA-EDU-2019-48.pdf

Alalwneh, K.M.N. & Alomari, M.F. (2018). The impact of a personalized system of instruction (PSI) on the achievement of the students in vocational courses. *International Journal of Education and Research, 6*(8), 81-92. Retrieved November 10, 2018, from https://www.ijern.com/journal/2018/August-2018/07.pdf.2/09/2018

Alemu, B.M., & Feyssa, T. (2020). The relationship between test anxiety and academic achievement of grade ten students of Shirka Woreda, Oromia Regional State, Ethiopia. *African Educational Research Journal*, 8(3), 540-550, http://doi:10.30918/ AERJ.83.20.097. Retrieved January 24, 2022, from https://files.eric.ed.gov/fulltext/ EJ1274398.pdf

Alexandre, J. & Enslin, C. (2017). The relationship between personalized instruction, academic achievement, knowledge application and problem-solving skills. *National Teacher Education Journal,* 10(1), 5-15

Alieme, S.O. (2014). *Effects of a personalised system of instruction and direct instruction on primary five pupils' self-efficacy and achievement in mathematics in Oyo state*.Unpublished PhD Thesis Institute of Education, University of Ibadan, Ibadan, Nigeria.

Ali, S. (2013). Factors affecting academic achievement of students. *American Journal of Educational Research,* 20131 (8), 283-289.

Allen, C. (2015). *Personalised system of instruction and student performance in high school weight training courses*: A dissertation presented in partial fulfilment of the requirements for the degree Doctor of Education. Liberty University.

Al-Mawajdeh, B. (2004). *Comparing the impact of PSI (Keller's Plan) and Cooperative learning on the Achievement of 7th-grade students in the subject of Islamic Education in Jordan*. Thesis, Mutah University, Kerak.

Alokan, F.B. (2010). Influence of Sex and Location on Relationship between student problems and Academic Performance. *The Social Sciences (TSS*), 5(4), 340-345.

Alordiah, C.O., Akpadaka, G., & Oviogbodu, C.O. (2015). The influence of gender, school location and Socio-Economic Status on students' academic achievement in Mathematics. *Journal of Education and Practice*. 6(17), 130-136. Retrieved August 2, 2019, from https://files.eric.ed.gov/fulltext/EJ1079759.pdf

Al-Otaibi, K. (2015). Modelling the Causal Relationship between Self-Directed Learning Skills, Learning Styles, and Academic Achievement among the students of Community Colleges at King Saud University*. Jordanian Journal of Educational Research*, 11(3), 255-268.

Alsheenqeeti, H. (2014). *Interviewing as a data collection method*: *A critical review*. English Linguistics Research, 3(1), 39-45:doi:10.5430/elr.v3n1p39. Retrieved December 14, 2018, from https://www.sciedu.ca/journal/index.php/elr/article/ view/4081/260

Al-Zaboun, M., Al-Mawadiah, R., Al-Mawajdeh, M., & Al-Mawajdeh, B. (2016). The Impact of PSI Method and (Jigsaw 2) Method on the Achievement of the students in the "Principles of Education" Course at Zarqa University*. The Arab Journal for the Quality of Higher Education*, 9(23), 101-117.

Amadalo, M.M., Ocholla, A.A., & Sakwa, T.W. (2016). Physics practical work and its influence on students' academic achievement. *Journal of Education and Practice, 7*(28), 129-134.

Amadike, N.O. (2007). *The use of computers in teaching and learning basic electricity in technical schools in Nigeria.* Owerri: Carrier Publishers Ltd.

Amaechi, O.J, & Thomas, C.G. (2016). Strategies of effective teaching and learning Practical skills in technical and vocational training programmes in Nigeria. *International Journal of Scientific Research Engineering & Technology (IJSRET), 5*(12), 598-603.

Amao, S.R., Adewuyi, A.S., Gbadamosi, J., Salami, T.B. & Ogunjinmi, O.O. (2016). Gender bias and achievement in agricultural science among public and private secondary school students in Oyo-west local government area of Oyo-state, Nigeria.*International Journal of the Guild of Contemporary Academic Researchers (IJGCAR),* 2(1), 102–108. Retrieved October 15, 2019, from https://www.researchgate.net/publication/303390001

Amatobi, V. E., Amatobi, D. A. (2020). The influences of gender and attitude differences to students' achievement in mathematics in Nigerian secondary schools: a case study of comprehensive secondary school Amurie-Omanze in South-Eastern Nigeria. *American Journal of Research Communication. 8(2): 1-8*. Retrieved January 17, 2022, from www.usa-journals.com, ISSN: 2325-4076.

Amusat, S.A., & Awoyemi, R.O. (2006). Influence of gender difference on students' level of achievement in chemistry in Osun State secondary schools. *Oro Science Education Journal.* 4 (5&6), 199-202.

Anderson, J.R. (2000). *Learning and memory: An Integrated approach (2nd ed.)*. New York: John Wiley and Sons, Inc.

Anikweze, C.M. (2011). Assessment of Teachers' Professional Skills in Nigeria: Needed Reforms. *Nigerian Journal of Educational Research and Evaluation,* 10, 57-68.

Anikweze, C.M. (2013). *Measurement and evaluation for teacher education (*3rd edition). Ibadan: Constellation (Nig) Publishers.

Anonymous, (2016). *Students' performance in rural and urban areas education essay. [Online].* Retrieved October 28, 2019, from http://www.ukessays.com/essays /education/students-performance-in-rural-and-urban-areas-education-essay.php# ixzz3heqL5Q9W.

Antwi, S.K., & Hamza, K. (2015). Qualitative and quantitative research paradigms in business research: A philosophical reflection*. European Journal of Business and Management, 7*(3), 217-225.Retrieved January 13, 2019, from www.iiste.org.

Apata, F.S. (2011). *Assessment of Students' Numerical Proficiency in Solving Physics Problems in Senior Secondary Schools in Kwara State*. Unpublished PhD. Thesis, University of Ilorin, Ilorin.

Atovigba M.V., Vershima, A.M., O'Kwu, E.I. & Ijenkeli, E., (2012). Gender trends in Nigerian secondary school students' performance in algebra. *Research Journal of Mathematics and Statistics*, 4(2):42-44.

Atsumbe, B., Owodunni, S., Raymond, E. & Uduafemhe, M. (2018). Students' achievement in basic electronics: effects of scaffolding and collaborative instructional approaches. *EURASIA Journal of Mathematics, Science and Technology Education, 14(8),* 1-17. https://doi.org/10.29333/ejmste/91898.

Atsumbe, B.N., Raymond, E. & Ajuwon, J. (2015). Effects of animation on students' academic achievement and retention in basic electricity at the technical college level in Benue State, Nigeria. *Institute for Science and Technology Education (ISTE).* Retrieved April 24, 2019, from http://uir.unisa.ac.za/bitstream/handle /10500/22407/

Attah, R.F., ITA, P.M., Nchor, E.E. (2018). Effect of students' attitude on academic achievement in the English language in senior secondary schools in Calabar metropolis, cross river state, Nigeria. *International Journal of Academic Research and Development.* 3(4), 164-167. www.academicsjournal.com

Awofala, A.O.A & Nneji, L.M. (2011). Effect of Framing and Team Assisted Individualized Instructional Strategies on Students' Achievement in Mathematics. *African Journal for the Study of Educational*. 4(3, 4), 75-89.

Ayodele, C.S & Adebiyi, D.R (2013). Study habits as influence of academic performance of university undergraduates in Nigeria. *Research Journal in Organizational Psychology and Educational Studies.* 2(3) 72-75. Emerging Academy Resources Retrieved January 12, 2019, from www.emergingresource.org

Ayonmike, C.S. (2014). *Comparative effectiveness of three teaching methods on students' psychomotor performance in brick/block-laying and concreting in Delta State technical colleges.* Unpublished PhD Dissertation. Department of Vocational Education, Nnamdi Azikiwe University, Awka.

Azukas, M.E. (2019). Cultivating a blended community of practice to promote personalized learning. *Journal of Online Learning Research*. 5(3), 275-310. Retrieved October 12, 2021, fromhttps://files.eric.ed.gov/fulltext/EJ1241727.pdf

Babagana, A.M & Medugu, J.D. (2012). Effects of instructional model on the achievement of basic electricity students in Borno State technical colleges. *Journal of Science, Technology and Education*, 1(2), 17-22.

Babbie E, (2011). *The Basics of Social Research, Fifth Edition*. USA, Belmont, CA 94002-3098. Wadsworth Cengage Learning**.**

Badru, A. (2016). Problem-Based instructional strategies and numerical ability as determinants of senior secondary achievement in mathematics. *Journal of Education and Practice,* 7(13), 89-95. Retrieved October 11, 2018, from https://files.eric.edu.gov/ ?id=EJ1102799.

Baidoo-Anu, D., Abiaw, P., & Kaedebi-Donkor, R. (2019). Parenting Styles as a Predictor of Academic Achievement of Junior High School Students in Aowin and Suaman District, Ghana. *Journal of Education and Practice*. 10(19), 47-61. http://doi: 10.7176/JEP/10-19-0

Bamiro, A.O. (2015). Effects of guided discovery and think-pair-share strategies on secondary school students' achievement in chemistry. SAGE Open, January-March 2015 (1–7). Retrieved February 2, 2020, from http://journals.sagepub.com.

Bandura, A. (1977). *Principles of behaviour modification*. New York: Holt, Rinehart and Winston.

Bandura, A. (1986). *Social Foundations of Thought and Action: A Social Cognitive Theory.* Prentice Hall Inc.

Bandura, A. (2001). *Social cognitive theory: An agentic perspective. Annual Review of Psychology,* 52, 1–26. https://doi.org/10.1146/annurev.psych.52.1.1.

Bashir, M. (2018). Adequacy and utilization of instructional materials for teaching electrical installation and maintenance work trade in Adamawa State technical colleges. *ATBU, Journal of Science, Technology & Education (JOSTE), 6*(2), 226-233.Retrieved April 24, 2019, from: www.atbuftejoste.com

Baum, W.M. (2005). *Understanding behaviourism*. *Behaviour, culture and evaluation.* Malden, MA: Blackwell publishing

Bautista, R.G. (2012). The effects of personalized instruction on the academic achievement of students in physics. *International Journal of Arts & Sciences,* 5(5):573-583.

Bell, S.H. (2008). *Quasi-Experimental Methods.* Retrieved October 30, 2018, from http://www.urban.org/toolkit/data-methods/quasiexperimental.cfm?renderforprint=1.

Berweger, B., Born, S., & Dietrich, J. (2021). Expectancy-value appraisals and achievement emotions in an online learning environment: within-and between-person relationships. *Learn. Instr*.77:101546. doi:10.1016/j.learninstruc.2021.101546

Bhargava, A. & Pathy, M. (2014). Attitude of student's teachers towards teaching profession. *Turkish Online Journal of Distance Education, 15*(3), 27-36.

Bhattacharyya, S., Kaur, R., Kaur, S., & Ali, S.A. (2017). Validity and reliability of a questionnaire: A literature review. *Chronicles of Dental Research, 6*(2), 16-32. Retrieved January 1, 2019, from http://cdronline.org/college/wp.content.

Bingham, A.J., Pane, J.F., Steiner, E.D., & Hamilton, L.S. (2018). Ahead of the Curve: Implementation Challenges in Personalized Learning School Models. Educational Policy 2018, 32(3), 454-489. https://sagepub.com/journalsPermissions.nav. doi: 10.1177/0895904816637688

Birnie, B.F. (2015). Making the Case for Differentiation. Clearing House: *A Journal of Educational Strategies, Issues and Ideas*, 88(2), 62–65. https://doi.org/10.1080/00098655.2014.998601

Block, J.H. (1971). Introduction to mastery learning: Theory and practice. In J. H. Block (Ed), *Mastery learning: Theory and practice*. New York: Holt, Rinehart, & Winston, 2-12.

Bloom, B.S. (1971). Mastery learning. In J.H. Block (Ed), *Mastery Learning*. *Theory and Practice.* New York, NY: Holt, Rinehart & Watson, 47-63.

Bloom, B.S. (1976). *Human characteristics and school learning*. New York: McGraw-Hill.

Bolarinwa, O.A. (2015). Principles and methods of validity and reliability testing of questionnaire used in social and health science research. *Nigeria Postgraduate Medical Journal, 22*(4), 195-201. Retrieved from http:// www. npmj.org/text

Brannen, J. (2016). *Mixing methods: Quantitative and qualitative research.* New York. Routledge, Taylor and Francis Group, 1-57.

Breakwell, M.G. (2012). Gender, parental and peer influences upon Science Attitudes and Activities. *Publish Understanding of Science* 1(2), 1-14.

Brendon, R.B. (2019). Quasi-experimental designs in applied behavioural health research. In S. Laher, A. Fynn & S. Kramer (Eds.), *Transforming Research Methods in the Social Sciences.* Case Studies from South Africa. South Africa: Wits University Press, 85-89.

Butler, R.C., Kohlert, J.G., McElrath, V.E., Wolfe, K.L. & Gross, G.G. (2015). Modified Personalized System of Instruction vs Traditional Lecture Method of Instruction Using a Within Design at a Small Liberal Arts College Psychology Research, 5(5), 317-326, doi:10.17265/2159-5542/2015.05.006

Carmo, J. dos Santos & Médici, A.D. (2018). Personalized System of Instruction (PSI) and Lesson Study (LS): A comparative analysis of two successful teaching methods. Science and Knowledge in Focus, 5-15, doi:10.18468/sc.knowl.focus.2018v1n1.p05-18

Carnine, D. (2000). *Why education experts resist effective practices (and what it would take to make education more like medicine).* Thomas B. Fordham Foundation website. Retrieved November 12, 2002 from: www.edexcellence. net/ library /carnine.html

Carroll, J.B. (1963). A model of school learning. *Teachers College Record, 64*, 723-733.

Chemeli, J. (2019). Impact of the five key formative assessment strategies on learner's achievement in mathematics instruction in secondary schools: A case of Nandi County, Kenya. *International Academic Journal of Social Sciences and Education*, 2(1), 212-229.

Chianson, L. (2014). Teachers' variables and learning environment, In F. B. Murray (Ed), the teacher educator's handbook: Burcaly a knowledge-based preparation of teachers (2nded) 261-276) San Francisco: Jossey-Bass.

Ciampa, K. (2014). Learning in a mobile age: An investigation of student motivation. *Journal of Computer Assisted Learning,* 30(1), 82-96. doi:10.1111/jcal.12036

Clark, John-Patrick, G. (2017). "*Engagement's mediation of the relationship between personalized learning and achievement*". Dissertations Western Kentucky

University Bowling Green, Kentucky. Paper 131, 1-129. Retrieved November 20, 2018, from https:// digitalcommons.wku.edu/diss/131

Clark, R.C., & Mayer, R.E. (2011). *E-Learning and the science of instruction: Proven guidelines for consumers and designers of multimedia learning* (3rd ed.). San Francisco, CA: John Wiley & Sons.

Clarke, P. (2017). *'Making use of assessments for creating stronger education systems and improving teaching and learning'.* Paper commissioned for the 2017/18 Global Education Monitoring Report, Accountability in education: Meeting our commitments. Paris: UNESCO. 1-42. ED/GEMR/MRT/2017/P1/6

Costa, M.B.C. (2014). Science and mathematics instructional strategies, teaching performance and academic achievement in selected secondary schools in Upland Cavite. *Master of Arts (Edu) thesis submitted to the graduate school Cavite state University.* Retrieved July 10, 2019, from http://www.academia.edu/8730794/ science_and_mathematics_instructional_strategies.

Coy, M.J. (2019). Research Methodologies: Increasing Understanding ofthe World. International *Journal of Scientific and Research Publications,* 9(1), 71-77. doi:10.29322/IJSRP.9.01.2019.p8511

Creswell, J.W. (2014). *Research Design: Qualitative, Quantitative and Mixed Methods Approaches*. (4th edition). California, SAGE Publication, Inc.

Çullhaj, S. (2017). Key features of personalized learning. *European Journal of Multidisciplinary Studies*. 2 (7):130-132.

Daluba, N.E., (2013). Effect of demonstration method of teaching on students' achievement in Agricultural Science. *World Journal of Education*. 3(6), 1-7. Retrieved August 15, 2018, from www.sciedu.ca/wje. doi:10.5430/wje.v3n6p1

Dania, P.O. (2014). Effect of gender on students' academic achievement in secondary school Social Studies. *Journal of Education and Practice.* 5(21), 78-85. Retrieved April 13, 2020, from http://citeseerx.ist.psu.edu/viewdoc/download? doi:10.1.1. 858.9719

Darling-Hammonda, L., Flooka, L., Cook-Harveya, C., Barronb, B., & Osher D. (2020). Implications for educational practice of the science of learning and development. Applied Developmental Science, 24(2), 97-140. https://doi.org/10.1080/10888691.2018.1537791

Davidescu, E. (2018). Tehnici de formare a deprinderilor de studiu individual prin învăţare personalizată. Didactica Pro ...18, 7-11.

Davis, D., & Sorrell, J. (1995). Mastery learning in public schools. Educational Psychology Interactive. Valdosta, GA: Valdosta State University. Retrieved May 15, 2019, from http://www.edpsycinteractive.org/files/mastlear.html

Dema, K., & Tshering, (2020). The effects of active learning approach in teaching and learning science: A case of one of the primary schools in Bhutan. *International Research Journalfor Qualityin Education.* 7(1), 1-7

Denler, H., Wolters, C., & Benzon, M. (2014). *Social cognitive theory*. Retrieved May 15, 2019, from http://www.education.com/reference/article/social-cognitive-theory/

Devinder, S. & Zaitun, A.B. (2006). Mobile learning in wireless classrooms, *Malaysian Online Journal of Instructional Technology (MOJIT),* 3(2), 26-42.

Dinga J.N., Mwaura, A.M., & Ng'ang'a, M.W. (2018). Relationship between achievement goal orientation and academic achievement among form three students in Kiambu County, Kenya. *International Journal of Education and Research,* 6(4): 53-68.

Diraso, D.K., Baba, M.R., Ibrahim, A.H. & Musa, J.D. (2019). Effect of Computer-Assisted Instructional Package on Teaching Lathe Machining Operations at Technical Colleges in Yobe State, Nigeria. *ATBU, Journal of Science, Technology & Education (JOSTE); 7(1), 51-62.*

Dorgu, T.E., (2015). Different teaching methods: a panacea for effective curriculum implementation in the classroom*. International Journal of Secondary Education. 3(6-1),* 77-87. https://doi.org/10.11648/j.ijsedu.s.2015030601.13

Education Resource Centre (ERC) (2010). *Exams & Record Office Report*: Deputy Director of Exams & Evaluation, Maiduguri, Borno State.

Eguabor, B., & Adeleke, A.M. (2017). Investigating differential learning outcomes of students in physics using animation and textual information teaching strategies in Ondo State secondary school. *European Journal of Sustainable Development Research*, *1*(2), 10. doi:10.20897/ejosdr.201710

Ekon, E.E., Ekwueme, C.O & Meremikwu, A., (2014). Effect of five phases of constructivist instructional model (cim) on junior secondary school two (JSS 2) students' cognitive achievement and interest in basic science and mathematics in Cross River State of Nigeria. Education, 4, (3): 74-77.

Ekwueme, C.O. (2013) *Mathematics teaching and learning in schools.* Calabar, Radiant Ventures Nig. Ltd.

Ellah, K.E., & Ita, P.M. (2017). Correlational relationship between school location and students' academic performance in English Language in Nigerian Secondary Schools. *International Journal of Scientific and Research Publications*, 7(9), 381-

384. Retrieved April 24, 2019, from http://www.ijsrp.org/research-paper-0917/ijsrp-p6946.pdf

Emaikwu, S.O. (2012). Assessing the effect of prompt feedback as a motivational strategy on students' achievement in secondary school mathematics. *Journal of Educational Research*, *3(4)*, 371-379.

Eraikhuemen, O.O. (2014). Influence of teaching facilities on academic achievement of students in secondary schools. *Electric Journal of Research in Educational Technology. 18*(8), 40-54

Essays, U.K. (November 2018). The Sensory Stimulation Theory Education Essay. Retrieved April 24, 2019, from https://www.ukessays.com/essays/education/the-sensory-stimulation-theory-education-essay.php?vref=1

Essien, E.E. (2017). Influence of school location on students' academic achievement in social studies in colleges of education in Cross River State, Nigeria.*Journal of Research in Science and Technology. 7(2), 72-87. Retrieved February 8, 2022, from*https://www.researchgate.net/publication/337146105

Eyre, H. (2007). Keller's Personalized System of Instruction: Was it a Fleeting Fancy or is there a Revival on the Horizon? *The Behaviour Analyst Today*, *8*(3), 317-329.https://doi.org/10.1037/h0100623

Eze, T.I., Obidile, J.I., Akamobi, O.G. (2019). Relative effectiveness of constructivism and meta-Learning teaching methods on male and female students' academic achievement and retention in basic electricity in technical colleges. *Journal of Education and Practice* 10(33): 58- 64.

Eze, T.I., Ezenwafor, J.I. & Molokwu, L.I. (2015). Effect of meta-learning teaching method on the academic performance of building trades students in technical colleges in South-east Nigeria. *International Journal of Vocational and Technical Education*, 7(10): 101-108. https://doi. org/10. 5897/IJVTE2015. %200189

Eze, T.I., Nwalo, C.N. & Udu, D.A. (2021). Comparative analysis of project and demonstration teaching methods in improving students' academic achievement in basic electricity in technical colleges. *Asian Journal of Interdisciplinary Research*, 4(2), 34-45.https://doi.org/10.34256/ajir2124

Eze, T.L. & Osuyi, S.O. (2018), "Effect of problem-based teaching method on students' academic performance in electrical installation and maintenance works in technical colleges in Edo state", *International Journal of Development and Sustainability*, (7)2, 666-678. Retrieved April 24, 2019, from *www.isdsnet.com/ijds*

Ezechi, N.G. & Ogbu, C.C. (2017). Science Education in Nigeria: Challenges and the Way Forward. *International Journal of Progressive and Alternative Education,* 4 (1), 2-11. Retrieved June 20, 2020 from https://www.globalacademicgroup.com/journals/asproaedu/SCIENCE%20EDUCATION%20IN%20NIGERIA.pdf

Ezeh, D.N. (2013). *Science without women: a paradox.* 75th Inaugural Lecture of the University of Nigeria, Nsukka delivered on 30th May, 2013. Nsukka: University of Nigeria Senate Ceremonials Committee.

Ezeudu, F., & Obi, T. (2013). Effect of gender and location on students' achievement in chemistry in secondary schools in Nsukka local government area of Enugu state, Nigeria. *Research on Humanities and Social Sciences, 3*(15), 50-55.

Faisal, R., Shinwari, L., & Mateen, H. (2016). Evaluation of the academic achievement of rural versus urban undergraduate medical students in pharmacology examinations. *Asian Pacific Journal of Reproduction*, 5(4), 317-320. http://dx.doi.org/10.1016/j.apjr.2016.06.002

Faremi, Y.A. (2014). Assessment of teaching strategies adopted for effective implementation of science subjects and trade modules curriculum in Nigerian technical colleges. *Journal of Educational and Social Research MCSER publishing, Romeo-Italy,* 4(6), 391-396.

Farhah, I., Saleh, A.Y., & Safitri, S. (2021). The role of student-teacher relationship to teacher subjectivewell-being as moderated by teaching experience. *Journal of Education and Learning (EduLearn)*. 15(2), 267-274. doi: 10.11591/edulearn.v15i2.18330

Federal Ministry of Education (2006). *The national master plan for technical and vocational education (TVE) development* in Nigeria the 21st century. Abuja: FME.

Federal Government of Nigeria (FRN) (2013). *National policy on education,* (6thed) Lagos: Nigerian Educational Research and Development Council (NEDRC).

Fox, E.J. (2013). Keller's personalized system of instruction. In J. Hattie & E.M. Anderman (Eds.), *International guide to student achievement,* pp. 359–361. Routledge. http://public.ebookcentral.proquest.com/choice/publicfullrecord.aspx?p=1114642

Friskawati, G.F., Ilmawati, H. & Suherman, A. (2017). Effect of personalized system for instructions (PSI) on physical fitness of senior high school nursing's student**.***1st Annual Applied Science and Engineering Conference*. IOP Conference. 2-6 doi:10.1088/1757-899X/180/1/012262

Ganai, M.Y. & Muhammad, A.M. (2013). Comparative study on adjustment and academic performance of college students. *Journal of Educational Research and Essays* 1(1), 5-8.

Gaheen, M.A., Ewees, A.A. & Eisa, M. (2021). Automated students Arabic essay scoring using trained neutral network by e-jaya optimization to support personalized system of instruction. Springer*, Educational and Information Technologies* 26(1):1165–1181. https://doi.org/10.1007/s10639-020-10300-6

Garbanzo, G.M. (2017). Factores asociados al rendimiento académico en estudiantes universitarios, una reflexión desde la calidad de la educación superior pública. *Revista educación*, 31(1), 43-63.

Gardner, H. (2011). Promoting learner engagement using multiple intelligences and choice-based instruction. *Adult Basic Education and Literacy Journal,* 5(2), 97–102. Retrieved August 8. 2019, from http://eric.ed.gov/?id=EJ936698

Garner, J., Denny, P. & Luxton-Reilly, A. (2019). Mastery Learning in Computer Science Education. In Twenty-First Australasian Computing Education Conference (ACE'19), January 29–31, 2019, Sydney, NSW, Australia. ACM, New York, NY, USA. https://doi.org/10.1145/3286960.3286965

Ginanjar, A. (2019). The effects of personalized system for instruction learning model on vocational school students' motivation. *Jurnal Pendidikan Jasmani dan Olahraga*, 4(1), 32-36. Retrieved April 12, 2020, from: *http://ejournal.upi.edu /index.php/ penjas/index*

Giridharan, K. & Raju, R. (2016). Impact of teaching strategies: demonstration and lecture strategies and impact of teacher effect on academic achievement in engineering education. *International Journal of Education and Science*, 14(3):174-186.

Goni, U., Yagana Wali, S.B., Ali, H.K. & Bularafa, M.W. (2015). Gender Difference in Students' Academic Performance in Colleges of Education in Borno State, Nigeria: Implications for Counselling. *Journal of Education and Practice,* 6(32):107-114. Retrieved January 20, 2022, from https://files.eric.ed.gov/fulltext/EJ1083483.pdf

Grant, L.K. &Spencer, R.E. (2003). The Personalized System of Instruction: Review and applications to distance education. *International Review of Research in Open and Distance Learning, 4(2), 1-17.*https://doi.org/10.19173/irrodl.v4i2.152

Guskey, T.R. (2010). Closing achievement gaps: Revisiting Benjamin S. Bloom's learning for mastery'. *Journal of Advanced Academics,* 19(1), 8–31

Guskey, T.R., & Gates, S.L. (1986). Synthesis of research on the effects of mastery learning in elementary and secondary classrooms. *Educational Leadership,* 43(8), 73-80.

Gutmann, B., Gladding, G., Lundsgaard, M., & Stelzer, T. (2018). Mastery-style homework exercises in introductory physics courses: Implementation matters. *Physical Review Physics Education Research. Urbana, Illinois 61801, USA.*

Department of Physics, University of Illinois at Urbana Champaign, 14, 1-12. doi: 10.1103/PhysRevPhysEducRes.14.010128

Hains, B.J., & Smith, B. (2012). Student-centred course design: empowering students to become self-directed learners. *Journal of Experiential Education*. 35(2):357–374.

Hall Rivera, J. (2017). The blended learning environment: A viable alternative for special needs students. *Journal of Education and Training Studies*, 5(2), 79-84. doi:10.11114/jets.v5i2.2125

Hamilton, L.S., Pane, J.F., & Steiner, E.D. (2014, November). *Using student data to support personalized learning.* Paper presented at the Association for Public Policy Analysis and Management Fall Conference, Albuquerque, NM.

Hannon, J.C., Holt, B.J., & Hatten, J.D. (2008). Personalized systems of instruction model: Teaching health-related fitness content in high school physical education. *Journal of Curriculum and Instruction*, *2*(2), 20-33. doi:10.3776/joci.2008.v2n2p20-33. Retrieved June 27, 2020, from http://www.joci.ecu.edu

Heck, R.C. (2009). Teacher effectiveness and student achievement. Investigating a multi-level cross-classified model. *Journal of Education Administration*, 7(22), 227-249.

Henson, K.T. (2014). *Constructivist Methods of teaching in Diverse Middle-level Classroom*. Boston: Allyn and Bacon.

Hill, A. & Rita, K. (2008). Constructivism: Learning Theory of the Future or Vestige of the Past. In *International Review of Research in Open and Distance Learning*. 9(3). ISSN: 1492-3831.

Hinneh, J.T. (2017). Attitude towards practical work and students 'achievement in biology: A case of private senior secondary school in Botswana*. IOSR Journal of Mathematics*, 13(4), 6-11.

Hofstein, A., Mamlok-Naaman, R., (2011). High-school students' attitudes toward and interest in learning chemistry. Educ. Qui_m. 22 (2), 90–102. Retrieved March 8th 2021, from http://creativecommons.org/licenses/by-nc-nd/4.0/)

Houchens, G.W., Crossbourne, T.A., Zhang, J., Norman, A.D., Chon, K., Fisher, L., & Schraeder, M. (2014). *Personalized learning: A theoretical review and implications for assessing kid-friendly student outcomes*. Paper presented at the MSERA. Annual Conference, Knoxville, TN.

Hussaini, I., Foong, L.M. & Karmamr, Y. (2015). Attitudes of secondary school students towards biology as a school subject in Birninkebbi Metropolis, Nigeria. *International Journal of Research and Reviews*, 2(10), 596-600.

Ibe, H.N. (2017). Boosting biology students' achievement and self-concept through a constructivist-based instructional model (CBIM). *Global Journal of Educational Research,* 16: 129-137. doi:http://dx.doi.org/10.4314/gjedr.v16i2.7

Ibeneme, O.T., & Emeasoba, N.C. (2017). Effect of cooperative teaching method on academic achievement of male and female office technology and management students in business communications in polytechnics. *NAU Journal of Technology & Vocational Education,* 2(1), 17-28.http://www. naujtved.com.ng]

Ifeanyieze, F.O. & Aneke, K. (2013) Competencies Required by Teachers in School-Based Assessment of Student in Secondary School*. Nigerian Journal of Educational Research and Evaluation, 12, 29-37*.

Illeris, K. (2004). Transformative Learning in the Perspective of a Comprehensive Learning Theory. *Journal of Transformative Education,* 2, *79-89.*

Imasuen, K. &Omorogbe, D.E.A. (2016). The Influence of Gender on Junior Secondary School StudentsAttitude towards Mathematics in Ovia North East LocalGovernment Area of Edo State. *An International Multi-disciplinary Journal, Ethiopia.* 10(4), 115-126, doi: http://dx.doi.org/10.4314/afrrev.v10i4.9

Iwu, R.U. & Azoro, A.V. (2017). A study on the barrier to participation of females in Science, Mathematics and Technology education in Imo State the way forward *Academic Journals on Education Research and Reviews.*12 (17), 882-838.

Jacob, B.A., & Ryan, J. (2018). How life outside of school affects student performance in school. Economic studies at Brookings, evidence speaks reports, 2(44), 1-13.March 22. Retrieved June 13, 2021, from https://www.brookings.edu/wp-content/uploads/2018/03/jacobs-and-ryan-report.pdf

Johnston, M. (2016). What more can we learn from early learning theory? The contemporary relevance for behaviour change interventions. *British Journal of Health Psychology*. https://doi.org/10.1111/bjhp.12165

Joiner, J. (2015). Student and teacher perspectives on the effects of mastery learning on the academic achievement of secondary students. *B.Ed. Thesis of Educational Specialist in the Department of Educational Foundations and Literacy University of Central Missouri. 1-98.* Retrieved October 12, 2018, from https://jckldigital.ucmo .edu/bitstream/handle/123456789/432/Joiner201530nT_Student.pdf?

Juditya, S., Suherman, A., Ma'Mun, A. & Rusdiana, A. (2018). Personalized System of Instruction (PSI) Model: Using audiovisual on basketball learning. 3rd International Conference on Sport Science, Health, and Physical Education

(ICSSHPE 2018), *Advances in Health Sciences Research,* 11, 313-315. Retrieved April 2, 2020, from http://creativecommons.org/licenses/by-nc/4.0/

Kalaivani, A. (2014). Personalized system of instruction (PSI Method) for innovative teaching methods and techniques. *International Journal of Pharmaceutical Science Invention*, 3(12), 28-30.

Kapici, H.Ö. & Akçay, H. (2016). Middle school students' attitudes toward science, scientists, science teachers and classes*. Asia-Pacific Forum on Science Learning and Teaching,* 17(1). Retrieved April 2, 2020, from https://www.eduhk.hk/apfslt/v17_issue1/kapici/page2.htm

Kamoru, U. & Ramon, O.G. (2017). Influence of self-concept, study habit, and gender on attitude and achievement of secondary school students in mathematics. *Journal for Leadership and Instruction,*16(1), 49-52. Retrieved May 23, 2020, from http://bit.ly/2XD0cb0

Kayode, G.M. & Ayodele, J.B. (2015). Impacts of Teachers' Time Management on Secondary School Students' Academic Performance in Ekiti State, Nigeria. *International Journal of Secondary Education.* 3(1), 1-7. doi: 10.11648/j.ijsedu.20150301.11

Keller, J.M. (2016). Motivation, learning, and technology: Applying the arcs-v motivation model. *Participatory Educational Research*, *3*(2), 1–15.

Keller, F.S. (1968).''Goodbye Teacher" *Journal of Applied Behavioural Analysis, 1*(1), 79-88.

Khatri, K.K. (2020). Research Paradigm: A Philosophy of Educational Research. *International Journal of English Literature and Social Sciences,* 5(5), 1435-1440. Retrieved February 14, 2022, from https://ijels.com/ ISSN: 2456-7620 https://dx.doi.org/10.22161/ijels.55.15

Kimmani, G.N., Kara, A.M., & Njagi, L.W. (2013). Teacher factors influencing students' academic achievement in secondary schools in Nyandarua County, Kenya. International *Journal of Education and Research*, 1(3), 1-14. Retrieved December 19, 2018, from https://www.ijern.com/images/March-2013/23.pdf

Kim, T. & Axelrod, S. (2014). Direct instruction: An educators' guide and a plea for action. *The Behaviour Analyst Today,* 6(2), 111-120. http://dx.doi.org/10.1037/h0100061

Kivunja, C. & Kuyini, A.B. (2017). Understanding and applying research paradigms in educational contexts. International Journal of Higher Education, 6(5), 26-41. https://doi.org/10.5430/ijhe.v6n5p26

Koh, N., Reddy, V., & Chatterji, M. (2014). Understanding validity issues surrounding test-based accountability measures in the US. *Quality Assurance in Education,* 22(1), 42-52.doi:10.1108/QAE-12-2013-0051

Kosterelioglu, I. (2018). Effects of Parenting Style on Students' Achievement Goal Orientation: A Study on High School Students. Educational Policy Analysis and Strategic Research, 13(4), 91-107. doi: 10.29329/epasr.2018.178.5

Kubiatko, M. (2013). *Postoje žiakov druhého stupňa základných škôl k prírodovedným predmetom*. Habilitačnápráca. Brno: Masarykova Univerzita

Kumazhege, S.Z. (2016). *Effects of edutainment on motivation and academic achievement of students in motor vehicle mechanics work in technical colleges of Adamawa State, Nigeria*. Unpublished PhD. Thesis, Department of Technology Education, Mautech, Yola.

Kyei Leonard, A.B. & Nokoe, K. Sagary (2011). Some gender differences in performance in senior high mathematics examinations in mixed high schools. American Journal of Social and Management Sciences, ScienceHuβ. Retrieved January 28, 2019, from http://www.scihub.org/AJSMS

Lawal, B.O. (2012). Attitude of Students towards technical education in Osun State. Asian Social Science, 8(3), 208-217. doi:10.5539/ass.v8n3p208. Retrieved October 5, 2019, from www.ccsenet.org/ass

Lin, Y.W., Tseng, C.L. & Chiang, P.J. (2017).The effect of blended learning in mathematics course.*EURASIA Journal of Mathematics Science and Technology Education*. ISSN 1305-8223. 13(3): 741-770. doi:10.12973/eurasia.2017.00641a

Maheshwari, V.K. (2012). *The Personalized System of Instruction: A Flexible and Effective Approach to Mastery Learning*. Retrieved from http://www.vkmaheshwari.com/WP/?p=392

Mao, P., Cai, Z., He, J., Chen, X. & Fan, X.(2021) The Relationship BetweenAttitude Toward Science and Academic Achievement in Science: AThree-Level Meta-Analysis.Front. Psychol. 12(784068), 1-12. doi: 10.3389/fpsyg.2021.784068

Mapotse, T.A. (2019). Technical Education through Action Learning: Bedrock of Sustainable Development. In F.W. Leal, A. Azul, L. Brandli, P. Özuyar, T. Wall (Eds.), *Quality Education*. Encyclopaedia of the UN Sustainable Development Goals. Springer, Cham, 1-17.

Maqbool, S., Ismail, S.A.M.B.M., Maqbool, S., & Hassan, S.U. (2018). Effects of Traditional Lecture Method and Multi-Sensory Approach on ELT Learners at Graduate Level. International Journal ofAcademic Research in Progressive Education and Development, 7(4), 488–505.

Marcela, V., & Dana, M. (2016). Attitude toward school and learning and academic achievement of adolescents. In *7th International Conference on Education and Educational Psychology. ICEEPSY* (Vol. 871).

Maxwell, J.A. (2013). Qualitative research design: An interactive approach (3rd ed.). *Applied social research methods,* 41, 214-253. Thousand Oaks, CA: Sage.

Mayer, G.R., Sulzer-Azaroff, B., & Wallace, M. (2014). Teaching new behavior: Shaping. In *Behavior Analysis for Lasting Change* (3rd ed), 248–269. Sloan Publishing.

Mazi, J.J. (2016). The Influence of School Environment on theCognitive Achievement of Students in Technical Colleges in KwaraState. Unpublished M.Ed. Thesis, University of Nigeria, Nsukka.

Mbonyiryivuze, A., Yadav, L.L., & Amadalo, M.M. (2019). Students' conceptual understanding of electricity and magnetismand its implications: A review. African *Journal of Educational Studies in Mathematics and Sciences.* 15(2), 55-67. doi: https://dx.doi.org/10.4314/ajesms.v15i2.5

Mcknight, C., Magid, A., Murphy, T.J., & McKnight, M. (2000). *Mathematics Education Research: A Guide for Research Mathematics.* Providence, RI: American Mathematical Society.

McGuirk, P.M & O'Neill, P. (2016). Using questionnaire in qualitative human geography. *In I. Hay (Eds), Qualitative research methods in human Geography,* 246-273. Don Mills, Canada Oxford University press.

Mehera, J.P. (2004). Difference in Students Achievement in mathematics between males and females of Burdulan District in West Bengal. *Journal of science Education,* 12 (6), 21-26.

Mello, D., & Less, C.A. (2013). *Effectiveness of Active Learning in the Arts and Sciences*.
Retrieved February, 03 2021 from https:www.scholarsarchire.jwu.edu/cgi/ viewcontent.cgi?article¼1044/context¼humanities_fac.

Metzler, M.W. (2011). *Instructional models for physical education.* (3rd ed). Holcomb Hathaway, Publishers, Scottsdale, Arizona.

Mitee, T.L. & Obaitan, G.N. (2015).Effect of Mastery Learning on Senior Secondary School Students' Cognitive Learning Outcome in Quantitative Chemistry. *Journal of Education and Practice,* 6(5), 34-38. Retrieved June 20, 2020, from www.iiste.orgI.

Moges, E. (2017). Determinant of academic performance of undergraduate students: In the Cause of Arba Minch University Chamo Campus. *Journal of Education and Practice,* 8(10): 155-166.

Momani, M., Asiri, M.A., & Alatawi, S.M. (2016). The impact of implementing active learning strategies in teaching English from the perspective of Tabuk educational region intermediate school teachers. *Asian Journal of Education Research*. 4(1), 19–35.

Mohajan, H. (2020). Quantitative Research: A Successful Investigation in Natural and Social Sciences. *Journal of Economic Development, Environment and People, 9*(4). doi:http://dx.doi.org/10.26458/jedep.v9i4.679

Morris, J.B. (2015). Gender and stem related advanced placement exams: A review of the Literature. *The Online Journal of New Horizons in Education*. 5(1), 55-71. Retrieved February 5, 2022, from https://www.tojned.net/journals/tojned/articles /v05i01/v05i01-07.pdf

Mphale, L.M. & Mhlauli, M.B. (2014). An Investigation on Students' Academic Performance for Junior SecondarySchools in Botswana. *European Journal of Educational Research.* 3(3), 111-127. Retrieved January 24, 2021, from https://files.eric.ed.gov/fulltext/ EJ1086046.pdf

Muhdin, M. (2016). Determinants of economics students' academic performance: Case study of Jimma University, Ethiopia. *International Journal of Scientific and Research Publications,* 6(1): 566-571.

Muise, J.M. (2015). *Using Peer Instruction to promote conceptual understanding in high school physics classes.* Montana: Montana State University.

Murphy, M., Redding, S. & Tyman, J.S. (Eds) (2016). *Handbook on personalized learning for states, districts, and schools*. Philadelphia, PA: Temple University, Centre on Innovations in Learning and Charlotte, NC: Information Age Publishing. 3-18. Retrieved October 9, 2018, from:https://files.eric.ed.gov › full text

Musa J.D., Diraso, D.K., L'Kama, J.D. & Adamu G.G. (2019). Effects of Meta-Learning on the Academic Achievement and Content Retention of Engineering Trades Students in Technical Colleges in Nigeria. *International Journal of Recent Innovations in Academic Research,* 3(7): 142-150.www.ijriar.com

Naboth-Odums, A. (2014). Critical Assessment of Just-In-Time Teaching Method as Against Conventional Teaching Methods on Academic Performance of Business Studies Students. *Journal of Educational and Social Research. Rome-Italy. MCSER Publishing. 4(5), 59-66.* doi:10.5901/jesr.2014.v4n5p59

NBTE (2016). *"National Board for Technical Education Modular Curriculum for Electrical Engineering Trades":* Kaduna; Nigeria.

National Business and Technical Examination Board (2019) National Technical and Business Certificate Syllabus, Reviewed Edition, NBTE, Kaduna

National Business and Technical Examinations Board (NABTEB) (2018). *Examiner Report 2012-2017*. NABTEB Osogbo Zone.

National Business and Technical Examination Board (NABTEB) (2015). *Chief Examiners Report*, Benin: Testa Printing Press Ltd.

National Business and Technical Examinations Board (NABTEB), (2008). ETF, Intervention in TVET Syllabus for engineering trades examination based on National Board for Technical Examination Modular curricula. Kaduna, NBTE.

Ndukwe, C.J. (2018). The effect of constructivist instructional model on senior secondary school students' achievement and retention in mathematics, Enugu state. *An unpublished master's dissertation of the Enugu State University of Science and Technology, Enugu.*

Niemi, H., Nevgi, A., & Aksit, F., (2016). Active learning promoting student teachers' professional competences in Finland and Turkey. *European Journal of Teacher Education*, 39 (4), 471–490.

Nieuwenhuis, J. (2014). Qualitative research designs and data gathering techniques. In *K. Maree (15th Ed.). First steps in research*, 69-97. Pretoria, South Africa: Van Schaik.

Nja, C.O., Orim, R.E., Neji, H.A., Ukwetang, J.O., Uwe, U.E., & Ideba, M.A. (2022). Students' attitude and academic achievement in a flipped classroom. Heliyon, 8(2022), 1-14, https://doi.org/10.1016/j.heliyon.2022.e08792

Nnamani, S.C. & Oyibe, O.A. (2016a). Effects of individualized instructional method on secondary School students' achievement in social studies. *British Journal of Education.* 4(3), 110-120, Published by European Centre for Research Training and Development UK. Retrieved August 6, 2018, from http://www.eajournals.org

Nnamani, S.C. & Oyibe, O.A. (2016b). Gender and academic achievement of secondary school students in social studies in Abakaliki urban of Ebonyi State. *British Journal of Education.* 4(8), 72-83, Published by European Centre for Research Training and Development UK. Retrieved September 14, 2019, from http://www.eajournals.org

Nnenna, G.E., & Adukwu, B.C. (2018). Influence of gender and school location on senior secondary school student's achievement in Biology in Agbani Education Zone of Enugu State, Nigeria. *Journal of Education and Practice*. 9(21), 45-51. Retrieved April 24, 2019, from www.iiste.org

Ntibi, J .Effiom-Edem, & Edoho, E.A. (2017). Influence of school location on students attitude towards mathematics and basic science. *British Journal of Education*. 5(10), 76-85, Published by European Centre for Research Training and Development UK. Retrieved April 24, 2019, from http://www.eajournals.org

Nworgu, B.G. (2015). *Educational Research; Basic Issues & Methodology: (3rd ed.)* Nsukka, Nigeria: University Trust Publishers.

Nworgu, B.G., Ugwuanyi, C.S. & Nworgu, L.N. (2013). School location and gender as factors in senior secondary school students' conceptual understanding of force and motion. *International Journal of Educational Research and Technology*. 4(4), 71-76. Retrieved February 07, 2022, from: https://www.researchgate.net/ publication/270591599

Odede, S.O. & Adewale, J.G. (2013).Student intrinsic and extrinsic factors as correlates of technical and vocational enrolment in Osun State. *In Learning; A Book in honour of Professor T.Y Yoloye*; Mokola, Ibadan: Society for the promotion of Academic and Research Excellence (SPARE), 286-296.

Odo, M.I., Adenle, S.O. & Okwori, R.O. (2012). Enhancing mastery of practical skill in students of vocational and technical education through activity based instruction.*Journal of Technical Education and Training (JTET),* 4(2), 21-29. Retrieved September 19, 2019, from http://penerbit.uthm.edu.my/ojs/index.php/JTET/ article/view/580

Ogbonna, C.E. (2013). A comparison of the perception of male and female students about introductory technology in selected schools in Nsukka Education Zone. Unpublished M.Ed thesis. University of Nigeria Nsukka.

Ogbe, A.O. & Omenka, J.(2017).Improvisation and utilization of resources in the teaching and learning of science and mathematics in secondary schools in CrossRiver State.*Global Journal of Educational Research*, 16, 2017: 21-28 doi: http://dx.doi.org/10.4314/gjedr.v16i1.4

Ogbu, J.E. (2015). Availability and utilization of instructional facilities for the teaching of basic electricity in Ebonyi state technical colleges. *Developing Country Studies*. *5* (21), 162-168. Retrieved April 24, 2019, from www.iiste.org

Ogbuanya, T.C. & Akinduro, I.R. (2017). Effects of floating facilitator and peer tutor instructional approach on students' psychomotor achievement in electrical installation and maintenance in technical colleges in Ondo State*. Nigeria Global Journal of Pure and Applied Mathematics. 13* (6), 2347-2371. Retrieved January 14, 2019, from http://www.ripublication.com

Ogbuanya, T.C., Akintonde, A.A., & Bakare, J. (2017). Assessment of practical skill training of technical college students in electrical and electronics trade-in Osun State, *Nigeria. International Journal of Applied Engineering*. 12(18): 7501- 7514.

Ogbuanya, T.C., Attahiru, A., Tiough, D.M. & Obe, M.O., (2017). Influence of psychosocial environment on students' achievement in basic electricity in government technical colleges in Niger State, Nigeria. *Global Journal of Pure and Applied Mathematics.* 13(8), 4199-4221. Retrieved August 14, 2018, from http://www.ripublication.com

Ogula, P.A., Kisigot, C.K., & Munyua, J., (2021). Effects of gender on students' academic achievement in publicsecondary schools in Marakwet East Sub County, Kenya. *International Journal of Humanities Social Sciences and Education (IJHSSE),*8(3), 01-10. https://doi.org/10.20431/2349-0381.0803001

Ogundu, I. (2010). The Influence' of Unsafe Workshop on Effective Workshop Operations in Technical Colleges in Rivers State. *International Journal of Educational Development*, 1(2), 1-5.

Ogundu, I., Amadi, S.W. & Igrubia, V. (2015). The effects of teacher constructed furnace on students' performance in heat treatment in technical colleges in Rivers State, Nigeria. *European Scientific Journal, 11*(16), 369-381. Retrieved August 8, 2019, from https://eujournal.org/index.php/esj/article/download/5875/5598

Okafor, M.N. (2014). *Teaching methods of basic electrical/electronics in technical college.* Ibadan: Special Books Ltd.

Okonkwo, C.C. (2014). Effects of individual and cooperative computers aided instructions on students' performance and attitudes. *Educational Research and Development*. 37(2), 15–24.

Okorie, E.U., & Ezeh, D.N. (2016). Influence of gender and location on students achievement in chemical bonding. Mediterranean *Journal of Social Sciences. MCSER publishing*, Rome, Italy. doi:10.5901/mjss.2016.v7n3p309

Okolie, U.C., Igwe, P.A. & Elom, E.N. (2019) Improving graduate outcomes for technical colleges in Nigeria. Australian Journal of Career Development 28(1), 21-30. Retrieved January 14, 2022, from https://journals.sagepub.com/doi/10.1177/1038416218772189

Okwelle, P.C. (2016). *Instructional strategies for technology education teacher*. Unpublished Monograph. Faculty of Technical andScience Education. RSU, Port Harcourt.

Olagunju, A.M., & Babayemi, J.O. (2014). Effects of enhanced explicit teaching (Explicit Teaching + Peer-tutoring) strategy and gender on students' achievement in Basic

Science in South-western Nigeria. *Ibadan Journal of Educational Studies.* 11(1&2), 119-132.

Olatide, A.E., (2018). Effect of two learning strategies on secondary school students' achievement in Social Studies in Kwara State, Nigeria, 1, 24-36. Retrieved June 15, 2019, from publications.uew.edu.gh › sites › default › files

Olatunde-Aiyedun, T.G. & Ogunode, N.J. (2021a). Shortage of professional science and environmental education teachers in Nigeria. *Asian Journal of Science Education*, 3 (1), 1-11. https://www.researchgate.net/publication/350819014_Shortage_of_ Professional _Science_and_Environmental_Education_Teachers_in_Nigeria

Oliver, M.C, Wood-mcConnney, A, Maor, D. (2017). Female senior secondary physics students' engagement in science, a qualitative study of constructive influences. *International Journal of STEM Education.* Online ISSN 2196-7682. 4.4. https://doi.org/10.1186/s4059-017-0060-9

Olugbade, D., Adekomi, A. & Sofowora, O.A (2016).Enhancing students' performance in basic science and technology in Nigeria using models LMS. *International Journal of Educational and Pedagogical Sciences,* 10(5), 1657-1660. Retrieved December 7, 2020, from scholar.waset.org/1307-6892/10004484.

Omori, A.E., Okon, A.E., & Etan, M.O. (2019). Instructional Strategy and Teacher-student Relationships as Predisposing Variables of Adult Students' Learning Interest in the Universities. *International Journal of Innovation Education and Research.* 7(5), 123-132.https://doi.org/10.31686/ijier.Vol7.Iss5.1483.Retrieved September 17*, 2019,* from www.ijier.net

Omrod, J.E. (1999). *Human Learning.* Third Edition. Upper Saddle River, N.J.: Prentice Hall.

Onah, F.N. (2017). Effect of self-instructional package on students' achievement and interest in Agricultural science in secondary schools in Enugu State, Nigeria. Unpublished PhD. Thesis, faculty of vocational and technical education, University of Nigeria, Nsukka.

Onasanya, S.A., Adegbija, M.V., Olumorin, C.O. & Daramola, F.O. (2009). Education reform and assessment of teachers' competence in instructional media technology use. *In Lawal A.R. (Eds), Education reforms in Nigeria- Past, Present and Future*. Lagos, Stirling Horden, 259-272.

Onodugo, I.C., Akubue, N.P., & Eneh, B.N., (2020). Impact of school environment on the academic performance of senior secondary school students in public secondary schools in Nigeria: A case of Agbani education zone. *International*

*Journal of Educational Research and Studies,*2(1), 12-21. Retrieved January 17th, 2022 from www.journalofeducation.net

Onoyase, S.O. (2015). *The impact of School Management Environment on Students' output quality in Oyo State Secondary Schools*. *Unpublished PhD Thesis,* University of Ibadan, Nigeria.

Onuka, O.U.A. & Akinyemi, T.F. (2012). Assessment as a Tool for Learning Improvement at the SSS Education Level. In C.V. Abe & A.O. Onuka (Eds.), *Revolutionizing Assessment and Evaluation Procedures in Education*, Ibadan: Stirling-Horden Publishers Ltd., 37-52.

Opoku-Asare, N.A.A. & Siaw, A.O. (2015). Rural-Urban disparity in students' academic performance in Visual Arts Education: Evidence from six senior high schools in Kumasi, Ghana. 1-14. Retrieved August 7, 2018, from https://journals.sagepub. com/doi/pdf/10.1177/2158244015612523

Orji, N.O., Ogar, S.I. & Aiyedun, T.G. (2018). Influence of jigsaw-based learning strategy on academic achievement of upper basic students in Basic Science in Etim-Ekpo of Akwa Ibom State. *AbujaJournal of Arts and Social Science Education (AJASSE),* 1(1)1-12.

Orlich, D.C., Harder, R.J., Callahan, R.C. &Trevisan, M.S. (2012). *Teaching strategies: A guide to effective instruction* (10th ed.), (e-book). Retrieved January 3, 2019, from www.books.google.com

Orubu, M.E.N. (2013). School based basement as predictor of students' performance in junior school certificate mathematics examination in Delta State. *NigerianJournal of Educational Research and Education,* 12, 37-44*.*

Othniel, J. (2015). Towards improving teaching of basic electricity/electronics in technical colleges in Bauchi State. *ATBU, Journal of Science, Technology & Education (JOSTE);* 3 (2), 59-62*.*

Oviawe, J.I., Uwameiye, R., & Uddin, P.S.O. (2017). Bridging skill gap to meet technical, vocational education and training school-workplace collaboration in the 21stCentury*. International Journal of Vocational Education and Training Research,* 3(1), 7-14. doi: 10.11648/j.ijvetr.20170301.12

Owodunni, A.S. (2018). *Influence of classroom interaction patterns on studentachievement in basic electricity at technical colleges in Federal Capital Territory, Abuja.*International Conference on 21st Century Education at HCT Dubai Men's College, UAE November. 7(1), 144-153. ISSN: 2330-1236, 21st-century academic forum.

Owoeye, U.O. & Yara, P.O (2011). School location and academic achievement of secondary schools in Ekiti State, Nigeria. *Asian Social Science,* 7(5), 26-30. Retrieved April 11, 2019, from https://www.researchgate.net/publication /272691898https://doi.org/10.5539/ass.v7n5p170

Owolabi, H.O. & Aderinto, M.O. (2010). Effect of personalized system of instruction on senior secondary school students' performance in mathematics. *Ilorin Journal of Education,* 29, 53-63.

Oyebola, J.O. (2013) Assessment: A Transformation Tool for Enhancing Students' Learning. *Nigerian Journal of Educational Research and Evaluation,* 12, 92-100.

Oyelekan, O.T (2014). Effects of Self and Peer Assessment on Students‟ Learning Outcomes in Senior Secondary School Physics in Osun State Nigeria. Unpublished Masters Dissertation, University of Ibadan, Nigeria.

Paiva, R.C., Ferreira, M.S., &Frade, M.M. (2017). Intelligent tutorial system based on personalized system of instruction to teach or remind mathematical concepts. *Journal of Computer Assisted Learning,* John Wiley & Sons Ltd. 33,370–381. https://doi.org/10.1111/jcal.12186

Paramitha, S.T. (2017). Influence of joyful learning on elementary school students' attitudes toward science. In: Proc. Int. Conf. on Mathematics, Science, and Computer Science Education (Bristol: IOP Publishing).

Pardo, A. (2018). On Task: Delivering Data-Informed, Personalized Learning Support Actions. *Journal of Learning Analytics*. 5(3), 235–249. http://dx.doi.org/10.18608/jla.2018.53.15

Patel, H.R. & Joseph, J.M. (2016). *Questionnaire designing process. A review.* J .Clin Trials 6, 255, doi:10.4172/2167-0870.1000255.

Petty, R.E. (2018). *Attitudes and persuasion: Classic and contemporary approaches*. Routledge. https://doi.org/10.4324/9780429502156

Pavot, W. (2018). The cornerstone of research on subjective well-being: Valid assessment methodology. In E. Diener, S. Oishi, & L. Tay (Eds.), *Handbook of well-being.* Salt Lake City,UT: DEF Publishers. Retrieved October 30, 2018, from https://www.nobascholar.com/chapters/15/download.pdf

Prewitt, S. (2014). The personalized system of instruction: Fidelity and effect on health-related fitness knowledge and in-class physical activity. Dissertation, University of Utah.

Priess, H.A., & Hyde, J.S. (2010). Gender and academic abilities and preferences. In J. Chrisler & D. McCreary (Eds.), *Handbook of gender research in psychology*, 1, 297–316. New York: Springer-Verlag.

Pritchard, T., Penix, K., Colquitt, G., McCollum, S. (2012). Effects of a weight training personalized system of instruction course on fitness level and knowledge. *The Physical Educator*, 69, 342-359.

Puyate, S.T. (2016). Facilities Planning in Industrial Education.Unpublished Monograph. Faculty of Technical Education and Science.RSU Port Harcourt.

Raj, S. (2012). Advantages and disadvantages of the classroom conventional lectures. Retrieved June 5, 2019, from http://www.ehow.com.

Raudonyte, I. (2019). *Use of learning assessment data in education policy-making*. Paris: IIEP-UNESCO. Programme and Meeting Document 1-35. CC BY-SA 3.0 IGO [9900]

Raymond, E. (2013). Comparative effect of cognitive and traditional task analysis-based instructional guides on technical college students' achievement and interest in electronics work in north–central, Nigeria.Unpublished doctoral dissertation, University of Nigeria, Nsukka, Enugu State.

Redding, S. (2016). Competencies and professionalized learning. In M. Murphy, S. Redding, & J. S Tyman (Eds). *Handbook on personalized learning for states, districts, and schools*. Philadelphia, PA: Temple University, Centre on Innovations in Learning and Charlotte, NC: Information Age Publishing, 3-18.

Rehman, A.A., && Alharthi, K. (2016). An Introduction to Research Paradigms 3(8): 51-59. *International Journal of Educational Investigations*. Retrieved February 14, 2022, from www.ijeionline.com

Robinson, R.N. (2017). Effectiveness of computer-aided instructions (CAI) on students' performance in basic electricity in technical colleges in Rivers state of Nigeria. *International Journal of Research - Granthaalayah,* 5(11), 14-21.

Robson, L.S., Shannon, H.S., Goldenhar, L.M., & Hale, A.R. (2001). *Guide to Evaluating the Effectiveness of Strategies for Preventing Work Injuries: How to Show Whether a Safety Intervention Really Works.* Cincinnati, National Institute for Occupational Safety and Health, Retrieved March 12, 2019, from http://www.mtpinnacle.com/ pdfs/safety-evaluation-effectiveness.pdf

Rubie-Davies, C.M., Peterson, E.R., Sibley, C.G., & Rosenthal, R. (2014). A teacher expectation intervention: Modelling the practices of high expectation teachers. *Contemporary Educational Psychology*, 40, 72–85. Retrieved December 28, 2018, from https://s3.amazonaws.com/academia.edu.documents/44838125.

doi:10.1016/j.cedpsych.2014.03.003

Saba, T.M., Ma'aji, S.A. & Tsado, J. (2011). Assessment of pedagogical skills in teaching of electrical and electronics engineering in the universities in northern Nigeria. *Review of Education Institute of Education Journal*, University of Nigeria, Nsukka, 23(1): 123-136.

Sakariyu, A.O., Taiwo, M.O. & Ajagbe, O.W. (2016). An investigation on secondary school students' attitude towards science in Ogun State. *Journal of Education and Practice*, 7(28), 125-128

Salami, S.O., (2007). Effects of Personalised system of instruction on students' academic achievement in chemistry. *Pakistan Journal of Social Sciences,* 4(1), 132-136.

Saunders, M.N.K., Lewis, P., & Thornhill, A. (2019). *Research methods for business students*. (8th ed.). New York: Pearson, 128-175. Revised edition. ISBN 9781292208800

Sanni, A.T. (2014). Effect of computer instructional package (CIA) on students' achievement and interest in basic electricity in technical colleges in Niger State, Nigeria. *Unpublished MTech.* Thesis, Industrial and Technology Education,Federal University of Technology, Minna. Nigeria.

Schutt, R.K. (2018). *Investigating the Social World: The Process and Practice of Research* (9th ed.). Thousand Oaks, CA: Sage.

Sesen, B.A., & Tarhan, L. (2010). Promoting active learning in high school chemistry: Learning achievement and attitude. *Procedia-Social and Behavioral Sciences*, *2*(2), 2625-2630.

Sharifi, F. & Farrokh, P. (2017). Social-Personalized versus Computer-Personalized Methods to Teaching English Learners' Reading, Comprehension Ability. *Multidisciplinary Journal of Educational Research*, 7(3), 287-315. doi: 10.17583/remie.2017.2775

Shittu, R.O. & Olanike, R.A. (2015).Teachers attitudes: A great influence on teaching and learning of Social Students. *Journal of Law and Globalisation,* 42(2), 67-79.

Singh, A., (2021). Quasi Experimental Design in Scientific Psychology. 1-7. Retrieved February 14, 2022, from http://dx.doi.org/10.2139/ssrn.3793568

Skinner, B.F. (1984). The evolution of behaviour. *Journal of Experimental Analysis of behaviour,* 41, 217-221. doi: 10.1901%2Fjeab1984.41-217

Smith, P.K., Cowie, H. & Blades, M. (2015). *Understanding children's development-basic psychology.* 6th edition. e-book. Blackwells.co.uk/bookshop/product/ 978111872980

Soliu, I.P., Badmus, O.T., Akanbi, A.O. & Omosewo, E.O. (nd: 1-18). Influence of school location and school type on senior school students' achievement in physics in Ilorin, Kwara State. Retrieved February 2, 2019, from https://www.academia.edu /34290404/ I

Springer, C.R., & Pear, J.J. (2008). Performance measures in courses using a computer-aided personalized system of instruction. *Computers and Education*, 51, 829-835.https://doi.org/10.1016/j.compedu.2007.09.002

Sreejesh, S., Mohapatra, S. & Anusree, M.R. (2014). *Business research methods: An Applied orientation.* New York. Springer

Stockinger, K., Rinas, R., & Daumiller, M. (2021). Student adaptability, emotions, and achievement: navigating new academic terrains in a global crisis. Learn. Individ. Differ. 90:102046. doi: 10.1016/j.lindif.2021.102046

Sunday, A.O. Olaoye, A.E. & Audu, H. (2021). Effects of co-operative and competitive teaching strategy on statistics achievement of students in secondary schools in Gwagwalada, Abuja, Nigeria. *Sapientia Foundation Journal of Education, Sciences and Gender Studies (SFJESGS), 3(1), 211-222.*

Svenningsen, L., & Pear, J.J. (2011). Effects of a computer-aided personalized system of instruction in developing knowledge and critical thinking in blended learning courses. *The Behavior Analyst Today*, *12*(1), 34–40. https://doi.org/10.1037/h01007

Taale, K.D. & Mustapha, B.A. (2014). Effects of teacher-constructed electrical models on students' academic achievement in basic electricity in technical colleges of Borno State. Nigeria. *International Journal of Innovative Social & Science Education Research, 2(1), 16-25*. Retrieved August 7, 2018, from www.seahipub.org

Tanenbaum, C., LeFloch, K., & Boyle, A. (2013). *Are personalized learning environments the next wave of K-12 education reform?* Washington, DC: American Institute for Research.

Thomas, C.G., & Amaechi, O.J., (2019). Influence of School Environment on Students'Academic Performance in Technical Colleges inRivers State.*International Journal of New Technology and Research (IJNTR)*. 5(3), 40-48. Retrieved August 20th, 2020, from https://www.ijntr.org/download_data/IJNTR05030036.pdf

Tikoko, B.J. & Omondi, E. (2022). The Relationship between School Location and Student Participation in Decision Making in Kenya. *Editon Cons. J. Arts., Humanity. Social Studies*, 4(1), 340-345. https://doi.org/10.51317/ecjahss.v4i1.297

Tirodkar, S. & Lawrence, A. (2021). Changing the Face of Education: Computer-Assisted Instruction in the Secondary Education Classroom. *Journal of student research*. High school edition. 10(3):1-9. ISSN: 2167-1907

Trumbull, E., & Lash, A. (2013). Understanding formative assessment: Insights from learning theory and measurement theory. San Francisco: WestEd.

UBEC, (2016). Universal Basic Education Commission. Education for All is the Responsibility of All. *UBEC 2015 Annual Report. Abuja, Nigeria.*

UKEssays, (November 2018). Students Performance in Rural and Urban Areas. Retrieved May 12, 2021, from https://www.ukessays.com/essays/education/students-performance-in-rural-and-urban-areas-education-essay.php?vref=1

Ukwuije, R.P.I. & Opkara, I.M. (2013) School-Based Assessment-Implications for Educational Transformation. *Nigerian Journal of Educational Research and Evaluation*, 12, 1-8.

UNICEF (2017). Gender Equality: Glossary of terms and concepts. UNICEF Regional Office for South Asia, 1-17. Retrieved January 22, 2022, from https://www.unicef.org/rosa/media/1761/file/Gender%20glossary%20of%20terms%20and%20concepts%20.pdf

Unity, O. & Igudu, U., (2015). Influence of Gender on Students' Academic Achievement in Government Subject in Public Secondary Schools in Oredo Local Government Area of Edo State, Nigeria. *Journal of Educational and Social Research.* MCSER Publishing, Rome-Italy. 5(2): 101-106, doi:10.5901/jesr.2015.v5n2p101

U.S. Department of Education (2015). *Competency-based learning or personalized learning*. Retrieved October 1, 2019, from http://www.ed.gov/oii-news/competency -based learning-or-personalized-learning.

Usman, V.I.M. (2018). Evaluation of Continuous Assessment Strategies for Effective Teaching and Learning of Economics in Nasarawa State University, Keffi, Nigeria. *International Journal of Strategic Research in Education, Technology and Humanities* 5(1): 48-55.

Usman, Y.D., & Madudili, G.C. (2020). Assessment of the impact of computer-assisted instruction on teaching and learning in Nigeria: A theoretical viewpoint. *International Journal of Education and Development using Information and Communication Technology (IJEDICT), 16(2), 259-271.* Retrieved June 2, 2021, from https://files.eric.ed.gov/fulltext/EJ1268789.pdf.

Usoro, A.D., Akpan, U.T. & Ikpe, S.A. (2018). Parameters in benchmarking technical colleges for quality educational goals in Nigeria. *Educational Research International*. 7(3): 53-61. Retrieved June 28, 2019, from http://www.erint.savap.org.pk/PDF

Uwizeyimana, D., Yadav, L.L., Musengimana, T., & Uwamahoro, J. (2018). The impact of teaching approaches on effective physics learning: an investigation conducted in five Secondary Schools in Rusizi District, Rwanda. *Rwandan Journal of Education,* 4(2), 2-14.

Valls, F.R., & Ponce, G.A. (2013). *Developing student-centred practices for second language learner (SLL) students.* Education Policy Analysis Archives, 21(55): 1-22.

Veal, A.J. (2018). *Research methods for leisure and tourism.* (5th ed) (e-book). Harlow, United Kingdom. Pearson. Retrieved September 13, 2018, from books.google.co.za.

Vilia, P.N., Candeias, A.A., Neto, A.S.,Franco, M.S., & Melo, M. (2017)Academic Achievementin Physics-Chemistry: The PredictiveEffect of Attitudes and ReasoningAbilities. *Front Psychology* 8, 1064, 1-9. https://doi.org/10.3389/fpsyg.2017.01064

Vincent, E.O., & Akpan, U.T. (2014). Instructional strategies and students' academic performance in electrical installation in technical colleges in Akwa Ibom State: Instructional skills for structuring appropriate learning experiences for students. *International Journal of Educational Administration and Policy Studies*, 6(5): 80-86.

Von Korff, J., Archibeque, B., Gomez, K.A., Heckendorf, T., McKagan, S.B.C., Sayre, E., & Sorell, L. (2016). Secondary analysis of teaching methods in introductory physics: A 50k-student study. *American Journal of Physics,* 84(12), 969-974.

Warner, D.A. (2021). *"A Review of Behavior Analysis in Education*" Capstone Projects. 5. 1-106. Retrieved January 26th, 2022, from https://scholarship.rollins.edu/mabacs_capstone/5

Wells, C.S. & Wollack, J.A. (2003*). An Instructor's guide to understanding test reliability.* Retrieved November 26, 2018, from https://testing.wisc.edu/Reliability.pdf

Wei-Li Yap (2016). Transforming conventional teaching classroom to learner-centred teaching classroom using multimedia-mediated learning module*. International Journal of Information and Education Technology,* 6(2): 105-112.

Wei-Li Yap, Mai Neo & Tse-Kian Neo (2016). Transforming from conventional teaching environment to a Learner-Centred teaching environment with the use of Interactive Multimedia Module in Tertiary Education. Proceedings of the 11th International Conference on e-Learning ICEL. Hosted by Universiti Sains Islam Malaysia Kuala Lumpur Malaysia. 147-156. 2-3rd June.

Wimmer, R.D. & Dominic, J. (2011) *Mass media Research: An introduction.* 9th Edition Boston, MA 02210USA, Wadsworth Publishing Company.

Wood, D.S. (2018).The Effects of Personalized Learning on student engagement in Elementary School. A Doctor of Education Dissertation in Leadership and Professional Practice. Trevecca Nazarene University. Published by ProQuest LLC(2019). Retrieved April 24, 2019, from https://search.proquest.com/docview /2176091382?pq-origsite=gscholar

Wosu, U.N., (2016). Effects of brainstorming and field trips teaching methods on junior secondary school students' learning outcomes in Business Studies in Rivers State, Nigeria. Unpublished PhD Thesis Institute of Education*,* University of Ibadan, Ibadan, Nigeria

Yadav, T & Chahal, D. (2016). The impact of caste, region and gender on students' academic achievement in Mahendragarh District. International Journal of Advanced Education and Research, 1(7): 33-36. Retrieved April 24, 2019, from www.alleducationjournal.com

Yang, D.H. (2010). Gender and classroom learning. *Psychology in the Schools,* 22, 08-223

Young, A. (2019). Personalized system of instruction in physical education. *International Journal of Arts and Humanities;* 5(1): 13-15. Retrieved June 28, 2019, from ijah.cgrd.org

Young, A.B. (2016*).* Implementation of the Personalized System of Instruction for the first time by an experienced teacher. *A dissertation Submitted in partial fulfilment of the requirements for the degree of Doctor of Philosophy in the Department of Kinesiology in the Graduate School of the University of Alabama.*

Yin, R.K. (2009). *Case study research: Design and methods* (4th Ed.). Thousand Oaks, CA: Sage.

Yin, R.K. (2012). *Applications of case study research* (3rd Ed.). Thousand Oaks, CA: Sage.

Yusuf, M.A. & Adigun J.T (2010). The influence of school, sex, location and type on students' academic achievement. *International Journal of Education in Science,* 2(2), 81-85.

Zais, M. (2011). *South Carolina School Environment Initiative. South Carolina Department of Education*, Columbia. Retrieved fromhtip://ed. sc.ov/agency/ac/Student-Inieri'ention-ervices/documents/SCSchoolEnvironmençRFP -Nov20] 1.pdf. December 2017.

Zakaria, A.B., Chine, S.K, & David T.O. (2015). *The impact of computer on the performance of students of electricity in colleges*. California: Sparrow Publishers.

Zakaria, D.A., Septiana, R.A. & Kurnia, D. (2018). Mastering basic motions of basketball using personalized system of instruction (psi) model based on electronic modules (e-module). *Journal Sampurasun: Interdisciplinary Studies for Cultural Heritage*, 4(2): 95-107 Retrieved July 12, 2020, from *journal.unpas.ac.id › article › download*

Zakariyya, A.A., Ndagara, A.S. & Yahaya A.A. (2016). Effects of mastery learning approach on senior secondary school students' performance in geometry in Bida, Nigerstate, Nigeria. ABACUS: *Journal of the Mathematical Association of Nigeria (MAN).*41(1), 17-25.

APPENDICES

Appendix 1

Letter of permission to Osun State Board for Technical and Vocational Education

Institute for Science and Technology Education,
University of South Africa,
Pretoria. South Africa.
16th August, 2019.

The Coordinating Director,
Osun State Board for Technical and Vocational Education,
No. 10 Mafowurosere,
Osogbo,
Osun State.

Dear Director,

Request for permission to conduct research titled: "Effects of Personalized and Direct system of instructions on technical college students' achievement in Basic Electricity" in all the Technical colleges in Osun State.

I, Odede Simeon Oluwole, I am doing a research under the supervision of Prof. Tome Mapotse, of the Department of Science and Technology Education towards a PhD degree at the University of South Africa (UNISA). We are requesting for your permission to use all technical colleges in the Osun state for a research entitled: Effects of Personalized and Direct System of Instructions on Technical College Students' Achievement in Basic Electricity. The participants will respond to questionnaire items that relates to basic electricity after which different teaching methods (Personalized and Direct System of Instructions) will be used to teach them by their subject teachers.

This study is expected to collect important information that could assist teachers on how to improve technical college students' academic achievement in basic electricity using different methods of teaching most especially students-centered methods. In this study, the participants will be year two students of basic electricity classes and their teachers. All participants in each school that will be used for the study will be given enlightenment briefing on what they will be expected to do. Participating teachers in the experimental groups will be trained by the researcher in respect to this study. They will be taught using the treatment packages for Personalized System of Instruction (PSI) and Direct Instruction (DI) as the bases of their training and helping them to develop their knowledge of creativity in teaching basic electricity concepts.

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsimile: +27 12 429 4150

Two groups of students will form the experimental group, where the teacher will use personalized system of instruction (PSI) and direction instruction method (DI). The students will be taught the topics selected in the test blue print using the PSI and DI respectively. Adequate tasks will be given to them to carry out both in the classroom and as take home assignment.

Another two groups of students will form the control group (one urban and one rural) Participating teachers in the control group will teach the basic electricity concepts using the conventional classroom practice existing in the schools. Students in the control group will not be exposed to any treatment package. They also will be given adequate tasks to carry out in form of class work and homework as the teacher deemed fit. The researcher will give basic electricity objective test items and close-ended attitude scale to both the experimental and control groups after which teaching will take place. The process of teaching is expected to last for six weeks. The conduct of the study will take place during the normal school lesson periods. The normal time table of the schools will be followed for the study. The regular basic electricity teachers for the school will be used. This exercise will not disrupt the academic calendar.

The benefits of this study are to enable the learner to study repeatedly at his/her own pace, this make learning easier, simpler and more enjoyable which culminate in better contents mastery. Consequently, these will promote effective teaching and learning which would enhance high performance of students in basic electricity and promote conceptual understanding and improve learners' attitude as well as their teachers. In addition, it will help the technical teachers to consider gender issues in the teaching and learning process. It will also provide the teachers the opportunity of being creative without necessarily relying dogmatically on the existing method specified in the curriculum.

Participating in this study is voluntary and participants are under no obligation to consent to participate. If they do decide to take part, they will be given information sheet to keep and be asked to sign a written consent form. Participants are free to withdraw at any time and without giving a reason. There are no negative consequences, inconveniences, risk or discomfort. There is no incentive, payment or reward offered for participating in this study.

If you would like to be informed of the final research findings, please contact Mr. Odede Simeon Oluwole on +2348033754244 or email odedesimeon@yahoo.com. The findings will be accessible for five years. Should you require any further information or want to contact the researcher about any aspect of this study, please contact Odede Simeon on +2348033754244, Email: odedesimeon@yahoo.com .

Yours sincerely,

Odede Simeon .O.
PhD Student in Technology Education

Appendix 2

Letter of approval from OSBTVE

OSUN STATE BOARD FOR TECHNICAL & VOCATIONAL EDUCATION

P.M.B 4412, OSOGBO, STATE OF OSUN, NIGERIA.

E-mail:- ossbtve@yahoo.com

Our Ref: OSSBTVE/ADM385/4 Your Ref: Date: 30th Sept., 2019

Odebe Simeon O.
Institute for Science and Technology Education,
University of South Africa,
Pretoria, South Africa.

APPROVAL LETTER FOR THE CONDUCT OF RESEARCH TITLED: "EFFECTS OF PERSONALISED AND DIRECT SYSTEM OF INSTRUCTION IN TECHNICAL COLLEGE STUDENTS' ACHIEVEMENT IN BASIC ELECTRICITY" IN ALL TECHNICAL COLLEGES IN THE STATE OF OSUN.

Above Subject refers, please.

2. I am directed to inform you that the Acting Executive Secretary has approved your request in the conduct of research work in our Colleges.

3. As indicated in your letter that the programme will not in any form affects the normal time-table of the Schools and will improve Teacher's creativity in the teaching of Basic Electricity across the Schools which will culminate to high performance of students in Basic Electricity.

4. However, the date chosen for the commencement of the programme should be forwarded to the Board headquarters for adequate sensitization and preparation of both Staff and Students.

5. I thank you.

30th Sept., 2019.

N.O. Ogundele
for: Ag. Executive Secretary.

Appendix 3

Letter of Permission to the Principals

Request for permission to conduct research at Government Technical College ________________Osun State.

Research Title: Effect of Personalised System of Instruction on technical college students' achievement in Basic Electricity.

Date: 16/07/2019

The Principal,
Name of School: ___________________________

Dear Principal,

I, Odede Simeon Oluwole, I am doing a research under the supervision of Prof. Tome Mapotse, of the Department of Science and Technology Education towards a PhD degree at the University of South Africa (UNISA). Your school is one of the selected schools to be use for a research entitled: Effect of Personalised System of Instruction on Technical College Students' Achievement in Basic Electricity. Basic electricity students and their teachers will be participating in the study.

This study is expected to collect important information that could assist teachers on how to improve technical college students' academic achievement in basic electricity using different methods of teaching most especially students-centred method. In this study, the participating students will respond to questionnaire items that relates to Basic Electricity after which either personalised system of instruction (PSI) or conventional lecture methods will be used to teach them by their subject teacher depending on the group they belong to. The participants will be year two students of Basic Electricity classes and their teachers. All participants will be given enlightenment briefing on what they will be expected to do.

Two groups will be involved in the study, which are the experimental and control groups. The experimental group are those group where PSI will be use to teach the students and in control group the participant will be taught using conventional lecture methods.
Participating teachers in the experimental group will be trained by the researcher in respect to this study. They will be taught using the treatment package for Personalised System of Instruction (PSI) as the bases of their training and helping them to develop their knowledge of creativity in teaching Basic Electricity concepts. A group of students will form the experimental group, where the teacher will use personalised system of instruction (PSI). The students will be

taught the topics selected in the test blue print using the PSI. Adequate tasks in form of class work and homework will be given to them to carry out both in the classroom and as take home assignment.
Another group of students will form the control group (urban and rural) Participating teachers in the control group will teach the Basic Electricity concepts using the conventional classroom practice existing in the schools. Students in the control group will not be exposed to any treatment package. They also will be given adequate tasks to carry out in form of class work and homework as the teacher deemed fit.

The researcher will give Basic Electricity objective test items and close-ended attitude scale to both the experimental and control groups after which teaching will take place. The students will be taught the topics selected in the test blue print of basic electricity curriculum. Adequate tasks will be given to them to carry out both in the classroom and as take home assignment. The process of teaching is expected to last for six weeks. The conduct of the study will take place during the normal school lesson periods. The normal time table of the schools will be followed for the study. The regular Basic Electricity teachers for the school will be used. This exercise will not disrupt the academic calendar.

The benefits of this study are to enable the learner to study repeatedly at his/her own pace, this make learning easier, simpler and more enjoyable which culminate in better contents mastery. Consequently, these will promote effective teaching and learning which would enhance high performance of students in Basic Electricity and promote conceptual understanding and improve learners' attitude as well as their teachers. In addition, it will help the technical teachers to consider gender issues in the teaching and learning process. It will also provide the teachers the opportunity of being creative without necessarily relying dogmatically on the existing method specified in the curriculum.

Participating in this study is voluntary and participants are under no obligation to consent to participate. If they do decide to take part, they will be given information sheet to keep and be asked to sign a written consent form. Participants are free to withdraw without any penalty at any time and without giving a reason. There are no negative consequences, inconveniences, risk or discomfort. There is no incentive, payment or reward offered for participating in this study.

Your school is selected as the control/experimental group: ______________________________

If you would like to be informed of the final research findings, please contact Mr. Odede Simeon Oluwole on +2348033754244 or email odedesimeon@yahoo.com. The findings will be accessible for five years. Should you require any further information or want to contact the researcher about any aspect of this study, please contact Odede Simeon on +2348033754244, Email: odedesimeon@yahoo.com .

Yours sincerely,

Odede Simeon .O.

PhD Student in Technology Education.

Principal's Name & Surname:

Address:____

Principal's Signature:_________________ Date:_________________

Appendix 4a

Letter of Approval from OSBTVE to the Principal Government Technical College Osogbo

OSUN STATE BOARD FOR TECHNICAL & VOCATIONAL EDUCATION

P.M.B 4412, OSOGBO, STATE OF OSUN, NIGERIA.

E-mail:- ossbtve@yahoo.com

Our Ref: OSSBTVE/ADM/383/7 Your Ref: Date: 04-02-2020

The Principal,
Government Technical College,
Osogbo.

APPROVAL LETTER FOR THE CONDUCT OF RESEARCH TITLED "EFFECTS OF PERSONALISED SYSTEM OF INSTRUCTIONS ON TECHNICAL COLLEGE STUDENTS' ACHIEVEMENT IN BASIC ELECTRICITY" IN ALL THE TECHNICAL COLLEGES IN THE STATE OF OSUN

Above Subject refers, please.

2. I am directed to inform you that Mr. Odede Simeon O. will be conducting a research in your School.

3. The programme will run for Six weeks, between February 10th, to March 20th, 2020.

4. The programme will not in any form affects the normal time table of the School and the regular Basic Electricity teachers of the School will be used.

5. Kindly accord him all the necessary assistance required.

6. I thank you.

N.O. Ogundele
For: Ag. Executive Secretary

Appendix 4b

Letter of Approval from OSBTVE to the Principal Government Technical College Inisa

OSUN STATE BOARD FOR TECHNICAL & VOCATIONAL EDUCATION
P.M.B 4412, OSOGBO, STATE OF OSUN, NIGERIA.
E-mail:- ossbtve@yahoo.com

Our Ref: OSSBTVE/ADM/383/10 Your Ref: Date: 04-02-2020

The Principal,
Government Technical College,
Inisa.

APPROVAL LETTER FOR THE CONDUCT OF RESEARCH TITLED "EFFECTS OF PERSONALISED SYSTEM OF INSTRUCTIONS ON TECHNICAL COLLEGE STUDENTS' ACHIEVEMENT IN BASIC ELECTRICITY" IN ALL THE TECHNICAL COLLEGES IN THE STATE OF OSUN

Above Subject refers, please.

2. I am directed to inform you that Mr. Odede Simeon O. will be conducting a research in your School.

3. The programme will run for Six weeks, between February 10th, to March 20th, 2020.

4. The programme will not in any form affects the normal time table of the School and the regular Basic Electricity teachers of the School will be used.

5. Kindly accord him all the necessary assistance required.

6. I thank you.

N.O. Ogundele
For: Ag. Executive Secretary

Appendix 4c

Letter of Approval from OSBTVE to the Principal Government Technical College Ile-Ife

OSUN STATE BOARD FOR TECHNICAL & VOCATIONAL EDUCATION

P.M.B 4412, OSOGBO, STATE OF OSUN, NIGERIA.

E-mail:- ossbtve@yahoo.com

Our Ref: OSSBTVE/ADM/383/8 Your Ref: Date: 04 - 02 - 2020

The Principal,
Government Technical College,
Ife.

APPROVAL LETTER FOR THE CONDUCT OF RESEARCH TITLED "EFFECTS OF PERSONALISED SYSTEM OF INSTRUCTIONS ON TECHNICAL COLLEGE STUDENTS' ACHIEVEMENT IN BASIC ELECTRICITY" IN ALL THE TECHNICAL COLLEGES IN THE STATE OF OSUN

Above Subject refers, please.

2. I am directed to inform you that Mr. Odede Simeon O. will be conducting a research in your School.

3. The programme will run for Six weeks, between February 10th, to March 20th, 2020.

4. The programme will not in any form affects the normal time table of the School and the regular Basic Electricity teachers of the School will be used.

5. Kindly accord him all the necessary assistance required.

6. I thank you.

N.O. Ogundele
For: Ag. Executive Secretary

Appendix 4d

Letter of Approval from OSBTVE to the Principal Government Technical College Gbongan

OSUN STATE BOARD FOR TECHNICAL & VOCATIONAL EDUCATION

P.M.B 4412, OSOGBO, STATE OF OSUN, NIGERIA.

E-mail:- ossbtve@yahoo.com

Our Ref: OSSBTVE/ADM/383/9 Your Ref: ______ Date: 04-02-2020

The Principal,
Government Technical College,
Iwo.

APPROVAL LETTER FOR THE CONDUCT OF RESEARCH TITLED "EFFECTS OF PERSONALISED SYSTEM OF INSTRUCTIONS ON TECHNICAL COLLEGE STUDENTS' ACHIEVEMENT IN BASIC ELECTRICITY" IN ALL THE TECHNICAL COLLEGES IN THE STATE OF OSUN

Above Subject refers, please.

2. I am directed to inform you that Mr. Odede Simeon O. will be conducting a research in your School.

3. The programme will run for Six weeks, between February 10th, to March 20th, 2020.

4. The programme will not in any form affects the normal time table of the School and the regular Basic Electricity teachers of the School will be used.

5. Kindly accord him all the necessary assistance required.

6. I thank you.

N.O. Ogundele
For: Ag. Executive Secretary

Appendix 5

Research Assistant Confidential Agreement

RESEARCH ASSISTANT CONFIDENTIAL AGREEMENT

I.. (name of research assistant) agree to assist Odede, Simeon Oluwole with his study by taken part in the training, teaching of students, administering of questionnaire, marking and grading the students' scripts . I agree to maintain full confidentiality when performing these tasks.

Specifically, I agree to:

1. keep all research information shared with me confidential by not discussing or sharing the Information in any form or format (e.g., disks, tapes, transcripts) with anyone other than the primary investigator;
2. hold in strictest confidence the identification of any individual that may be revealed during the course of performing the research tasks;
3. not make copies of any raw data in any form or format (e.g., disks, tapes, transcripts), unless specifically requested to do so by the primary investigator;
4. keep all raw data that contains identifying information in any form or format (e.g., disks, tapes, transcripts) secure while it is in my possession. This includes:
    - keeping all digitized raw data in computer password-protected files and other raw data in a locked file;
    - closing any computer programs and documents of the raw data when temporarily away from the computer;
    - permanently deleting any e-mail communication containing the data; and
    - using closed headphones if transcribing recordings;
5. give, all raw data in any form or format (e.g., disks, tapes, transcripts) to the primary investigator when I have completed the research tasks;

6. destroy all research information in any form or format that is not returnable to the primary investigator (e.g., information stored on my computer hard drive) upon completion of the research tasks.

Name of research assistant:

Address:

Research Assistant Signature: Date: ____________

Researcher's Name: Odede Simeon Oluwole

Researcher's Signature: Date:____________

Appendix 6

PARTICIPANT INFORMATION SHEET: THE LETTER FOR CONSENT

16/07/2019
Title: Effect of Personalised System of Instruction on Technical College Students' Achievement in Basic Electricity.

DEAR PROSPECTIVE PARTICIPANT?
My name is Odede, Simeon Oluwole, I am doing a research under the supervision of Prof. Tome Mapotse of the department of Science and Technology Education towards a PhD degree at University of South Africa (UNISA). We are inviting you to participate in a study entitled, *"Effect of Personalised System of Instruction on Technical College students' achievement in Basic Electricity"*.

WHAT IS THE PURPOSE OF THE STUDY?
This study aims at investigating the influence of personalised system of instruction on the students' achievement regarding the theme 'Basic Electricity' in technical colleges in Osun State, Nigeria. This study is expected to collect important information that could assist teachers on how to improve technical college students' academic achievement in Basic Electricity using different methods of teaching most especially those that incorporate students-centred methods. Subsequently the study will enhance lecturer's performance in delivering Basic Electricity themes.

WHY AM I INVITED TO PARTICIPATE IN THIS STUDY?
You are invited as: (1). teacher because you have the expertise of the topic scrutiny and you are one of the teacher teaching basic electricity in the school, who knows everything about the subject as well as the students. (2). student in the experimental/control groups because you are one of the students studying a trade for whom basic electricity is compulsory, you are in the best position to provide answer to the questions raised in this study. I obtained your contact details from the school principal. I have all year two (TC II) Basic Electricity class and one Basic Electricity teacher in each school as the participants for this research.

WHAT IS THE NATURE OF MY PARTICIPATION IN THIS STUDY?
As participating teacher in the experimental and control groups, you will be trained by the researcher on how to use the treatment packages for Personalised System of Instruction (PSI). Base on this training you will teach the topics selected in the test blue print using the PSI, given students adequate tasks both in the classroom and as take home assignment. As participating teacher in the control group, you are expected to teach Basic Electricity concepts using the conventional classroom practice existing in the school. The teaching will take place in the classroom during your normal school lesson periods. You will also administer the questionnaire to the students, marking and grading the students' scripts.

As participating student in both the experimental and control group, you will respond to objective test items in Basic Electricity (TC II) curriculum content and closed-ended attitude questions at the beginning of the whole exercise, thereafter, teaching will take place in both groups, using PSI teaching method, depending on the group you are. The teaching is expected to last for six weeks and taking place in your classroom during normal school lesson periods. At the end of the sixth week, you will equally respond objective test items.

CAN I WITHDRAW FROM THIS STUDY EVEN AFTER HAVING AGREED TO PARTICIPATE?
Participating in this study is voluntary and you are under no obligation to consent to participation. If you do decide to take part, you will be given this information sheet to keep and be asked to sign a written consent form. You are free to withdraw without penalty at any time and without giving a reason. But it will not be possible to withdraw once the questionnaire has been submitted.

WHAT ARE THE POTENTIAL BENEFITS FOR TAKING PART IN THIS STUDY?

The benefits are to have positive impact on the students' participation after been taught with personalised system of instruction (PSI) which will enable the learner to study the skills repeatedly at his/her own pace, also participating students having exposed to work as a group rather than as individuals, will develop their sense of cooperative learning. Participant in the control group will also benefit since their teachers will also involve in the training, the method will also be use to teach them after the study has been completed. This procedure will provide for individual differences, eliminate tension and make learning easier, simpler and more enjoyable which will culminate in better mastering of the skills. Consequently, these will promote effective teaching and learning which would enhance high performance of students in Basic Electricity, it is hoped that this study will provide empirical support for the assumption that basic electricity concepts could be learnt effectively using PSI. It will also provide educational policy makers with the information useful in formulating educational policies like the development of technical college Basic Electricity curriculum and considering the level at which technical college teachers discharge their duties during the teaching and learning of Basic Electricity.

ARE THERE ANY NEGATIVE CONSEQUENCES FOR ME IF I PARTICIPATE IN THE RESEARCH PROJECT?

There are no negative consequences, inconveniences or discomfort.

WILL THE INFORMATION THAT I CONVEY TO THE RESEARCHER AND MY IDENTITY BE KEPT CONFIDENTIAL?

The information is confidential, and your name will not be recorded anywhere, and no one will be able to connect you to your responses. Your responses will be given a code number or a pseudonym and you will be referred to in this way in the data, any publication, or other research reporting methods such as conference proceedings. Your anonymous data may be used for other purposes, such as a research report, journal articles and conference proceedings. But individual participants will not be identified in such reports. Your responses may be reviewed by people responsible for making sure that research is done properly, including the external coder and members of the Research Ethics Review Committee. Otherwise, records that identify you will be available only to people working on the study, unless you give permission for other people to see the records. In brief, your responses will be protected in any publication of the information in order to keep them privacy.

HOW WILL THE RESEARCHER(S) PROTECT THE SECURITY OF DATA?

Hard copies of your responses will be stored by the researcher for a period of five years in a locked cupboard/filing cabinet in the researcher home for future research or academic purposes; electronic information will be stored on a password protected computer. Future use of the stored data will be subject to further Research Ethics Review and approval if applicable. Hard copies will be shredded, and electronic copies will be permanently deleted from the hard drive of the computer using a relevant software programme.

WILL I RECEIVE PAYMENT OR ANY INCENTIVES FOR PARTICIPATING IN THIS STUDY?

There is no incentive, payment or reward offered for participating in this study.

HAS THE STUDY BEEN CLEARED FOR ETHICS BY THE RELEVANT INSTITUTION?

This study has received written approval from the Research Ethics Review Committee of Institute for Science and Technology Education (ISTE), Unisa. A copy of the approval letter can be obtained from the researcher if you so wish.

HOW WILL I BE INFORMED ABOUT THE FINDINGS/RESULTS OF THE RESEARCH?

If you would like to be informed of the final research findings, please contact Mr. Odede Simeon Oluwole on +23408033754244 or +27791829012 email odedesimeon@yahoo.com. The findings are accessible for five years. Should you require any further information or you want to contact the researcher about any aspect of this study, please contact Odede Simeon Oluwole on +2348033754244, Email: odedesimeon@yahoo.com. Should you have concerns about the way in which the research has been conducted, you may contact Prof. Mapotse, tel: +27763090060, Email: Mapotta@unisa.ac.za. Office: +2348033754244

Thank you for taking time to read this information sheet and for participating in this study.
Regards,

Odede Simeon .O.
PhD Students in Technology Education.

Appendix 7

Letter of Consent/Assent to the Students

CONSENT/ASSENT TO PARTICIPATE IN THIS STUDY (STUDENTS)(Return slip)

I, ___________________ (participant name), confirm that the person asking my consent to take part in this research has told me about the nature, procedure, potential benefits and anticipated inconvenience of participation.

I have read (or had explained to me) and understood the study as explained in the information sheet.

I have had enough opportunity to ask questions and am prepared to participate in the study.
I understand that my participation is voluntary and that I am free to withdraw at any time without penalty (if applicable).

I am aware that the findings of this study will be processed into a research report, journal publications and/or conference proceedings, but that my participation will be kept confidential unless otherwise specified.

I agree to the recording of the questionnaire. I have received a signed copy of the informed consent agreement.

Participant Name & Surname:

Participant Signature: Date

Researcher's Name & Surname: Simeon Oluwole Odede

Researcher's Signature:  Date

Appendix 8

Ethical Clearance Approval

UNISA university of south africa

UNISA ISTE ETHICS REVIEW COMMITTEE

25 October 2019

Dear MR SIMEON OLUWOLE ODEDE

ERC Reference # :2019_CGS/ISTE+08
Name : MR SIMEON OLUWOLE ODEDE
Student #: 64095991

Decision: Ethics Approval from 28/10/2019 to 28/10/ 2024

Researcher(s): MR SIMEON OLUWOLE ODEDE
E-mail address: 64095991@mylife.unisa.ac.za
Telephone #0791829012

Supervisor (s): PROF. TOMÉ MAPOTSE
E-mail address: mapotta@unisa.ac.za
Telephone #012 799 7007

Working title of research:

EFFECT OF PERSONALISED SYSTEM OF INSTRUCTION ON TECHNICAL COLLEGE STUDENTS' ACHIEVEMENT IN BASIC ELECTRICITY.

Qualification: 90040 Doctor of Philosophy

Thank you for the application for research ethics clearance by the Unisa **ISTE** Ethics Review Committee for the above mentioned research. Ethics approval is granted for **5 YEARS**.

*The **low risk application** was **expedited** by the ISTE Ethics Review Committee on 25-10-2019 in compliance with the Unisa Policy on Research Ethics and the Standard Operating Procedure on Research Ethics Risk Assessment. The decision will be tabled at the next ISTE Committee meeting for ratification.*

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsimile: +27 12 429 4150
www.unisa.ac.za

The proposed research may now commence with the provisions that:

1. The researcher(s) will ensure that the research project adheres to the values and principles expressed in the UNISA Policy on Research Ethics.
2. Any adverse circumstance arising in the undertaking of the research project that is relevant to the ethicality of the study should be communicated in writing to the ISTE ERC Committee.
3. The researcher(s) will conduct the study according to the methods and procedures set out in the approved application.
4. Any changes that can affect the study-related risks for the research participants, particularly in terms of assurances made with regards to the protection of participants' privacy and the confidentiality of the data, should be reported to the Committee in writing, accompanied by a progress report.
5. The researcher will ensure that the research project adheres to any applicable national legislation, professional codes of conduct, institutional guidelines and scientific standards relevant to the specific field of study. Adherence to the following South African legislation is important, if applicable: Protection of Personal Information Act, no 4 of 2013; Children's act no 38 of 2005 and the National Health Act, no 61 of 2003.
6. Only de-identified research data may be used for secondary research purposes in future on condition that the research objectives are similar to those of the original research. Secondary use of identifiable human research data require additional ethics clearance.
7. No fieldwork activities may continue after the expiry date **28/10/2024**. Submission of a completed research ethics progress report will constitute an application for renewal of Ethics Research Committee approval.

Note:

*The reference number **2019_CGS/ISTE+08** should be clearly indicated on all forms of communication with the intended research participants, as well as with the Committee.*

Yours sincerely,

Signature
Chair of ISTE ERC : Prof K Padayachee
E-mail: padayk@unisa.ac.za
Tel: (012) 429-6191

Signature
Executive Dean : Prof B Mamba
E-mail: mambabb@unisa.ac.za
Tel: (011) 670 9230

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsimile: +27 12 429 4150
www.unisa.ac.za

Appendix 9

PERSONALISED SYSTEM OF INSTRUCTION (PSI) INSTRUCTIONAL GUIDE

Introduction: This is Personalised System of Instruction (PSI) package designed on the topic Alternating circuit, Magnetism and electromagnetism and transformer. The package must be read through step by step at one's own speed, and the directions must be followed exactly as written in the package. It is also permissible to call the teacher's attention to any points that need to be clarified.

MODULE ONE

Unit 1

Topic: Concept of alternating current (a.c) circuit

Objectives: The students should be able to carry out the following activities after the package;

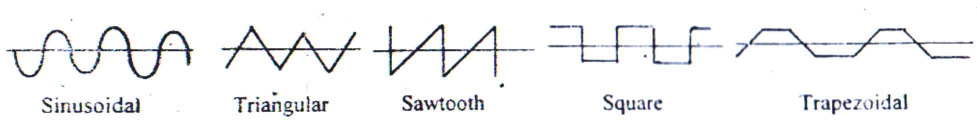
(a) Define and identify alternating current (a.c) signal
(b) Explain the generation of sinusoidal signal
(c) State and explain the parameters of a.c circuit.

Procedure:

Content One: Define alternating current (a.c)

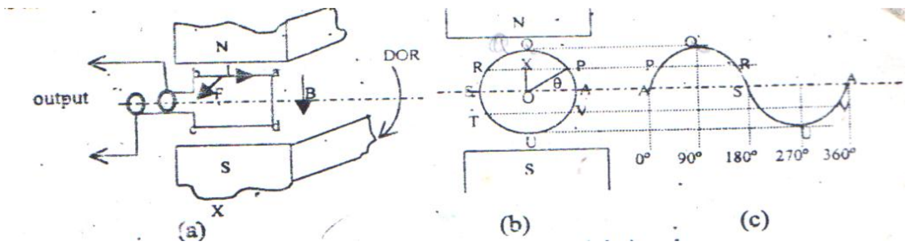
Step 1:To define alternating current signal. The student finds the definition of alternating current in electrical text books which is the current whose magnitude and direction vary periodically. The current rises from its minimum value to a maximum value and then falls back to the minimum value, and so on.

Step 2: To identify different types of a.c. signal. The students are taken to electronic laboratory/workshop and were provided with oscilloscope, signal generator, and other materials to identify different types of a.c. signal.Common examples of a.c. signal



Content Two: Explain the generation of sinusoidal signal

Step 1: The generation of sinusoidal signal: The student to read from the electrical/electronic text books to find out the generation of a sinusoidal signal which can be illustrated by the rotation of a single-turn coil conductor in a magnetic field. Consider the sides ad and bc of the coil rotating at a constant speed inside a uniform magnetic field. DOR means "direction of rotation" of the coil.



Generation of sinusoidal signal

$i(t) = I_{max}\sin\theta$

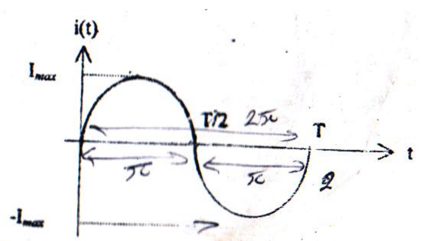
$= I_{max}\sin\omega t$

Where I_{max} = peak value of current, and

ω = constant angular speed of rotation of the coil (in rad/s)

Content Three: State and explain the parameters of a.c circuit.

Step 1: the parameters of a.c signal. Students to read from the electrical/electronic text books to discover the some important and common parameters of sinusoidal signals are defined below with the aid.



Parameters of a sine wave

1. Cycle, 2. Period, t, 3.Frequency,f, 4.Amplitude, (i_{max}), 5.Peak-to-peak value (i_{p-p}), 6. Average value (i_{av}), 7. Root-mean-square or effective value, $_{rms,}$ 8. Form factor:

STUDY QUESTION:

A sinusoidal current signal is represented by the expression i (t) = 10sin6284t (ampere)

Obtain the following parameters of the signal: (a) amplitude (b) peak-to-peak value (c) rms value (d) average value (e) angular frequency (f) frequency (g) period (h) form factor.

Unit 2

TOPIC: Resistors, capacitors, inductors action in an a.c circuit.

Objectives: The students should be able to carry out the following activities after the package;

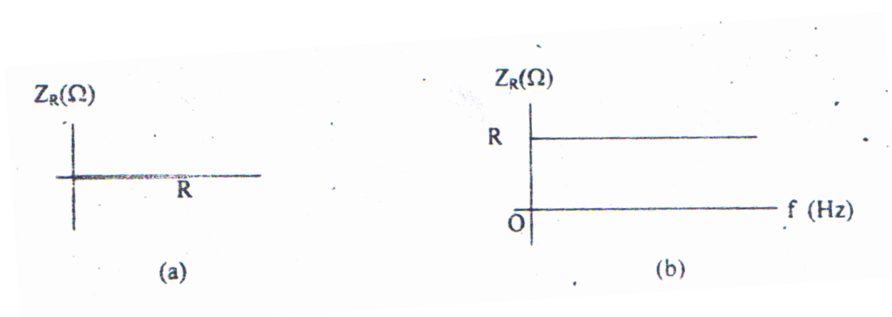
(a) Explain the meaning of reactance, capacitive reactance, inductive reactance and impedance, giving its symbol, unit and formula and use the formula to solve problems.

(b) Explain the action of resistors, capacitors and inductors in a.c circuits using ohm's law and draw the phase relationship between current and voltage.

(c) State the phase relationship and power in an ideal capacitor and power in an ideal inductor.

Content One: The definition of resistance, capacitive reactance, inductive reactance and impedance giving its symbol, and unit.

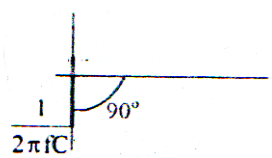
Step 1: definition of resistance. The student reads from Electrical/Electronic text books or from the net the definition of resistance which was defined as the opposition a resistor (conductor) offers to the flow of electric current. The impedance of a pure resistor R ohm is $Z_R = R$ (Ω). This is represented by the impedance phasor. The phasor is a line segment of length R lying on the right (positive) horizontal axis.



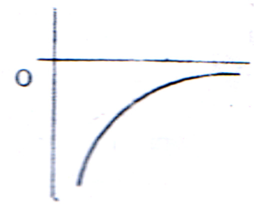
Pure resistance (a) impedance phasor (b) frequency curve

Step 2: define capacitive reactance. The student finds from Electrical/Electronic text books or from the net the definition of capacitive reactance.The opposition to alternating current flow due the capacitance of a capacitor is known as the CAPACITIVE REACTANCE, Xc. For a pure capacitor of C Farads, the capacitive reactance is given by the formula, Where f = frequency of the a.c. supply to the capacitor $Xc = \frac{1}{\omega C} = \frac{1}{2\pi fC} \quad (ohm)$

The impedance phasor of a capacitor is a line segment of length Xc = $1/2\pi fC$ and making an angle of -90^o to the positive horizontal axis.



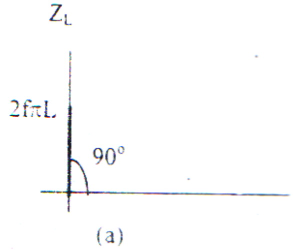
(a)

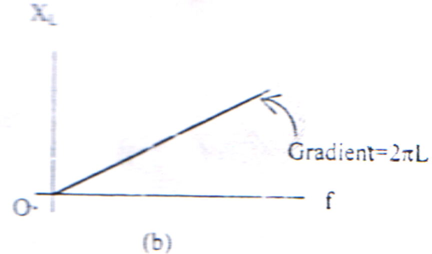


(b)

Capacitive reactance (a) impedance (b) frequency curve

Step 3: definition of inductive reactance. The student finds from Electrical/Electronic text books or from the net the definition of inductive reactance. The opposition to alternating current flow due to the inductance of an inductor is known as INDUCTIVE REACTANCE, X_L. For a pure inductor of inductance (L) henry, the inductive reactance is given by the formula $X_L = \omega L = 2\pi fL$ (Ω). The impedance phasor of an inductor is a line segment of length $2\pi fL$ and taking an angle of +90^o to the positive horizontal axis.





Inductive reactance (a) impedance phasor (b) frequency curve

Step 4: define impedance. The student finds from Electrical/Electronic text books or from the net the definition of impedance. The impedance, Z, of a component can be defined as the ratio of instantaneous voltage to instantaneous current. That is, Impedance is the combined opposition to current flow offered by resistance, capacitance

$Z = \frac{v(t)}{i(t)}$ and inductance. It is measured in ohm (Ω).

Content Two: discover action of resistors, capacitor and inductor in a.c circuits using ohm's law and draw the phase relationship between current and voltage.

Step 1: discover action of resistor in a.c circuit. Students are taken to the electronics laboratory and were provided with oscilloscope, signal generator, resistor and other materials to discover action of resistor in a.c circuit which can be either IN-PHASE or OUT-OF-PHASE.

Step 2: discover action of capacitor in a.c circuit. Students are taken to the electronics laboratory and were provided with oscilloscope, signal generator, capacitor and other materials to discover action of capacitor in a.c circuit.

Step 3: discover action of inductor in a.c circuit. Students are taken to the electronics laboratory and were provided with oscilloscope, signal generator, inductor and other materials to discover action of inductor in a.c circuit

SELF TEST

Calculate the reactance of a (a) 10μF capacitor and (b) 40mH inductor at 50 Hz.

MODULE TWO

TOPIC: Series R-C, R-L, and L-C circuit.

Objectives: The students should be able to carry out the following activities after the package;

(a) Derive the formula for the impedance and current of a series, R-C, R-L, and L-C circuit.

(b) Solve problem in series R-C, R-L, and L-C circuit.

(c) Derive the formula for the impedance and current of a series, and solve problems in series R-L-C circuit.

(d) Identify and derive the three types of power using Power Triangle.

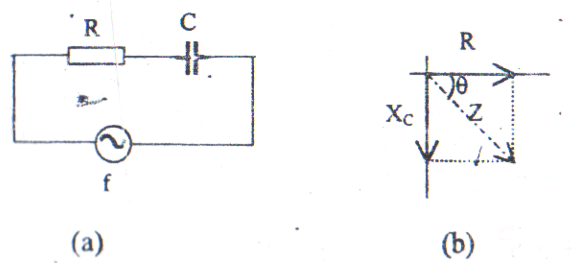
Content One: Derive the formula for the impedance and current of a series, R-C, R-L, and L-C circuit

Step 1: To derive the formula for impedance resistor-capacitor in series. The student derives the formula for the impedance and current of a resistor and a capacitor connected in series**.** In order to obtain the total impedance of the series network, the vector sum of the impedance of each component is determined, and then added together vectorially. Thus, as shown in figure, the magnitude of the total impedance is

$$Z = \sqrt{R^2 + X_C{}^2}$$

Z makes an angle of θ° with the R-phasor with given by the formula

$$\theta = \tan^{-1}\frac{X_C}{R}$$



Series RC Network

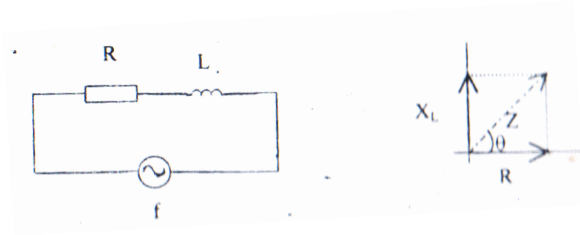
As the frequency of the supply signal increases, R remains constant but X_C decreases, hence reducing the total impedance.

Step 2: to derive the formula for impedance resistor-inductor in series. The student derives the formula for the impedance and current of a resistor and inductor connected in series**.** The total impedance is given by the formula.

$$Z = \sqrt{R^2 + X_L{}^2}$$

$$\theta = \tan^{-1}\frac{X_L}{R}$$

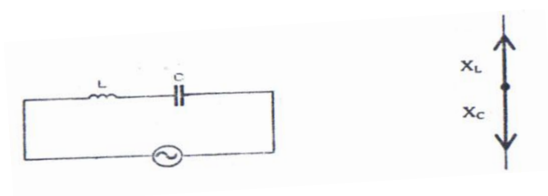
Z makes an angle θ° with the R phasor where θ is given by the formula



(a) (b)

Series RL Network

Step 3: to derive the formula for impedance inductor-capacitor (LC) in series. The student derives the formula for the impedance and current of an inductor and capacitor connected in series**.** An inductance L and a capacitance C connected in series across an a.c. supply. The total impedance phasor is simply obtained by adding algebraically the two reactance. The larger of the two reactance determines the direction of the total impedance. Hence, the total impedance can be capacitive of inductive, or even zero if $X_L = X_C$.



(a) (b)

Series LC Network

As the supply frequency increases, then X_L increases while X_C decreases.

Content Two: solve problem in series R-C, R-L, and L-C circuit.

Step 1: to solve problem in series R-C, the student finds from Electrical/Electronic text books or from the internet problems relating to Resistor-Capacitor network under the supervision of the instructor.

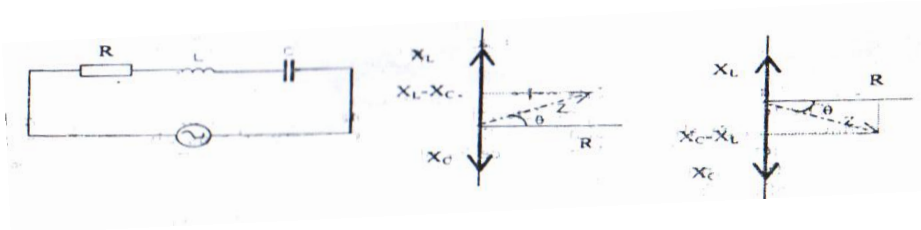
Step 2: The student solve problems relating to Resistor-Inductor network while the instructor supervised.

Step 3: The student solve problems relating to Inductor-Capacitor network.

Content Three: derive the formula for the impedance and current of a series R-L-C

Step 1: to derive the formula for the impedance and current of a series R-L-C, the student derives the formula for the impedance and current of a resistor, inductor and capacitor connected in series by combining the formula of series R-C and L-C together. A series

RLC network. There are two distinct cases here, depending on whether the total reactance is capacitive or inductive.



(a) (b) (c)

Series RLC Network

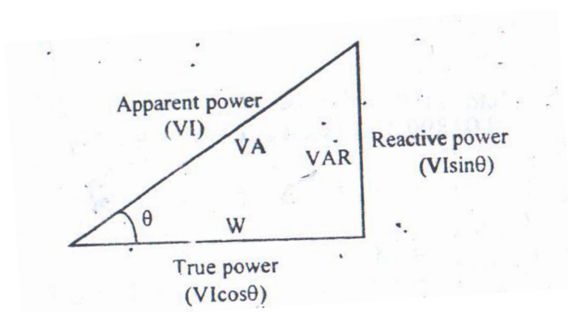
$X_C > X_L$; hence, the total impedance is

$$Z = \sqrt{R^2 + (X_C - X_L)^2}$$

Step 2: Solve problems on R-L-C network. Students to solve some problems under the supervision of the instructor.

Content Four: Identify and derive the three types of power using Power Triangle

Step 1: to identify the three types of power. Students use the power triangle from electrical/electronic textbook to identify true power, reactive power and apparent power thus; the phasors of these powers form what is referred to as the POWER TRIANGLE as illustrated. The instructor should explain and clarify certain issues where necessary.



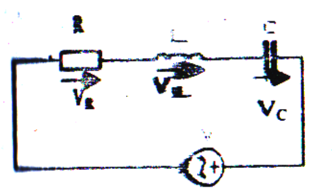
The Power Triangle

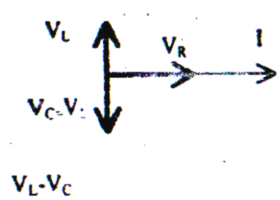
Step 2: to derive the true power, reactive power and apparent power using Power Triangle. Students to make use of Pythagoras theorem to derive the formula thus; APPARENT POWER, P_{app}, is the amount of power that appears to have been dissipated in a circuit. It is simply obtained by multiplying the rms voltage by the rms current, that is, P_{app} = VI, measured in VOLT-AMPERES (VA). **TRUE POWER (or ACTIVE POWER)**, P_{tr}, is the actual power dissipated in a circuit, obtained from the expression P_{tr} = VI.cosθ, measured in WATTS (W). **REACTIVE POWER,** P_r, is the "wattless" power that does not work in a circuit, but rather increases the current taken by the load. It is obtained from the expression. P_r = VIsinθ, measured in VOLTAMPERE REACTIVE (VAR)

Step 3: to derive POWER FACTOR, (pf) true power, reactive power and apparent power. Students derive power factor from the identified type of power thus; the term POWER FACTOR of a circuit can be defined as the cosine of the angle between current and voltage phasors in the circuit. The instructor provides guidance where necessary.

Step 4: explain series resonant circuit. Students to read from the Electrical/Electronic textbooks to discover the RESONANCE circuit. (i.e if the inductive reactance and capacitive reactance of the circuit are equal). That is, at resonance: $X_L = X_C$ or

$2\pi f_o L = \frac{1}{2\pi f_o C}$ Which gives the resonant frequency, f_o, as $f_o = \frac{1}{2\pi\sqrt{LC}}$





Illustrating Resonance

MODULE THREE

Topic: Basic Concept of Magnetism, Electromagnetism; Applications of Magnetic circuits.

Objectives: At the end of the lesson, students should be able to;

(a) Explain the basic concepts of magnetism
(b) Explain the electric and magnetic fields and electromagnetism
(c) List and explain the application of magnetic circuits.

Procedure:

Content One: Explain the basic concepts of magnetism.

Step 1: To explain the basic concepts of magnetism. The student will read from text books to find out basic concepts of magnetism thus; many appliances and equipment we make use of in our homes or offices depend upon magnetism for their operation. Typical examples are tape recorders, television receivers, automobiles, air conditioners and telephone.

Step 2: To identify two types of magnet. A magnet is a piece of material substances which has the property of attracting some materials, like iron, but does not attract some other materials, such as plastics. A magnet can be either natural magnet or artificial magnet.

N: north pole

S: south pole

A bar magnet

A magnet, therefore, points in the north-south direction when freely suspended and also attracts iron filings. The lodestone is now rarely used because its degree of magnetization is very small.

Artificial Magnets

A considerable degree of magnetization can be achieved in magnetic materials through artificial means. There are two categories of artificial magnets: permanent magnets and temporary magnets.

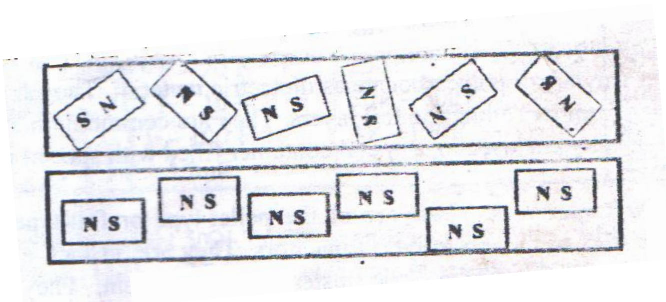
PERMANENT MANETS are artificial magnets that retain their magnetic property (or MAGNETISM) for a long time. They are commonly made from iron alloys. Alnico magnet, for example, is composed of aluminum, nickel, cobalt, iron and copper in a certain proportion. Ceramic materials also make good permanent magnets. Permanent magnets are used, for example, in moving-coil measuring instruments, loudspeakers and electric motors.

TEMPORARY MAGNETS (e.g. **ELECTROMAGNETS)** are made by sending a current through a wire wound around a piece of iron. The material becomes, and remains, magnetic as long as current flows through them. Materials used for making temporary magnets include soft iron, ferrite and silicon steel. They are commonly used in electric motors, generators, transformers, electric fans, electric belts, relays etc.

THEORY OF MAGNETISM

An electric current produces a MAGNETIC FIELD which is the space around a magnet where a magnetic material will be attracted by the magnet. However, current is the movement of electrical charges; hence any moving charge should create a magnetic field. The electrons and molecules, which both possess charge and are in motion, therefore, have magnetic field associated with them.

The molecular theory of magnetism explains that each molecule of a magnetic substance is a magnet having both north and south poles. Prior to magnetization, however, the molecules are arranged in a random way in different directions and groups. Thus, the molecules and hence the materials, end up to be non-magnetic.



Illustrating Theory of Magnetism

During magnetization process, however, the molecules are being forced to align in one direction with polarities. In the end, one end of the bar becomes the south pole (S) while the other end becomes the north pole (N).

Content Two: to detect magnetic quantities an terms

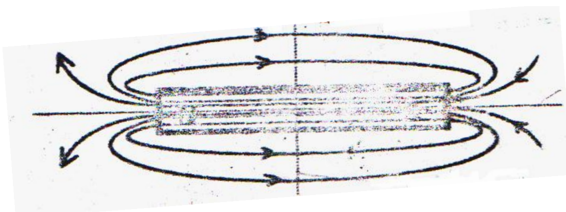
Step 1: to detect a magnetic line of force: Students are taken to the workshop/laboratory and were provided with magnet and iron filling under the supervision of the teacher.

MAGNETIC QUANTITIES AND TERMS

Some common quantities and terms, which are relevant to magnetism and magnetic field, are discussed below.

Magnetic Lines of Force

These are the imaginary lines assumed to start from the North Pole outside the magnet, and, from south to north inside the magnet. The magnetic lines of force are more intense near the poles of the magnet and become weaker as the distance from the magnet is increased.



Magnetic Lines of force

The space defined by the magnetic lines of force around a magnet is known as the MAGNETIC FIELD.

The imaginary line joining the two poles of a magnet is known as the MAGNETIC AXIS. The imaginary line perpendicular to the magnetic axis and passing through the centre of the magnet is known as the MAGNETIC NEUTRAL AXIS.

Magnetic Flux

This is the total number of magnetic lines of force existing in a magnetic field. It is measured in WEBBER (Wb).

Magnetic Flux Density, B

This is the total number of lines of force (flux) per unit cross-sectional area.

Therefore,

$$\text{Flux density} = \frac{\text{Total flux}}{\text{cross – sectional area}}$$

or,

$$B = \frac{\phi}{A}$$

Where B = flux density

ϕ = total magnetic flux

A = cross-sectional area

Magnetic flux density is measured in TESLA (T), where

1 Tesla (T) = 1 Weber per square metre (Wb/m^2)

Example:

Calculate the magnetic flux density in a magnetic material of 4cm^2 cross-sectional area and having a total flux of 6 Wb through it.

Magnetomotive Force, mmf

This is the force which drives the magnetic flux through a magnetic circuit. It is equivalent to the electromotive force (emf) in electric circuits.

Magnetomotive force is measured in AMPERE-TURNS (AT). Thus,

mmf = NI

where N = number of turns in the coil,

I = value of current in amperes

Example:

Determine the number of turns of a coil required to develop an mmf of 10 AT if 2 ampere current moves through it.

Magnetic Field Strength

This is sometimes known as MAGNETIC FIELD INTENSITY MAGNETISING FORCE. It is the quantity of mmf available to create a magnetic field for each unit length of a magnetic circuit. Therefore,

$$H = \frac{mmf}{l} = \frac{NI}{l}$$

The unit of measurement of the magnetic field strength is AMPERE-TURNS PER METER (AT/m).

Example:

In a magnetic circuit, a 5-turn coil carries a current of 3 ampere. If the average length of the magnetic circuit is 15cm, calculate the magnetic field intensity.

Permeability, μ

Different materials have different ability to conduct magnetic flux. For example, magnetic lines of force prefer to pass through a soft iron than through air, hence, the soft iron is said to have greater permeability than air. PERMEABILITY is, therefore, defined as the ability of the magnetic materials to conduct magnetic lines of force (or magnetic flux). Mathematically, it is given by the formula

$$\mu = \frac{B}{H}$$

Where B is the magnetic flux density and H is the magnetic field strength.

Permeability is measured in WEBERS PER METER PER AMPERE-TURN (Wb/m.AT) or HENRY PER METRE (H/m)

Permeability of a material is commonly given with respect to the permeability of air. Thus,

$$\mu = \mu_r \mu_o$$

Where μ_r = RELATIVE PERMEABILITY of the material and is unitless, and

$\mu_o = 4\pi \times 10^{-7}$ Wb/A.m. (i.e. permeability of air).

The relative permeability of all non-magnetic materials, including air, is about 1, while values for magnetic materials range between 30 and 6000.

Example:

The magnetic flux density and field strength in a magnetic material are 5×10^{-2}T and 400AT/m respectively. Calculate the relative permeability of the material.

Reluctance, S

RELUCTANCE is the opposition offered by a magnetic material to the establishment of magnetic flux in it. It depends upon the material and the physical dimensions of the material Air. For example, has 50 to 5000 times the reluctance of common magnetic materials.

Reluctance is equivalent to resistance in electrical circuits. Its unit of measurement is AMPERE-TURNS PER WEBER (AT/Wb).

In electric circuits, current takes the lowest resistance path. Similarly in magnetic circuits, flux takes the lowest reluctance path.

(a) (b) (c)

Air, a high reluctance material, is the medium through which the flux passes. The flux spreads out in the air beyond the boundaries of the magnet's pole pieces.

The solid iron, placed between the poles, offers a low-reluctance path. Hence, the flux hardly spreads out but is concentrated within the iron.

An iron-ring is placed between the poles. The flux is guided by the low-reluctance iron-ring piece. The air-space within the ring is, however, completely protected (or shielded) from the magnetic flux. The ring, therefore, offers a MAGNETIC SHIELD to any object placed inside the ring itself.

Evaluation/Study Question

What is a magnet?

Distinguish between artificial magnets and natural magnets

Distinguish between permanent magnets and temporary magnets

Explain the molecular theory of magnetism

Define the following terms as they relate to magnetism and magnetic field (a) magnetic lines of force (b) magnetic flex (c) magnetic flux density (d) magnetic field strength (e) magnetomotive force (f) permeability of a material (g) reluctance of a material

Sketch the B-H curve of a magnetic material. Explain the curve

What is hysteresis loop?

Explain the following terms with the aid of the hysteresis loop: (a) residual magnetism (b) coercive force (c) hysteresis loss.

MODULE FOUR

Topic: Transformer, Core Laminations of Transformers, Losses in Transformer, types and uses of Transformers.

Objectives: The students should be able to carry out the following activities after the package

(a) Define and explain the concept of transformer

(b) Explain the reasons for laminating the core of transformers and the types of losses in transformer.

(c) Explain the types and uses of transformers.

INSTRUCTIONAL MATERIALS: Transformers, oscilloscope, signal generator, multimeter,

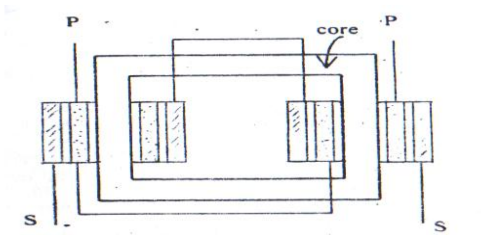
PROCEDURE:

Content One: Define and explain the concept of transformer

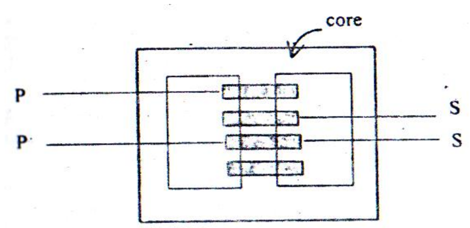
Step 1: To define transformer. The student finds the definition from Electrical/Electronic textbooks or from the internet the definition of a transformer which is an electrical a.c. component or equipment which consists of two or more coils that are linked together by mutual inductance. It is used to transfer electrical power from one coil to another. It can be used to change voltage, current or impedance from one value to another.

Step 2: To describetransformer construction. The student reads from Electrical/Electronic textbooks or from the internet the description of a transformer. Power is applied to the transformer through one of the coils which is known as PRIMARY winding. Power is taken from another coil known as the SECONDARY winding. The primary winding converts the input electrical energy into magnetic energy while the secondary winding converts the magnetic energy back to electrical energy. The two windings are, therefore, magnetically coupled but electrically insulated from each other. The teacher to clarify some issues if necessary.

Step 3: To explaincore-type and shell typetransformer construction. The student reads from Electrical/Electronic textbooks or from the internet the core-type and shell type of a transformer**.** In the core-type transformer, a single magnetic circuit is used. In the shell-type, a double magnetic circuit is used. Windings and core arrangements of the two types of core formation are illustrated.



Core-type transformer



Shell-type transformer

Step 4: explaintransformer action. The student finds from Electrical/Electronic textbooks or from the internet the transformer action**.** One of the principal applications of transformers is to change voltage from one value to another.

Step 5: discover the efficiency of a transformer. The student finds from Electrical/Electronic textbooks or from the internet the efficiency of a transformer.

The EFFICIENCY,η, of a transformer is defined as

$$\eta = \frac{P_s}{P_p} \times 100$$

While the power loss is given by

$P_L = P_p - P_s$

STUDY QUESTION:

1. A transformer contains 45 turns of primary winding and 20 turns of secondary windings. If the primary voltage is 230V, calculate (a) the secondary voltage (b) turns-per-volt ratio.
2. A transformer’s secondary winding contains 100 turns and supplies 12V to an external load. If the secondary of the same transformer is to be rewound to supply 9V calculate the new number of turns.

3. A 10MW generating station supplies 20kV to the primary of a power transformer. If the transmission current is not to exceed 20A, calculate the required secondary voltage. (Assume a power factor of 1).

SELF TEST:

1. A 16-ohm loudspeaker is to be matched to an amplifier having an output impedance of 10kΩ. Determine the required transformer turns-ratio.
2. Calculate the efficiency of a transformer that requires 11MVA of primary power to provide 10MVA of secondary power.

MODULE 5

Content: discover causes, types of power losses in a transformer and explain them; and how to minimized these losses.

Step 1: To discover causes of power losses in a transformer. The student finds from electrical textbooks or from the internet the causes of power losses in the transformer. The power consumed by the transformer itself constitutes the power loss. It is the difference between the secondary power and the primary power as written in equation. In the worked example above, the power loss is (11-10) MVA = 1MVA.

Step 2: To identify types of power losses in a transformer. The student finds from electrical textbooks or from the internet the causes of power losses in the transformer. Power loss in a transformer is mainly caused by any or combination of the following:

1. Hysteresis loss
2. Eddy current loss
3. Copper (I^2R) loss

Both hysteresis loss and eddy current loss, jointly called IRON LOSSES, occur in the core materials, while copper loss occurs in the windings. All these losses convert electrical energy into heat in the transformer.

Step 3: To explain the different types of power losses in a transformer. The student finds from electrical textbooks or from the internet the different types of power losses in the transformer.

1. Hysteresis Loss
2. Eddy Current Loss
3. Copper or I^2R Loss

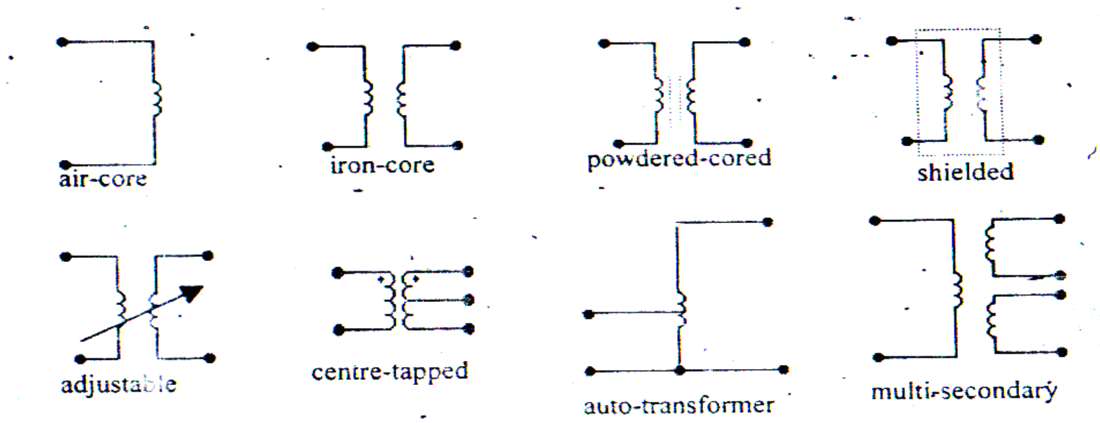
Step 4: To explain how power losses can be reduced in a transformer. The student finds from electrical textbooks or from the internet the how power losses can be reduced in a transformer. (1) HYSTERESIS LOSS can be reduced by making use of silicon-steel alloy. The core is laminated up to audio-frequency range but not above since hysteresis loss increases with frequency increase. (2) One common method of reducing eddy current loss is by laminating (slicing up) the core into thin sections. Each lamination is insulated with a thin layer of oxide. The high resistance of the oxide on each lamination effectively reduces the flow of eddy current. (3) Copper loss is commonly minimized by using a coil conductor of as large a cross-sectional area as possible.

Content: Discover types and uses of a transformers

Step 1: To discover types and uses of a transformer. The student will read from electrical/electronic textbooks or from the internet the different types of transformer.The different types of transformer depend on their applications. Students are

1. Power Transformers and uses
2. Audio Transformers and uses
3. Constant-voltage Transformers and uses
4. Isolation Transformers and uses
5. Auto-transformers and uses
6. Regulating (or Variable) Transformers and uses. The teacher to clarify issues if need be.

Step 2: To discover the circuit symbols for some of the different types of transformers**.** The student discovers from the internet or electrical/electronic textbooks thecircuit symbols for some of the different types of transformers.



Circuit symbols of various transformer types

EVALUATION

The students should attempt to answer the following questions:

1. What is a transformer?
2. Distinguish between the core-type and the shell-type transformers
3. What is (a) a step-down transformer (b) a step-up transformer?
4. The primary voltage and current of a transformer are 240V and 2A respectively. If the primary-to-secondary turns ratio is 20:1, calculate (a) they secondary voltage (b) the secondary current (c)the turns-per-volt ratio of the transformer
5. Write shortly on the following types of power losses in transformers (a) hysteresis loss (b) eddy-current loss (c) copper loss
6. Explain the ways by which the power losses could be reduced
7. State the function(s) of each of the following types of transformers. (a) power transformer (b) audio transfer (c) isolation transformer (d) constant voltage transformer
8. Draw a typical test circuit that can be used to determine in a transformer (a) hysteresis and eddy-current losses (b) copper loss.

APPENDIX 10

LESSON PLAN USING CONVENTIONAL LECTURE APPROACH

LESSON ONE
SUBJECT: Basic Electricity
CLASS: Trade 2

Topic: Concept of alternating current (a.c) circuit

Reference: Electric circuit Analysis, by Schuler and Fowler

Objectives: At the end of the lesson, students should be able to;

a. Define and identify alternating current (a.c) signal
b. Explain the generation of sinusoidal signal
c. State and explain the parameters of a.c circuit.

Instructional Materials: Chalkboard, A.C motor;

Previous knowledge: Students are familiar with a.c. motor,

Introduction: The instructor introduces lesson by asking the students to state ohm's law and state its formula.

Presentation:

Step 1**:** The instructor defines alternating current (a.c) signal.

Step 2: The instructor identifies types of alternating current (a.c) signal.

Step 3: The instructor explains the generation of sinusoidal signal.

Step 4: The instructor state and explain the parameters of a.c circuit.

Evaluation: The lesson is evaluated as follows:

(a) defines alternating current (a.c) signal?

(b) identifies types of alternating current (a.c) signal?

(c) explains the generation of sinusoidal signal?

(d) State and explain the parameters of a.c circuit?

Conclusion: The students are corrected and asked to copy notes into their notebooks.

Assignment: Students are to read on Resistor in an A.C circuit from home against the next class.

LESSON TWO

SUBJECT: Basic Electricity

CLASS: Trade 2

Topic: Resistor, capacitor and inductor action in an A.C circuits; Power in A.C resistive circuits.

Reference: Electric circuit Analysis, by Schuler and Fowler

Objectives: At the end of the lesson, students should be able to;

(a) Explain the action of resistors in A.C circuits using ohm's law.
(b) Explain the action of capacitor in A.C circuits.
(c) Explain the action of inductor in A.C circuits.
(d) Draw the phase relationship between current and voltage.
(e) State the formula for power in A.C resistive circuits
(f) Solve problem in ac resistive circuits
g. Explain the meaning of capacitive reactance giving its symbol.
h. State the unit and formula and use the formula to solve problems

Instructional Materials: Chalkboard, notebook, calculator

Previous knowledge: Students are familiar with resistors, A.C circuits and ohm's law

Introduction: The instructor introduces lesson by asking the students to state ohm's law and state its formula.

Presentation:

Step 1**:** The instructor explains the actions of resistor in A.C circuits using ohm's law.

Step 2: The instructor explains the actions of capacitor in A.C circuits

Step 3: The instructor explains the actions of inductor in A.C circuits.

Step 4: The instructor draws the waveforms and the phase relationship.

Step 5: The instructor states and explains the formula for calculating power in ac resistive circuits as the students listen.

Step 6: The instructor solves problems related to the formulas in the steps above while the students watch and ask questions.

Step 7**:** The instructor explains the meaning of capacitive reactance, gives its symbol and unit and states the formula for calculating capacitive reactance of a capacitor.

Step 8**:** He goes further by using the formula to solve a problem while the students watch. He then allows them to ask questions.

Evaluation: The lesson is evaluated as follows:

(a) explain the actions of resistor, capacitor and inductor in ac circuits using ohm's law?

(b) draw the waveforms and relationship as they have learnt?

(c) state the formulas for calculating power in ac resistive circuits?

(d) solve some problems while the instructor goes round to check and mark.

Conclusion: The students are corrected and asked to copy notes into their notebooks.

Assignment: Students are given a problem to solve from home against the next class.

LESSON THREE

SUBJECT: Basic Electricity

CLASS: Trade 2

Topic: Series R-C, R-L, and L-C circuit.

Reference: Basic Electricity Made Easy, by M.A. Lasisi

Objectives: At the end of the lesson, students should be able to;

a. State the formula for the impedance and other parameters of a series, R-C, R-L, and L-C circuit.
b. Solve problem in series R-C, R-L, and L-C circuit.
c. State the formula for the impedance and current of a series, R-L-C circuit.
d. Solve problem in series R-L-C circuit.

Instructional Materials: Chalkboard, notebook, calculator

Previous Knowledge: Students are familiar with the use of resistors and capacitors

Introduction: The lesson is introduced by asking the students to explain the action of capacitors in ac circuits.

Step 1: The instructor expresses the formulas of the various parameters of the series R-C, R-L, and L-C circuit as the students pay attention and asks any question they might have.

Step 2: The instructor uses the formulas to solve problem in series R-C, R-L, and L-C circuit as the students watch and ask questions.

Step 3: The instructor expresses the formulas of the various parameters of the series R-L-C circuit.

Step 4: The instructor uses the formulas to solve problem in series R-L-C circuit.

Evaluation: The instructor evaluates the lesson by asking the students to solve a given problem as the instructor goes round to check.

Conclusion: Corrections are made and the students are allowed to copy notes

Assignment: Students are asked to read about concept of Magnetism, Electromagnetism, and application of magnetic circuits against the next lesson.

LESSON FOUR

SUBJECT: Basic Electricity

CLASS: Trade 2

Topic: Basic Concept of Magnetism, Electromagnetism, application of magnetic circuits

DURATION: 90 Minutes (Double periods)

Reference: Electrical Technology by Theraja

Instructional Objectives: At the end of the lesson, students should be able to;

a. Explain the basic concepts of magnetism
b. Explain the electric and magnetic fields and electromagnetism
c. List and explain the application of magnetic circuits

Instructional Materials: Chalkboard, diagrams, notebook

Previous Knowledge: Students are familiar with magnets and their effects on magnetic materials.

Introduction: The instructor introduces the lesson by asking the students to explain their experiences with magnets.

Presentation:

Step 1: The instructor explains the concepts of magnetism by its definition as the students.

Step 2: The instructor explains the meaning of electric and magnetic fields.

Step 3: He then explains the concept of electromagnetism as the magnetic effect of electric current and allows the students to ask questions.

Step 4: The instructor lists and explains the application of magnetic circuits and then allows the students to ask question.

Evaluation: The instructor evaluates lesson by asking the students the following questions

1. explain magnetism
2. explain electromagnetism
3. list the major applications of magnetic circuits.

Conclusion: He concludes the lesson by making corrections and asking the students to copy notes.

Assignment: Students are asked to read about transformers against the next class.

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LESSON FIVE

SUBJECT: Basic Electricity

CLASS: Trade 2

Topic: Transformer, Core laminations of transformers, losses in transformer, types and uses of transformers.

Reference: Electric circuit analysis, by Schuler and Fowler

Objectives: At the end of the lesson, students should be able to;

(a) Define and explain the concept of transformer.

(b) Explain the reasons for laminating the core of transformers.

(c) List and explain types of losses in transformer.

(d) Mention and explain the types and uses of transformers.

Instructional Materials: Transformer accessories, charts, chalkboard.

Previous knowledge: Students are familiar with transformers in their various homes.

Introduction: The instructor introduces the lesson by asking the students to mention areas in which they have seen transformers in action before.

Presentation:

Step 1: The instructor defines and explains the meaning of transformer.

Step 2: The instructor explains the reasons for laminating the cores of transformers.

Step 3: He goes ahead to explains the types of losses in transformers and then allows the students to ask questions.

Step 4: The instructor lists and explains the types of transformers in use.

Step 5: He then explains the uses of each type of transformer and allows the students to ask questions.

Evaluation: The instructor evaluates the lesson by asking the students to

1. explain the concept of transformer?
2. state the reason for laminating transformer?
3. state and explain the type of losses in transformer?
4. list the types and uses of transformers?

Conclusion: Corrections are made and the students are allowed to write notes.

Assignment: Students are asked to read about the construction of transformers ahead of next lesson.

APPENDIX 11

BASIC ELECTRICITY ACHIEVEMENT TEST

UNIVERSITY OF SOUTH AFRICA (UNISA), SOUTH AFRICA
INSTITUTE FOR SCIENCE AND TECHNOLOGY EDUCATION

Section A: Personal Data

Name of School: ....

Location of school: Rural ( ) Urban ( )

Class: ....

Gender: Male ( ) Female ( )

Age range: 15-18 years ( ), 19-22 years ( ), 23-26 years ( )

INSTRUCTIONS:

1. Please read each question attentively and select the appropriate answer.
2. Do not cheat or peep on your friends.
3. Fill in the blanks on the answer page with your school name, class, gender, age, and given number.
4. Please give the examiner both your question and answer booklet.

BASIC ELECTRICITY ACHIEVEMENT TEST

1. The number of completed electron cycles in a second in an alternating current is called
   A. revolution
   B. hertz
   C. frequency
   D. electromotive force
2. The total opposition offered to an A.C/D.C. current is termed
   A. resistance
   B. inductance
   C. impedance
   D. capacitance
3. In a pure inductive A.C. circuit, the current
   A. leads the voltage by 90^0
   B. lags the voltage by 90^0
   C. is in phase with the voltage
   D. is out of phase with the voltage
4. The power in A.C circuit is calculated by the formula
   A. P=VI

B. $P=VICos\theta$
C. P=VIA
D. $P=\frac{V2}{R}$ A

5. The figure below represents a/an

Z

A. resistance
B. inductance
C. capacitance
D. impedance

6. The inductive reactance of an A.C is 44Ω. Calculate the inductance when it is connected across 240V 50HZ A.C supply.
A. 0.24H
B. 0.14H
C. 0.34H
D. 0.44H

7. In a pure sinusoidal resistive circuit the current
A. lags the voltage by 90^0
B. leads the voltage by 90^0
C. are in phase with the voltage
D. are out of phase with the voltage

8. Determine the supply current of a coil having a resistance of 6Ω and inductance of 0.03H when connected to 100V 50Hz supply
A. 11.31A
B. 8.95A
C. 5.89A
D. 9.85A

9. In an A.C sine wave, half of a cycle equals
A. 0^0
B. 90^0
C. 180^0
D. 360^0

10. The effective value of an A.C sine wave is known as
A. peak value
B. form factor value
C. root mean square value
D. mean value

11. If the peak value of an A.C voltage is given as 220 V. The mean value is
A. 110.00 V
B. 140.14 V
C. 155.54 V
D. 345.91 V

12. The unit of measurement of capacitance is
A. Kelvin
B. Hertz
C. Farad
D. Henry

13. "Break down voltage" is an operational characteristics of
A. an inductor
B. a capacitor

C. a resistor
D. a transformer

14. The voltage ratio of a series circuit is termed
    A. X_L factor
    B. Q factor
    C. X_C factor
    D. X factor
15. An A.C circuit is said to be resistive if it consists of
    A. resistors
    B. capacitors only
    C. inductors only
    D. resistor, capacitor and inductor
16. The bandwidth of RLC circuit is given as
    A. resonance frequency × impedance
    B. resonance frequency × quality factor
    C. resonance frequency ÷ impedance
    D. resonance frequency ÷ quality factor
17. An A.C. circuit consists of an inductor of 2mH connected to 220V, 50Hz supply. The inductive reactance of the circuit is
    A. 0.628Ω
    B. 6.280Ω
    C. 62.800Ω
    D. 628.8000Ω
18. The unit of measurement of inductance is
    A. Ampere
    B. Lumen
    C. Henry
    D. Farads
19. Which of the following is an inductor
    A. choke
    B. capacitor
    C. ceramic
    D. starter
20. The value of inductive reactance is determined using the formula
    A. 2πFC
    B. 2πFL
    C. 2πFR
    D. ½πFC
21. The frequency at which the voltage across an inductor equals that of capacitor is known as:
    A. resonance
    B. impedance
    C. quality factor
    D. power factor
22. The capacitive reactance of a 50μF capacitor connected to a 220V 50Hz A.C supply is
    A. 6.37Ω
    B. 63.65Ω
    C. 636.50Ω
    D. 1110.00Ω

23. A capacitor of value 8μF is connected to a 220V, 50Hz supply. The capacitive reactance of the capacitor is
    A. 0.4Ω
    B. 27.5Ω
    C. 39.8Ω
    D. 397.8Ω
24. The phase difference between current and supply voltage is known as
    A. reactive power
    B. power factor
    C. active power
    D. power angle
25. For resonance to occur in an A.C circuit
    A. $X_C=X_L$
    B. $X_L=Z$
    C. $Z>R$
    D. $Z<R$
26. The time taken to complete one cycle of an alternating current is called
    A. cycle
    B. period
    C. frequency
    D. wave form
27. In an A.C circuit, the expression $f=\frac{1}{2}\pi\sqrt{LC}$ is
    A. resonance frequency
    B. band width frequency
    C. Q-factor frequency
    D. Impedance frequency
28. Magnetism is defined as
    A. a force field that acts on some materials but not on other materials
    B. a force field that act against some materials
    C. a force field that oppose some materials
    D. a force field that accept some materials but not on other materials
29. Which of the following correctly defines electromagnetism?
    A. Electromagnetism is a magnetic field that oppose by electric current
    B. Is a magnetic field that are created by electric current
    C. Is a magnetic field that separated by electric current
    D. Is a force field that accept electric current
30. The invisible lines of force that make up the magnetic fields are known as
    A. magnetic charge
    B. magnetic loss
    C. luminous
    D. magnetic flux
31. Which of the following correctly defines Unlike magnetic poles
    A. create of force of dislike
    B. create a force of unity
    C. create a force of repulsion
    D. create a force of attraction
32. The region where magnetic force can be felt is called
    A. magnetic field
    B. magnetomotive force

C. magnetic induction
D. coverage area

33. A transformer with common winding to both primary and secondary is called
    A. single phase transformer
    B. auto transformer
    C. core transformer
    D. three phase transformer
34. A transformer connected to 480 V 50Hz supply has a primary winding of 1200 turns. The emf induced in the secondary winding of 600 turns is
    A. 360V
    B. 240V
    C. 120V
    D. 60V

35. A conductor cutting magnetic lines of force will experience and inducement of
    A. e.m.f
    B. potential difference
    C. resistance
    D. capacitance
36. The unit of magnetic flux is
    A. ampere/metre
    B. weber
    C. tesla
    D. ampere
37. The following are types of transformers except
    A. current transformer
    B. auto transformer
    C. core transformer
    D. star transformer
38. The characteristics of magnetic lines of force includes the following except that the lines
    A. forms closed loops
    B. act from north and south
    C. are elastic
    D. intersect themselves
39. Copper losses in a transformer occur in
    A. primary winding only
    B. secondary winding
    C. secondary and primary windings
    D. core of the transformer
40. A transformer has transformation ratio of 5:1. If the primary voltage is 220V, the secondary voltage is
    A. 44volts
    B. 88volts
    C. 1100volts
    D. 2200volts
41. A 220V, 50Hz A.C transformer has 200 turns in the primary winding. The emf induced in the secondary winding is
    A. 110V
    B. 182V
    C. 364V

D. 440V

42. The polarity of a magnet when freely suspended, point towards
    A. North pole
    B. South pole
    C. East pole
    D. West pole
43. The concept whereby a change in the current in the closed circuit results in change of flux thereby causing induced e.m.f in the coil is known as
    A. magnetism
    B. inductance
    C. induction
    D. hysteresis
44. An auto transformer has
    A. one winding
    B. two windings
    C. three windings
    D. four windings
45. Eddy current loss in a transformer is caused by heat generated due to current flowing in the
    A. primary winding
    B. secondary winding
    C. laminated iron core
    D. both primary and secondary winding
46. The following are losses in transformer except
    A. iron loss
    B. copper loss
    C. eddy current loss
    D. degredation loss
47. A transformer in which the primary windings are more than the secondary is called
    A. auto transformer
    B. step down transformer
    C. step up transformer
    D. double wound transformer
48. A transformer has primary winding of 280turns at 220V A.C. Calculate the secondary winding if the secondary voltage is 160volts.
    A. 126 turns
    B. 204 turns
    C. 385 turns
    D. 412 turns
49. The losses in a transformer associated with heat effects is called
    A. iron loss
    B. winding loss
    C. copper loss
    D. primary loss
50. The windings of transformer are laminated to prevent
    A. shock
    B. high voltage
    C. eddy current
    D. copper loss

Appendix 12

STUDENTS' ATTITUDE TO BASIC ELECTRICITY QUESTIONNAIRE (SABEQ))

UNIVERSITY OF SOUTH AFRICA (UNISA), SOUTH AFRICA
INSTITUTE FOR SCIENCE AND TECHNOLOGY EDUCATION

Introduction

This questionnaire has been developed to determine students' attitude towards Basic Electricity. Please rate how you feel with each of the following statement as correctly as possible by putting check in the appropriate box. The information supplied shall be treated with utmost confidentiality.

Section A: Personal Data

Name of School: ....

Location of school: Rural ( ) Urban ( )

Class: ....

Gender: Male ( ) Female ( )

Age range: 15-18 years ( ) 19-22 years ( ) 23-26 years ( )

Section B: Students' Attitude to Basic Electricity questionnaire (SABEQ)

Instruction:

Please give your opinion for each statement by putting a tick [√] in any of the columns that suits you attitude.

For instance, if the statement is not true of me you tick one [√]

Options: 1=Not True of me (NTM), 2= Fairly True of me (FTM), 3= Much True of me (MTM),
4= Very True of me (VTM).

S/N	Item Description	VTM **(4)**	MTM **(3)**	FTM **(2)**	NTM **(1)**
A.	**Students' factors**				
1.	Basic electricity lessons are not very interesting				
2.	I do not like Basic Electricity because it involves practical work				
3.	I hate Basic Electricity lessons because they involve calculations				

4.	The calculations involved in Basic Electricity are challenging				
5.	Studying Basic Electricity is a waste of time				
6.	I am not always attentive during Basic Electricity lesson.				
7.	I do not feel at ease during a Basic Electricity test.				
8.	I am always afraid of attempting Basic Electricity questions				
9.	Basic Electricity lessons are always dull and boring.				
10	I am always afraid when studying Basic Electricity.				
11	I fear being harmed by electricity in Basic Electricity class				
12.	I do not enjoy studying Basic Electricity.				
13.	Basic Electricity makes me feel uneasy and confused.				
14.	Topics in Basic Electricity are not interesting				
15.	I do solve Basic Electricity problems myself				
16.	I like to learn more about Basic Electricity concepts				
17.	Basic Electricity is my least favourite subject				
18.	I am excited whenever I solve problems in Basic Electricity correctly.				
19.	I enjoy answering questions during Basic Electricity lesson.				
20.	Calculations in Basic Electricity are very interesting.				
B.	**HOME FACTORS**				
21.	My knowledge of Basic Electricity is not useful at home				
22.	Doing homework in Basic Electricity is a burden				
23.	I have no time to do my assignment at home				
24.	I do not practice what I learn in Basic Electricity at home				
25.	I prefer watching television /video than studying Basic Electricity				
26.	My parents are not interested in Basic Electricity				
C.	**PRESTIGE FACTOR**				
27.	I am not always punctual at Basic Electricity class				
28.	I do not like Basic Electricity because it seems not to be industrious				
29.	I do not like any career relating to Basic Electricity				
30.	I have opted for Basic Electricity because as there are associated jobs opportunities				
D.	**TEACHER FACTOR**				

31.	I hate Basic Electricity lesson because of the way my teacher teaches				
32.	My Basic Electricity teacher does not take time to explain problem				
33.	My Basic Electricity teacher does not use instructional materials to teach.				
34.	My Basic Electricity teacher does not give me assignments regularly.				
35.	My Basic Electricity teacher is not friendly.				
36.	My Basic Electricity teacher does not deserve praises				
37.	My teacher does not encourage me to study Basic Electricity				
E.	**SCHOOL FACTOR**				
38.	My school does not have enough instructional materials for Basic Electricity lessons.				
39.	My school does not have a Basic Electricity workshop.				
40.	My school does not have sufficient Basic Electricity teachers.				
41.	My school does not have qualified Basic Electricity teachers.				
F.	**GOVERNMENT FACTOR**				
42.	Basic Electricity teachers should be paid special salary				
43.	Government does not provide enough Basic Electricity text-books to schools				
44.	Government does not provide Basic Electricity equipment and tools				
45.	Government does not provide Basic Electricity workshops				

Appendix 13

Achievement Test Marking Scheme

ANSWERS

1. C
2. C
3. B
4. B
5. D
6. B
7. C
8. B
9. C
10. C
11. B
12. C
13. B
14. B
15. D
16. D
17. A
18. B
19. A
20. B
21. A
22. B
23. D
24. B
25. A
26. B
27. A
28. A
29. B
30. D
31. C
32. A
33. B
34. B
35. A
36. B
37. D
38. C
39. C
40. A
41. D
42. A
43. B
44. A
45. C
46. D
47. B
48. B
49. A
50. C

Appendix 14

Reliability Test of the Questionnaire

Scale: students' factors

Case Processing Summary

		N	%
Cases	Valid	83	100.0
	Excluded[a]	0	.0
	Total	83	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.872	.904	20

Item Statistics

	Mean	Std. Deviation	N
Basic electricity lessons are not very interesting	1.43	.913	83
I do not like basic electricity because it involves practical work	1.39	.762	83
I hate Basic Electricity lessons because they involve calculations	1.46	.901	83
The calculations involved in Basic Electricity are challenging	2.01	2.437	83
Studying basic electricity is a waste of time	1.47	.967	83
I am not always attentive during Basic Electricity lesson.	1.60	.987	83
I do not feel at ease during a Basic Electricity test.	1.83	1.046	83
I am always afraid of attempting Basic Electricity questions	1.53	.874	83
Basic Electricity lessons are always dull and boring.	1.54	.888	83
I am always afraid when studying Basic Electricity.	1.61	.973	83
I fear being harmed by electricity in Basic Electricity class	1.78	1.071	83
I do not enjoy studying Basic Electricity.	1.64	1.054	83
Basic Electricity makes me feel uneasy and confused.	1.73	1.116	83
Topics in Basic Electricity are not interesting	1.78	1.137	83
I do solve Basic Electricity problems myself	2.64	1.235	83
I like to learn more about Basic Electricity concepts	2.90	1.216	83
Basic Electricity is my least favourite subject	2.82	1.181	83
I am excited whenever I solve problems in Basic Electricity correctly.	3.02	1.249	83
I enjoy answering questions during Basic Electricity lesson.	2.92	1.181	83

Calculations in Basic Electricity are very interesting.	3.06	1.172	83

Scale Statistics

Mean	Variance	Std. Deviation	N of Items
40.18	158.565	12.592	20

Scale: home factors

Case Processing Summary

		N	%
Cases	Valid	83	100.0
	Excluded[a]	0	.0
	Total	83	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.852	.853	6

Item Statistics

	Mean	Std. Deviation	N
My knowledge of Basic Electricity is not useful at home	1.59	.988	83
Doing homework in Basic Electricity is a burden	1.69	1.023	83
I have no time to do my assignment at home	1.61	.998	83
I do not practice what I learn in Basic Electricity at home	1.45	.887	83
I prefer watching television /video than studying Basic Electricity	1.70	1.021	83
My parents are not interested in Basic Electricity	1.99	.930	83

Scale Statistics

Mean	Variance	Std. Deviation	N of Items
40.18	158.565	12.592	20

Scale: prestige factors

Case Processing Summary

		N	%
Cases	Valid	83	100.0
	Excluded[a]	0	.0
	Total	83	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.928	.929	4

Item Statistics

	Mean	Std. Deviation	N
I am not always punctual at Basic Electricity class	1.49	.992	83
I do not like Basic Electricity because it seems not to be industrious	1.54	.979	83
I do not like any career relating to Basic Electricity	1.70	.997	83
I have opted for Basic Electricity because as there are associated jobs opportunities	1.92	1.095	83

Scale Statistics

Mean	Variance	Std. Deviation	N of Items
6.65	13.596	3.687	4

Scale: teachers' factors

Case Processing Summary

		N	%
Cases	Valid	83	100.0
	Excluded[a]	0	.0
	Total	83	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.973	.973	7

Item Statistics

	Mean	Std. Deviation	N
I hate Basic Electricity lesson because of the way my teacher teaches	1.69	.936	83
My Basic Electricity teacher does not take time to explain problem	1.61	.998	83
My Basic Electricity teacher does not use instructional materials to teach.	1.65	1.005	83
My Basic Electricity teacher does not give me assignments regularly.	1.63	.996	83
My Basic Electricity teacher is not friendly.	1.60	1.115	83
My Basic Electricity teacher does not deserve praises	1.71	1.042	83
My teacher does not encourage me to study Basic Electricity	1.63	1.044	83

Scale Statistics

Mean	Variance	Std. Deviation	N of Items
11.52	43.984	6.632	7

Scale: school factors

Case Processing Summary

		N	%
Cases	Valid	83	100.0
	Excluded[a]	0	.0
	Total	83	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.890	.891	4

Item Statistics

	Mean	Std. Deviation	N
My school does not have enough instructional materials for Basic Electricity lessons.	1.70	.894	83
My school does not have a Basic Electricity workshop.	1.64	.918	83
My school does not have sufficient Basic Electricity teachers.	1.60	1.011	83
My school does not have qualified Basic Electricity teachers.	1.51	.929	83

Scale: government factors

Case Processing Summary

		N	%
Cases	Valid	83	100.0
	Excluded[a]	0	.0
	Total	83	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.856	.859	4

Item Statistics

	Mean	Std. Deviation	N
Basic Electricity teachers should be paid special salary	2.42	1.289	83
Government does not provide enough Basic Electricity text-books to schools	2.40	1.287	83
Government does not provide Basic Electricity equipment and tools	2.10	1.185	83
Government does not provide Basic Electricity workshops	2.12	1.152	83

Scale Statistics

Mean	Variance	Std. Deviation	N of Items
9.04	16.913	4.113	4

Scale: students' attitude

Case Processing Summary

		N	%
Cases	Valid	83	100.0
	Excluded[a]	0	.0
	Total	83	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.952	.960	45

Item Statistics

	Mean	Std. Deviation	N
Basic electricity lessons are not very interesting	1.43	.913	83
I do not like basic electricity because it involves practical work	1.39	.762	83
I hate Basic Electricity lessons because they involve calculations	1.46	.901	83
The calculations involved in Basic Electricity are challenging	2.01	2.437	83
Studying basic electricity is a waste of time	1.47	.967	83
I am not always attentive during Basic Electricity lesson.	1.60	.987	83
I do not feel at ease during a Basic Electricity test.	1.83	1.046	83
I am always afraid of attempting Basic Electricity questions	1.53	.874	83
Basic Electricity lessons are always dull and boring.	1.54	.888	83
I am always afraid when studying Basic Electricity.	1.61	.973	83
I fear being harmed by electricity in Basic Electricity class	1.78	1.071	83
I do not enjoy studying Basic Electricity.	1.64	1.054	83
Basic Electricity makes me feel uneasy and confused.	1.73	1.116	83
Topics in Basic Electricity are not interesting	1.78	1.137	83
I do solve Basic Electricity problems myself	2.64	1.235	83
I like to learn more about Basic Electricity concepts	2.90	1.216	83
Basic Electricity is my least favourite subject	2.82	1.181	83
I am excited whenever I solve problems in Basic Electricity correctly.	3.02	1.249	83

I enjoy answering questions during Basic Electricity lesson.	2.92	1.181	83
Calculations in Basic Electricity are very interesting.	3.06	1.172	83
My knowledge of Basic Electricity is not useful at home	1.59	.988	83
Doing homework in Basic Electricity is a burden	1.69	1.023	83
I have no time to do my assignment at home	1.61	.998	83
I do not practice what I learn in Basic Electricity at home	1.45	.887	83
I prefer watching television /video than studying Basic Electricity	1.70	1.021	83
My parents are not interested in Basic Electricity	1.99	.930	83
I am not always punctual at Basic Electricity class	1.49	.992	83
I do not like Basic Electricity because it seems not to be industrious	1.54	.979	83
I do not like any career relating to Basic Electricity	1.70	.997	83
I have opted for Basic Electricity because as there are associated jobs opportunities	1.92	1.095	83
I hate Basic Electricity lesson because of the way my teacher teaches	1.69	.936	83
My Basic Electricity teacher does not take time to explain problem	1.61	.998	83
My Basic Electricity teacher does not use instructional materials to teach.	1.65	1.005	83
My Basic Electricity teacher does not give me assignments regularly.	1.63	.996	83
My Basic Electricity teacher is not friendly.	1.60	1.115	83
My Basic Electricity teacher does not deserve praises	1.71	1.042	83
My teacher does not encourage me to study Basic Electricity	1.63	1.044	83
My school does not have enough instructional materials for Basic Electricity lessons.	1.70	.894	83
My school does not have a Basic Electricity workshop.	1.64	.918	83
My school does not have sufficient Basic Electricity teachers.	1.60	1.011	83
My school does not have qualified Basic Electricity teachers.	1.51	.929	83
Basic Electricity teachers should be paid special salary	2.42	1.289	83
Government does not provide enough Basic Electricity text-books to schools	2.40	1.287	83
Government does not provide Basic Electricity equipment and tools	2.10	1.185	83
Government does not provide Basic Electricity workshops	2.12	1.152	83

Scale Statistics

Mean	Variance	Std. Deviation	N of Items
83.86	775.954	27.856	45

Appendix 15
Reliability for Achievement Test

Scale: Test Reliability

Case Processing Summary

		N	%
Cases	Valid	83	98.8
	Excluded[a]	1	1.2
	Total	84	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.937	.883	50

Item Statistics

	Mean	Std. Deviation	N
Q1	.93	.261	83
Q2	.89	.313	83
Q3	.89	.313	83
Q4	.89	.313	83
Q5	.34	.476	83
Q6	.35	.480	83
Q7	.90	.297	83
Q8	.41	.495	83
Q9	.95	.215	83
Q10	.94	.239	83
Q11	.93	.261	83
Q12	.40	.492	83
Q13	.95	.215	83
Q14	.40	.492	83
Q15	.76	.430	83
Q16	.33	.471	83
Q17	.93	.261	83
Q18	.96	.188	83
Q19	.42	.497	83

Q20	.59	.495	83
Q21	.54	.501	83
Q22	.36	.483	83
Q23	.92	.280	83
Q24	.39	.490	83
Q25	.55	.500	83
Q26	.60	.492	83
Q27	.40	.492	83
Q28	.98	.154	83
Q29	.45	.500	83
Q30	.60	.492	83
Q31	.42	.497	83
Q32	.93	.261	83
Q33	.60	.492	83
Q34	.41	.495	83
Q35	.78	.415	83
Q36	.41	.495	83
Q37	.98	.154	83
Q38	.63	.487	83
Q39	.57	.499	83
Q40	.42	.497	83
Q41	.73	.444	83
Q42	.40	.492	83
Q43	.93	.261	83
Q44	.81	.397	83
Q45	.40	.492	83
Q46	.42	.497	83
Q47	.99	.110	83
Q48	.98	.154	83
Q49	.57	.499	83
Q50	.58	.497	83

Scale Statistics

Mean	Variance	Std. Deviation	N of Items
32.88	105.156	10.255	50

Appendix 16

Basic Electricity Curriculum

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN ELECTRICAL INSTALLATION AND MAINTENANCE WORK		
MODULE: BASIC ELECTRICITY	Course Code: CEI 11	Contact Hours: 264 Hours

GENERAL OBJECTIVES:

On completion of this module, the trainee should be able to:

1. Understand the structure of matter and its relevance to electricity/electronics.
2. Understand the chemical sources of electromotive force.
3. Understand the construction of resistors, inductors and capacitors and explain their functions in a simple circuit
4. Know the values of resistor(s).
5. State Ohm's Law and apply it to calculate resistance, voltage and current.
6. Distinguish between AC and DC quantities.
7. Understand the principles of transformer, its construction and operation.
8. Analyse, connect and carry out simple calculation on simple electrical circuit.
9. Interpret basic electronic signs and symbols.
10. Understand the operation, uses and limitations of indicating instruments and operate them.

PROGRAMME: NTC IN ELECTRICAL INSTALLATION AND MAINTENANCE WORK			
Course: CEI 11 - BASIC ELECTRICITY		Course Code: CEI 11	Contact Hours: 264 Hours
Course specification: At the conclusion of this module, the student should be able to understand and demonstrate the basic electrical theory Theoretical Content			
	General Objective 1.0: Understand The Structure Of Matter And Its Relevance To Electricity/Electronics.		
Week	Specific Learning Outcome:	Teachers Activities	Resources
1-3	On completion of this module the trainees should be able to: 1.1 Define: a. Molecule b. Electron c. Atom d. Electric charge e. Electric Current f. Coulomb 1.2 Explain the difference between positive and negative charges. 1.3 Explain the flow of electricity 1.4 Distinguish between insulators and conductors	• With diagram define atom, electron, proton, molecule, electric charge, electric current, Coulomb. • Give full explanation on the difference between positive & negative charge. • Describe how electricity flows. • Explain insulator and conductors with sample	• Chalkboard • Textbooks
	General Objective 2.0: Understand The Chemical Source Of Electromotive Force.		
Week	Specific Learning Outcome:	Teachers Activities	Resources
4-6	2.1 Define: a. Electric power b. Energy 2.2 Distinguish between emf and potential difference (p.d) 2.3 Identify the following: a. Primary Cells b. Secondary Cells 2.4 Test for the condition of a cell or battery	• Explain electric power and energy stating their unit, symbol and formula. Work problems based on Power and Energy • Distinguish the differences between emf and pd. • Show primary and secondary cells and describe their construction. • Use instruments and visual observation to show how to test cell condition.	• Chalkboard • Textbook • Calculator • Primary cell • Battery

PROGRAMME: NTC IN ELECTRICAL INSTALLATION AND MAINTENANCE WORK			
Course: CEI 11 - BASIC ELECTRICITY		Course Code: CEI 11	Contact Hours: 264 Hours
	General Objective 2.0: Understand The Chemical Source Of Electromotive Force.		
Week	Specific Learning Outcome:	Teachers Activities	Resources
8	2.5 Connect cells in: a. Series b. Parallel c. Series - Parallel	• Show how cells can be connected in series, and series -parallel Advantages of cells in series or parallel connections. e.g voltage in series and on parallel	• Primary Cell
	2.6 Explain the effects of internal resistance on battery voltage output.	• Explain with calculations how resistance affect battery voltage.	• Chalkboard
	General Objective 3.0: Understand The Construction Of Resistors, Inductors And Capacitors And Explain Their Functions.		
Week	Specific Learning Outcome:	Teachers Activities	Resources
9-11	3.1 Identify the various types and sizes of the following: a. Resistors b. Capacitors c. Inductors. 3.2 Identify the following resistors: a. Composition type resistor b. Wire wound type resistor c. Variable resistors d. Fixed resistors 3.3 State the function of the following: a. Resistor b. Capacitor c. Inductor in a Circuit 3.4 Describe the constructional detail of the following: Resistors Capacitors Inductors 3.5 Explain the meaning of power rating of a resistor 3.6 Identify the power rating of different resistance types. 3.7 Explain the practical application of various types of resistors 3.8 Identify the working Voltage of a capacitor	• Define and show resistors, capacitors and inductors. State their unit and symbols • Show students various types of resistors • Explain and show how each can be connected and their function. • Describe on chalkboard the constructional detail of the three. • Explain power rating of resistor. • Show how to identify the power rating of each resistor. • Explain the application of resistor in a circuit. • Explain the maximum working voltage of a capacitor.	• Capacitors • Inductors • Resistors & Chalk board

PROGRAMME: NTC IN ELECTRICAL INSTALLATION AND MAINTENANCE WORK			
Course: CEI 11 - BASIC ELECTRICITY		Course Code: CEI 11	Contact Hours: 264 Hours
	General Objective 4.0: Know The Values Of Resistor(s).		
Week	Specific Learning Outcome:	Teachers Activities	Resources
12-13	4.1 Explain the colour coding system of a. resistors b. capacitors 4.2 Calculate the following: a. Resistance of a resistor using colour codes b. capacitance of a capacitor using colour codes 4.3 Identify the tolerance of resistors and capacitors. 4.4 Calculate the value of the tolerance of any a. Resistor using colour codes b. Capacitors using colour codes	• Show and explain how to identify colour coding of resistor. • From colour code, show how to calculate the valves of resistor and capacitor • Show and calculate the tolerance of resistors and capacitors • Show and calculate the tolerance of resistors and capacitors.	• Chalkboard • Textbooks • Calculator • Chalk Board • Color Coded Resistors
	General Objective 5.0: State Ohm's Law And Apply It To Calculate Resistance, Voltage And Current		
Week	Specific Learning Outcome:	Teachers Activities	Resources
1-7	5.1 Define Ohm's law 5.2 Calculate resistance, Voltage or Current using Ohm's law e.g. - $R = V/I$ 5.3 Connect a. resistors in series b. resistors in parallel c. series and parallel connection 5.4 Connect a. batteries in series b. batteries in parallel c. batteries in series parallel connection 5.5 Connect capacitors in series and parallel and capacitors in series parallel connection as above.	• Define Ohm's Law • Work some calculations on Ohm's law • Show how resistor can be connected in series, parallel and series-parallel and perform calculations. • Refer students to batteries connected in the three modes by asking questions. • Show capacitor in series parallel and in series-parallel. • Explain the implication of modes 5.3 - 5.5 • Work samples of Capacitors and inductor in series & parallel.	• Chalk Board • Batteries • Resistors • Multimeter

PROGRAMME: NTC IN ELECTRICAL INSTALLATION AND MAINTENANCE WORK			
Course: CEI 11 - BASIC ELECTRICITY		Course Code: CEI 11	Contact Hours: 264 Hours
	General Objective 5.0: State Ohm's Law And Apply It To Calculate Resistance, Voltage And Current		
Week	Specific Learning Outcome:	Teachers Activities	Resources
1-7	5.6 State the implication of the connections mode in 5.3 - 5.5 5.7 Calculate the inductance, capacitance connected in series and parallel. 5.8 Define Kirchoff's laws:- a. Current law b. Voltage law	• Define the law. Use vector diagram to explain the current law. E.g. $I_1 + I_2 + I_5 = I_3 + I_4$	• Textbooks • Chalk and Black board
8-13	5.9 Solve simple numerical problems involving 5.8a & 5.8b above. 5.10 Define Superposition theorem 5.11 Solve simple numerical problems to illustrate Superposition theorem	• Define the voltage laws. Draw a simple circuit to illustrate the law, • State the law. Draw a simple circuit to illustrate the law • Super position theorem. Use simple circuit to illustrate the theorem.	- do - - do - - do -
	General Objective 6.0: Distinguish Between AC And DC Current And Voltage		
Week	Specific Learning Outcome:	Teachers Activities	Resources
1-7	6.1 Explain the difference between AC and DC. 6.2 Explain the Characteristic of alternating current. 6.3 Define peak value, mean value, RMS value, Frequency of Wave. 6.4 Calculate peak value from RMS values of Current, and voltage, and vice versa 6.5 Describe the simple treatment of R,L,C in AC circuit. 6.6 Explain the concept of resistance in AC circuit. 6.7 Calculate inductive and capacitive reactance. $X_L = 2\pi fL$ (Inductive reactance) $X_c = 1/2\pi fC$ (Capacitive reactance)	• With the aid of a diagram explain the difference between AC to DC. • Explain fully AC. • Draw diagrams to explain AC variables like RMS, mean valve, etc. • Work some samples on how to calculate the variables above • Explain the effect of AC on R,L,C in parallel i.e. voltage and current relationships • Explain resistor in AC circuit. • Explain inductive and capacitive reactance and work some calculation on $X_L X_c$, (like $X_{c\ above}$)	• Lesson note • Chalkboard • Chalk Board • Signal Generator • osciloscope

PROGRAMME: NTC IN ELECTRICAL INSTALLATION AND MAINTENANCE WORK			
Course: CEI 11 - BASIC ELECTRICITY		Course Code: CEI 11	Contact Hours: 264 Hours
	General Objective 7.0: Understand The Principles Of Transformer, Its Construction And Operations.		
Week	Specific Learning Outcome:	Teachers Activities	Resources
8	7.1 Explain the concept of Magnetism a. temporary and permanent magnets b. magnetic field c. magnetic poles d. law of attraction and repulsion	• Define magnet and explain temporary, permanent and natural magnet. • Define laws of magnet, show diagram where necessary.	• Magnet • Soft Iron • DC Power • Coil • Compass • Copper Coil
9-13	7.2 Explain the effect of fields as applied to electro-magnetism 7.3 State the colour code used for the winding of transformer. 7.4 Describe with the aid of sketches the principles of operation of a single phase, double wound transformer. 7.5 State the reasons for laminating the core of a transformer. 7.6 Explain the types of losses in transformers and state ways to reduce them. 7.7 Calculate transformer efficiency 7.8 Construct a simple single phase double wound transformer 7.9 Identify the following types of transformers: a. Auto-transformer; b. C-Core transformer; c. Toroidal transformer. d. Rudolf transformer e. Audio transformer f. 3-phase transformer g. Current transformer; State the uses of each type of transformer	• Show and explain magnetic fields. • Explain fully mode of winding of transformer. Explain $\frac{VP}{VS} = \frac{NP}{NS}$ • Show lamination and explain reasons for lamination. • List and explain iron and copper loss and how to reduce them • Explain efficiency and work some sample on efficiency • Demonstrate how to construct double would. • Explain fully different type of transformers e.g. power, isolation auto etc. • Make available for inspection a number of examples.	• Transformer Components. • A transformer • Chart • Calculator • Textbook • Lesson plan • Chalkboard • Different types of transformers

PROGRAMME: NTC IN ELECTRICAL INSTALLATION AND MAINTENANCE WORK			
Course: CEI 11 - BASIC ELECTRICITY		Course Code: CEI 11	Contact Hours: 264 Hours
	General Objective 8.0: Analyse, Connect And Carry Out Simple Calculations On Simple Electrical Circuit.		
Week	Specific Learning Outcome:	Teachers Activities	Resources
1-3	8.1 Explain the difference between series and parallel circuit 8.2 Calculate the total resistance in a series DC circuit 8.3 Calculate the voltage drop across each resistor of a series circuit 8.4 Calculate the total resistance of a parallel circuit 8.5 Investigate by experiment, the effect of resistors in series and in Parallel. 8.6 Calculate the current in each arm of a parallel circuit.	• Define an electric circuit and state the difference between series and parallel. • Give students calculation • Work samples on Vd on each resistor in a circuit and ask students to do same. • Request students to work some calculation • Carry out experiment to show the effect of resistor in series and in parallel. • Show how to calculate the current in each arm.	• Chalkboard • Textbooks/Notes • Calculator • Notes • Resistors • DC power supply multimeter
4-13	8.7 Investigate the effect of capacitor in an electric circuit.	• Ask question on connection of capacitor.	• Chalk Board
	8.8 Calculate the total voltage and current in series and parallel connected cells.	• Calculate voltage and current in series and parallel cells.	• Chalk Board
	8.9 Calculate the voltage and current in a series and parallel circuit.	• Calculate voltage & current in series and parallel circuit.	• Chalk Board

PROGRAMME: NTC IN ELECTRICAL INSTALLATION AND MAINTENANCE WORK			
Course: CEI 11 - BASIC ELECTRICITY		Course Code: CEI 11	Contact Hours: 264 Hours
	8.10 Investigate the current and voltage relationship in: a. an inductive circuit e.g. current leads the applied voltage. b. Capacitive circuit, e.g. current lags the applied voltage c. The combination of capacitance and inductance (i) in series (ii) in parallel.	• Define Pf and show this effect on phasor diagrams with calculations.	• Chalk Board
	8.11 Calculate impedance in an AC Circuit	• Define impedance, give the symbols, unit and formula • Calculate impedance	• Textbooks • Note • Calculator • Chalk Board
	8.12 Explain the meaning of resonance in: a. a series circuit b. a parallel circuit	• Draw and explain resonance in series and parallel and simple calculations.	• Chalk Board
	8.13 Explain the simple meaning of a. Q factor b. Bandwidth	• Define Qf, B.W. and Fr. State the relationship among the three.	• Chalk Board
	8.14 Calculate resonant frequency.	• Do some calculations on the three.	• Chalk Board
	General Objective 9.0: Interpret Basic Electronic Signs And Symbols.		
Week	Specific Learning Outcome:	Teachers Activities	Resources
1	9.1 State the common abbreviations used in electrical and electronic circuits. I = Current A = Amp C = Capacity V = Voltage	• List and show various abbreviations used in electrical and electronics circuits.	• Textbooks • Note
2	Draw the graphical symbols for components, units and systems used in electronics/electrical system e.g. transistor, amplifiers, switch, socket outlet, etc.	• Ask questions on symbols used on electrical and electronics.	• Chalkboard

PROGRAMME: NTC IN ELECTRICAL INSTALLATION AND MAINTENANCE WORK			
Course: CEI 11 - BASIC ELECTRICITY		Course Code: CEI 11	Contact Hours: 264 Hours
	General Objective 10.0: Understand The Operation, Uses And Limitations Of Indicating Instruments And Operate Them,		
Week	Specific Learning Outcome:	Teachers Activities	Resources
3-13	10.1 Describe the functional part of the multi-meter 10.2 Set and the meter for: a. AC and DC voltage measurement b. Resistance measurement c. Ac and DC current measurement 10.3 Use the Ohm-meter to test semi-conductor devices. 10.4 Recognize a fault condition of meter	• Describe the parts, operation and uses of multimeter. • Demonstrate how to use the instrument in measuring current voltage and resistance both on AC and DC • Show how to use the multimeter to test diode, transistors etc. • Explain how to identify fault and how to rectify such.	• Multimeter - digital and analogue • Ohmeter • Chalkboard • Note. • Chalk Board

Appendix 17

Certificate of Proofreading and Editing

56 Daphne Road
Maroelana
Pretoria 0081
Tel: 0027123466198
Cell: 0027724331090
Fax: 0027866265604

Sandra Duncan

Professional Editing services

21/04/2022

To whom it may concern:

This is to certify that I Sandra Duncan have language edited the below Thesis and the onus is therefore on the author to make the recommended changes and address any comments made.

Prepared by,

SIMEON OLUWOLE ODEDE

Titled

THE EFFECT OF A PERSONALISED SYSTEM OF INSTRUCTION ON TECHNICAL COLLEGE STUDENTS' ACHIEVEMENT IN BASIC ELECTRICITY

Yours sincerely

Sandra Duncan

Sandra Duncan