CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Education is acknowledged as a vital instrument for achieving national development. It is through education that ignorance is eliminated and skills for productivity acquired. Imogie (2014) affirmed that no nation can develop to its fullest without effective and efficient educational system. The value and functionality of any educational system lie in its ability to actualize the goals of education. Federal Republic of Nigeria (FRN), (2014) stated that one of the aims and objectives of education in Nigeria is to help the child acquire appropriate skills, abilities and competencies both mental and physical as equipment for the individual to live in and contribute to the development of the society. Such knowledge, skills and abilities are acquired through the training provided in the school.

The achievement of this objective rests squarely on the learner, the environment and the teaching method employed by the teacher. Teaching method is defined as a way by which the teacher presents materials to learners and engages them in the task of learning the curriculum content (Ogwo & Oranu, 2006). It involves the interaction of the teacher, learners and the subject matter. Teaching method is basically geared towards ensuring that learners learn well and understand the logics inherent in what is being taught, (Okeke in Oboh & Umeh, 2013).

O'Banon in Ugwu (2014) categorized teaching methods into two: the teacher-centered approach and the learner-centered approach. The teacher-centered approaches include all the teaching methods that see the teacher as possessor of knowledge. These methods include lecture/expository, demonstration, discussion. The learner-centered approaches include all the teaching methods that do not see the teachers as decision-makers and problem solvers but rather as the guide in the learning process. Such approaches provide the students the opportunity to participate in the learning, to influence the content, activities, materials and pace of learning. Learning in these approaches could be collaborative, cooperative and competitive. Teachers' involvement include questioning, guiding, validating, monitoring, motivating, encouraging, suggesting, modeling and clarifying (McKenzie in Ugwu, 2014).

The current methods of teaching in Nigerian schools (technical colleges inclusive) are mainly based on teacher-centered approach. This teaching method which includes the lecture method, does not sufficiently give students the opportunity to participate in the classroom activities. Students' involvement in this teaching approach is just to listen and sometimes take down some notes if necessary during the lecture, combine the information and organize it. Lecture method thus emphasizes teaching more than learning and pays little or no attention to the process of learning thereby dwarfing students' creative thinking which is necessary in today's workplace.

This is not to indicate that lecture method is without value as it could be used to cover a large content area at a time and students are given the same content at the same time. It can equally be used to teach a large class which is a prominent feature of most

Nigerian schools. However, it is not the most effective way to help technical education students (especially for basic electricity students) develop and use higher order cognitive skills to solve complex real world problems. This is because it could encourage rote learning which does not lead to proper acquisition of knowledge and applied skills. Furthermore basic knowledge could be forgotten at any time. Mayer in Ogbuanya and Usoro (2012) stated that the inability of the teacher to use activities that could encourage students to gather data, respond to questions, manipulate materials and observe consequences prior to the beginning of lesson have stranded the major objective of teaching. Nwachukwu in Eze (2014)) stated that Nigeria may not achieve the educational objectives if technical education teachers continue to rely heavily on the teacher-centered approach for instruction of which one of the subjects involved is basic electricity in the technical colleges.

Basic electricity is a trade-related module of the technical college syllabus taught in years I, II and III as stipulated by Federal Republic of Nigeria (FRN) (2014). It was designed to provide the trainees with basic knowledge and practical skills in electrical and electronics technology. Being the only module that cuts across the entire engineering and related technical subjects, it ought to be taught well to ensure that students acquire the necessary knowledge and skills for employment after graduation. Lucas, Spencer and Claxton (2012) affirmed that the effectiveness of any skill-oriented educational process depends largely on the quality of teaching and learning in the classroom, workshop or, laboratory.

Effective instruction in technical subjects is an active process demanding task not only from the teacher but also from the learners. It will appear there is no single teaching and learning method that can be considered to be more appropriate for achieving effective instructional delivery. Whichever teaching method is employed by technical education teachers should make provision for active involvement of the learners and accommodate their learning diversities. Ogwo in Ogbuanya and Akinduro (2017) noted that technical teachers should realize the need for a better understanding of what method to use in teaching and learning situations as they constitute the major contributory role in students' acquisition of knowledge and skill. Egedegbe (2016) stated that lecture and demonstration is particularly effective in teaching a skill that can be observed. Ogwo and Oranu (2006) affirmed that demonstration method is the most widely used instructional method for acquisition of practical skills as it involves verbal and practical illustration of a given procedure. Disagreeing with this view, Igboko and Ibeneme (2006) agreed that the use of traditional teaching method like lecture and demonstration alone had proved incapable of producing the effect required for coping with the challenges of globalization and rapid technological development. In the same vein, Omeje (2011) noted that use of teacher-centered approach to instruction by technology teachers do not actively involve students and could lead to inadequate practical skills acquisition and poor performance. It is therefore important to engage students' creative thinking, knowledge synthesis in order to develop problem-solving skills by adopting learner-centered approach like constructivism and meta-learning.

Constructivist teaching method is a learner-centered approach to instruction based on constructivist learning theory that says that all knowledge is constructed from a base

of prior knowledge. Dougiamans and Papert in Cey (2011) saw constructivism as teaching with an approach that seeks opportunities for students to analyze, investigate, collaborate, share, build and generate ideas based on what they already know rather than facts, skills and processes they can talk freely. Constructivism brings to light the significance of social cognitive, interactions, cooperation and collaboration to teaching and learning context. In other words, students construct their own understanding through the interactions of their existing experiences with whatever they come into contact with. This makes learning a social activity which engages learners to question, challenge and formulate their own ideas and conclusions (Ultanir, 2012). Jackson in Gjergo and Samarxhius (2014) opined that constructivism underpins a number of approaches which includes situation learning, concept mapping, anchored instruction, problem-based learning, cognitive apprenticeship, discovery learning, scaffolding and collaboration.

Collaboration is a constructivist teaching approach which involves group of students working together to solve a problem, complete a task or create a product. It provides opportunity for students to interact, share and compare their solutions, methods and answers. Okeke and Okey, (2018) stated that collaboration promotes group work, more retention, encourages students to be engaged in learning process and transfer of knowledge. Research carried out by Jantan as cited by Fui (2011) found out that students process information more effectively when they are actively involved in the teaching-learning process. In the same vein, research findings of Oludipe and Oludipe (2010) revealed that there was improvement in academic performance of students in integrated science in constructivist group than their counterpart in the conventional lecture group. In

other words students' academic achievement improves when a teacher employs a teaching method that is learner- centered such as constructivist, meta-learning e.t.c.

Meta-learning teaching method is a learner-centered approach to teaching and learning that trains the learner's consciousness on the use of meta- cognitive processes for learning (Ogwo & Oranu, 2006). Meta-cognition means knowledge about one's own thinking process. Meta-learning according to Winters (2013) is a concept that describes the process of becoming aware of oneself as a learner and applying this knowledge towards becoming a more effective learner. This knowledge is used to monitor and regulate cognitive processes, reasoning, comprehension, problem-solving learning. In other words, in the meta-learning classroom, basic electricity students can plan, execute, monitor and evaluate the learning activities. Paris and Winogard in Amaechi (2012) opined that what is important is that meta-learning (self-regulated learning) can help describe the ways that people approach problem, apply strategies, monitor performances and interpret the outcome of their effort.

Meta-learning instructional approach emphasises active learning and guided discovery providing the teachers with the instructional tools to cope with the diversity of abilities and learning preferences amongst students in the classroom. Paris and Winogard in Amaechi (2012) further observed that learners in meta-learning classroom are the most successful students because they set goals for their performance, plan how best to use their time, focus their attention on the learning task, keep themselves motivated. As they study, they could use effective learning strategies, monitor their progress, and evaluate the final outcome of their efforts to improve future efforts. Several studies have shown

that students taught with meta-learning instructional method could perform better than those taught with conventional method in some subjects.

Research carried out by Offiah and Akusoba (2009) on effects of meta-cognitive learning cycle on academic achievement of secondary school chemistry students showed that the achievement mean score of students taught with meta-learning is significantly higher than those taught with conventional method. Also in a study conducted by Anyichie and Onyedika (2012) on the effects of self-regulated learning strategy on secondary school students' academic achievement on mathematics, it was discovered that the academic achievement of students taught using self-regulated learning differed significantly with the academic achievement of those taught with lecture method. In the same vein, a study carried out by Eze, Ezenwafor and Molokwu (2015) on the effects of meta-learning teaching method on the academic performance of building trade students indicated that academic achievement of those taught with meta-learning improved significantly better than those taught using conventional teaching method. This is an indication that when students are actively involved in teaching and learning situation it tends to improve their academic achievement.

Academic achievement refers to the successful result of interaction between a teacher and a student (Igbo and Ihejiene, 2014). It is designed to measure an individual's level of skill accomplishment or knowledge in a specific area. Success in the area of academics is determined through achievement test. The purpose of testing achievement is to help the teacher and the students evaluate and estimate the degree of success attained in learning a given concept. It is appropriate in determining the efficiency of instruction

and also useful in testing the retention of information or skill. Obodo in Iji (2010) asserted that achievement is in collaboration with retention. Dancis (2009) and Kirschner, Sweller and Clark (2016) confirmed the statement when they said students learn and retain more when they can develop their knowledge and meaning from their own experience. Retention helps in knowledge development, and knowledge development can be guaranteed when students are actively involved in the teaching and learning processes. Students' active participation in a lesson facilitates mastery and retention.

Retention according to Hayme (2003) is the ability for someone to remember what was taught after a period of time. For the purpose of this study, retention is defined as the ability to keep the knowledge of basic electricity learnt and to be able to recall it when required. There are factors that could influence retention as well as academic achievement of every learner. These factors according to Okeke (2015) include parental education and occupation, family type, family size, age of the learner and gender.

Gender refers to the sexual classification of humans into male and female. There has been conflicting reports on effects of teaching methods on student's achievement and retention across gender. Most studies show that on the average, girls do better in school than boys which implies that female academic achievement is higher compared to boys. In calculative or more practical subjects or courses, boys tend to perform better than girls. In a study conducted by Eze, Ezenwafor and Molokwu (2015) on effects of meta-learning teaching approach on the academic achievement of building trade students, the findings revealed that there is a significant difference in the achievement of male and female students taught building trades using meta-learning teaching approach. Also, the finding

of the study carried out by Emeli (2012) revealed that male students taught with AUTOCAD performed better than female students taught with the same method. However, in a study carried out by Eze, Ezenwafor and Obidile (2016), the finding revealed that there was no significant interaction effect of teaching methods and gender on students' retention in financial accounting. Also, Gana (2015) reported in a study that there was no significant interaction effect of teaching methods and gender on students' academic achievement and retention of quantum physics. Research study carried out by Emelikwu (2011) on the relative effectiveness of three teaching methods in the measurements of students' achievement in mathematics showed that conventional teaching method (teacher-centered) often rely heavily on the sense of hearing which is the least in instructional media. Emelikwu further stated that teacher-centered approach seldom allows the learner the privilege of experience, practice or application of knowledge. The major problem faced by most students is inability to remember what they have learnt which could result to students performing poorly in achievement test. Retention in basic electricity is not acquired by mere memorization rather through student participation rooted in appropriate teaching method.

If research studies carried out by Offiah and Akusoba (2009), Oludipe and Oludipe (2010), Nayak (2013), Eze, Ezenwafor and Molokwu (2015) among others revealed that constructivist and meta-learning teaching methods can improve students' academic achievement and retention in some subjects, there is need therefore to compare the effectiveness of constructivist and meta-learning teaching methods on students' academic achievement and retention in basic electricity in technical colleges to determine the comparative effectiveness of the two teaching methods.

1.2 Statement of the Problem

The current method of teaching in Nigerian technical colleges is mainly teacher-centered which is content-driven and do not give students the opportunities to participate actively in the class instruction. Many documented studies like that of Anyichie and Onyedika (2012), Glaser and Bruostain (2017), Adunola (2011) and Ganyampfu (2013) had shown that students' poor academic achievement is as a result of teaching methods employed by teachers which are mainly teacher-centered. Regrettably, the NABTEB Chief Examiner's report of technical colleges in Anambra State (2017) (see Appendix A page 115) has shown that students' academic achievement in Basic Electricity for National Technical Certificate Examinations 2013-2017 have been poor. Similarly, Ogbu (2011) observed that students' unsatisfactory performance in Basic Electricity in national examinations has persisted over the last ten years and consequently has resulted in unemployment, poverty among craftsmen and scarcity of skilled men and women needed for the growth of the nation's economy. The declining academic performance of Basic Electricity students in Anambra State as reported by Ogbu (2011) and NABTEB Chief Examiner's report (2017) among others is a great concern to students, teachers, vocational educators and stakeholders considering the relevance of basic electricity in this present world of work. Thus, there is need for teachers to explore the teaching methods that would guide and motivate learners to deeply learn information and concepts, in order to construct new ideas, identify new relationships and create new models of thinking and behaviours.

However, in spite of the research findings on the effectiveness of constructivist teaching method and meta-learning teaching method on some subjects, there seem to be

no studies on the comparative effectiveness of these teaching methods for Basic Electricity in technical colleges. It is not known how such teaching methods (constructivist and meta-learning) influence students' academic achievement and retention in Basic Electricity. It is also unclear which of the teaching methods is more effective in improving student's academic achievement and retention in Basic Electricity. For the moment, the effectiveness of constructivist and meta-learning teaching method on students' academic achievement and retention in basic electricity in technical college seem to be unknown. The study, therefore, seeks to investigate the comparative effectiveness of constructivist and meta-learning teaching methods on students' academic achievement and retention in Basic Electricity in technical colleges with a view to finding out which of the two methods is more effective.

1.3 Purpose of the Study

The purpose of this study was to determine the comparative effectiveness of constructivist and meta-learning teaching methods on students' academic achievement and retention in basic electricity in technical colleges in Anambra State. Specifically, the study determined the:

1. Effectiveness of constructivist and meta-learning teaching methods on the academic achievement mean scores of technical college students in basic electricity.
2. Effectiveness of constructivist and meta-learning teaching methods on retention mean scores of technical college students in basic electricity.

3. Effectiveness of constructivist teaching method on academic achievement mean scores of male and female technical college students in basic electricity.
4. Effectiveness of meta-learning teaching method on academic achievement mean scores of male and female technical college students in basic electricity.
5. Effectiveness of constructivist teaching method on retention mean scores of male and female technical college students in basic electricity.
6. Effectiveness of meta-learning teaching method on retention mean scores of male and female technical college students in basic electricity.
7. Interaction effect of teaching methods (constructivist and meta-learning) and gender on technical college students academic achievement mean scores in basic electricity.
8. Interaction effect of teaching methods (constructivist and meta-learning) and gender on technical college students retention mean scores in basic electricity

1.4 Significance of the Study

The outcome of the study would be beneficial to technical education students, teachers, parents, curriculum planners, the society at large and future researchers.

Specifically, the findings of this study would be of immense benefit to technical education students in the sense that by applying appropriate teaching methods, the students will become more actively involved and then will be more interested and motivated to learn. In this way, basic electricity students will be able to retain the skills and knowledge learnt thereby improving their academic achievement. It will equally help the students to acquire the skills and knowledge needed for self-employment or paid employment.

Teachers would benefit from the findings of the study because if the students are exposed to relevant skills, knowledge and attitudes using appropriate teaching method for improved academic achievement and retention, the teachers would in turn be exposed to more recent instructional strategies which if adjusted to, will enhance their capabilities.

Parents would also benefit from the findings of the study, because if the students are provided with the adequate skills and knowledge needed for immediate employment in industries, they could be easily employed in industries or be self employed. They would thereby contribute to the family economy and relieve their parents of some financial problems.

Similarly, curriculum planners would gain from the findings of the study because it is expected that the study will serve as a platform for them to identify and provide the needed resources such as adequate infrastructure, adequate tools and equipment for effective teaching and learning of basic electricity. In this way, it will assist the curriculum planners in achieving the educational aims of self-reliance. Also, it will help the curriculum planners to plan for in-service training for the technical education teachers and so keep them abreast with the new methods for instructional delivery.

Furthermore, the society would benefit immensely from this study in the sense that if students acquire the necessary skills, knowledge and attitude, the graduates could secure and retain jobs thereby reducing the number of educated unemployed youths in the society. This study will also serve as a reference material for further research studies. Those who wish to carry out further studies in the area could use the findings as reference material and source of literature.

1.5 Scope of the Study

The study was delimited to the comparative effectiveness of constructivist and meta-learning teaching methods on students' academic achievement and retention in Basic electricity in technical colleges in Anambra State. The study covered three course contents - resistors, capacitors and inductors selected from the National Technical Certificate syllabus for engineering trades in Basic electricity which are among the passive elements in electronics. The content that was not covered in the study is the transformers. The aspect of constructivist teaching method the study dwelled on is collaboration.

1.6 Research Questions

The study was guided by the following research questions:

1. What is the effectiveness of constructivist teaching method `on academic achievement mean scores of technical colleges students in Basic Electricity when compared with those of students taught with meta-learning teaching method?
2. What is the effectiveness of constructivist teaching method on retention mean scores of technical colleges students in Basic Electricity when compared with those of students taught with meta-learning teaching method?
3. What is the effectiveness of constructivist teaching method on academic achievement mean scores of male and female technical college students in basic electricity?

4. What is the effectiveness of meta-learning teaching method on academic achievement mean scores of male and female technical college students in basic electricity?
5. What is the effectiveness of constructivist teaching method on retention mean scores of male and female technical college students in basic electricity?
6. What is the effectiveness of meta-learning teaching method on retention mean scores of male and female technical college students in basic electricity?
7. What is the interaction effect of constructivist and meta-learning methods and gender on technical college students' academic achievement mean scores in basic electricity.
8. What is the interaction effect of the teaching methods (constructivist and meta-learning) and gender on technical college students' retention mean scores in basic electricity.

1.7 Hypotheses

The following research hypotheses were tested at 0.05 level of significance.

1. There is no significant difference between the academic achievement mean scores of technical college students taught basic electricity using constructivist teaching method and those taught using meta-learning teaching method.
2. Significant difference does not exist between the retention mean scores of technical college students taught basic electricity using constructivist teaching method and those taught using meta-learning teaching method.

3. There is no significant difference between the academic achievement mean scores of male and female technical college students taught basic electricity using constructivist teaching method.
4. Significant difference does not exist between the academic achievement mean scores of male and female technical college students taught basic electricity using meta-learning teaching method.
5. There is no significant difference between the retention mean scores of male and female technical college students taught basic electricity using constructivist teaching method
6. Significant difference does not exist between the retention mean scores of male and female technical college students taught basic electricity using meta-learning teaching method.
7. There is no significant interaction effect of teaching methods (constructivist and meta-learning) and gender on technical college students' academic achievement mean scores in basic electricity.
8. There is no significant interaction effect of teaching methods (constructivist and meta-learning) and gender on technical college students' retention mean scores in basic electricity

CHAPTER TWO

REVIEW OF RELATED LITERATURE

This chapter presents a review of literature relating to the study. The review was organised under the following sub-headings:

Conceptual Framework

- Constructivism
- Meta-learning
- Basic Electricity
- Teaching Methods
- Academic Achievement
- Retention

Theoretical Framework

- Constructivist learning theory
- Cognitive apprenticeship

Theoretical Studies

- Classroom application of constructivism
- Strategies for Collaboration Instructional Approach.
- Strategies for Cognitive Apprenticeship Approach.
- Meta-learning classroom environment.
- Gender influence of Academic Achievement and Retention in technology education.

Related Empirical Studies.

- Studies on constructivists' teaching methods.
- Studies on meta-learning teaching methods.

Summary of Review of Related Literature

2.1 Conceptual Framework

This sub-heading discussed the concepts that were used in the present study.

2.1.1 Constructivism

Constructivism is a theory that takes its root from research of cognitive psychologists. Piaget in Scridev (2013) viewed constructivism as a system of explanations of how learners, as individuals adapt and refine knowledge. Piaget's view focused on learning as an individual intellectual construction based on experiences. Bada (2015) defined constructivism as an approach to teaching and learning based on the premise that cognition (learning) is as a result of "mental construction". On the other hand, Fritscher (2008) saw constructivism as a type of learning theory that explains human learning as an active attempt to construct meaning in the world around us. It focuses on meaning-making and knowledge construction and not on mere memory formation. Constructivists believe that students actively construct knowledge based on what they already know and the new information they encounter. Nayak (2013) defined constructivist approach to learning as a strategy that can enable the learner construct valid knowledge and transmit it in different contexts. The author went further to say that learning in the constructivist framework contributes to intellectual, social and psychological development of learners unlike other methods of instruction.

Advocates of constructivists approach to learning agreed that constructivist pedagogies represent a synthesis of cognitive and social perspectives, where knowledge is seen as personally constructed and socially mediated. Huitt in Odundo (2013) stated

that individuals create or construct their own knowledge or new understanding through interactions with what they already know and believe as well as the ideas, events and activities which they come in contact with. In the process, the individual attains a level of self -regulation which fits into the cognitive structure of the individual. Murphy in Ogwo and Oranu (2006) opined that constructivists perceived learning as requiring self-regulation and building of conceptual structures through reflection and abstraction. They postulated that learners cognitively construct their knowledge through experiences. Experiences enable them to create schemes-mental models in their heads and these schemas are changed, enlarged and made more sophisticated through assimilation and accommodation (Clark in Ogwo & Oranu 2006).Constructivism according to Jackson in Gjergo &Samarvhius (2014) underpins a number of important approaches. These include; situated learning, concept- mapping, anchored instruction, problem-based learning, cognitive apprenticeship, discovery learning, scaffolding and collaboration. Constructivism in the context of this study is a learning process that explains human learning as an active attempt to construct knowledge based on what they already know and the new information they encounter.

Collaboration

Collaboration in education is an approach that engages learners in active learning where they work and learn together in small groups to accomplish shared goals (Planitz in Wachanga, Githae & Kerero, 2015). The authors further stated that collaboration helps students to explore their ideas, clarify and expand the ideas for themselves and to one another, and finally make the ideas their own. This involves students working in small

groups to share strength, develop their weaker skills and learn to deal with conflict when guided by clear objectives.

In other words, collaboration is an approach in which students interact in small groups with the aim to succeed collectively. Collaborative learning can occur in peer to peer or larger groups. Peer teaching/learning is a type of collaborative learning that involves students working in peers or small groups to discuss concepts, or find solution to problems. The effectiveness of collaborative learning depends on factors such as members' prior knowledge, the composition of a group and the quality of explanations (Janssen in Lai, 2012). Collaboration as used in this study is an approach in which students interact in small groups with the aim to succeed collectively.

2.1.2 Meta-Learning

The term meta-learning first occurred in 1970 in the area of educational psychology when a cognitive psychologist, John Favel emphasized the importance of reflecting about one's thinking. Meta-learning according to Bigg in Lemka, Buaka and Gabrys (2013) is being aware of and taking control of one's own learning. The author went further to say that meta-learning is viewed as an understanding and adaptation of learning itself on a higher level than merely acquiring subject knowledge. It then follows that a person who is aware and capable of meta-learning is able to assess learning approach and adjust it according to the requirements of a specific task. Maudsley in Eze, Ezenwafor and Molokwu (2016) described meta-learning as the process by which learners become aware and increasingly in control of habits of perception, inquiry learning and growth that they have internalized. In the same vein, Slabbert in Ogwo and

Oranu (2006) defined meta-learning as a conscious practice (activities) of a learner who is intentionally aware of the learning process.

These conscious activities entail working on oneself to the extent that one intentionally (voluntarily) controls one's thought processes and monitors its input throughout. The author further explained that meta-learning is an endogenous exercise that trains the learner consciousness on the meta-cognitive process for learning. In the same vein, Tunner (1986) viewed meta-learning as a process in which the learner has a deeper awareness of the content, context of study and centering on the "hidden curriculum". From the above definitions, one can deduce that meta-learning is the activity of the learner who is purposefully monitoring the changing objects of the awareness of consciousness.

A teacher can encourage students to go "meta" in their learning by informing the students what the learning contents/experience is all about, what the specific objectives are, what tools are to be used to motivate them and help to achieve the objectives. Jackson in Winner (2013) stated that meta-learning is closely associated with meta-cognition and self regulation. Meta-cognition literally means knowledge about knowledge. It is a complex construct involving cognitive knowledge and cognitive regulation. The knowledge according to Woolfolk (1998) is used to monitor and regulate cognitive processes;-reasoning, comprehension and problem solving. Crippen and Hartley (2006) opined that cognitive knowledge is characterised by declarative knowledge, procedural knowledge and conditional knowledge.

Declarative knowledge: Knowledge about self and strategies to employ in learning. For example in basic electricity, students' knowledge of the formula for calculating the capacitance of a capacitor, the method of calculating the value of a resistor using colour coding.

Procedural knowledge: Knowledge of how to do something, how to perform the steps in a process. For instance, students' ability to apply the formula in calculating the capacitance of a capacitor, ability to determine the resistance of a resistor using colour coding.

***Conditional knowledge*:** Knowledge about when to use a procedural, skills or strategies and when not to use them, why a procedure works, and under what conditions and why one procedure is better than another. For example, ability of basic electricity students to know that for a faulty capacitor and resistor to be replaced in a circuit board, there is need to find out the value of the particular capacitor and resistor as well as their equivalents.

Cognition regulation on the other hand could be classified according to Crippen and Hartley (2006) into planning (analysis of the learning task in terms of content, competences needed and relationship to be established), monitoring (ability to engage in periodic self testing while learning is going on) and evaluation (appraising the products and regulatory processes of one's learning).

Self-regulation as an aspect of meta-learning is a process that assists students in managing their thoughts, behaviours and emotions in order to successfully navigate their learning experiences (Zumbrunn, Tadlock & Robert, 2014). Hester, Anouk and Danny

(2012) opined that meta-cognition is the instrument that controls and forms the basis of the process of self-regulation.

2.1.3 Basic Electricity

Basic electricity is a trade-related module in the field of electricity and electronics in all levels of education (Ogbu, 2010). It is designed to provide the trainee with basic knowledge and practical skills in electrical and electronics technology. Basic electricity is the only module that cut across entire engineering and related trade subjects. It is taught in technical colleges in years I, II and III as stipulated by Federal Republic of Nigeria (FRN), (2014) in the National Technical Certificate (NTC) syllabus. The curriculum is embodied in the curricular booklet for engineering trades (NABTEB, 2017).

The three year content is divided into twelve principal units which are again divided into three for NTC I, NTC II and NTC III classes. Each year's course content is further divided into three for the three terms in school year (NABTEB, 2017). The objectives of basic electricity as outlined in the National Business and Technical Examination (NABTEB, 2017) are that at its completion, the students should be able to demonstrate an understanding of the following principal units of the total course contents; structure of matter and its relevance to electricity, sources of electromotive force, electric circuit analysis, basic components-resistors, capacitors, inductors, ohmic values and functions of resistors, Ohm's law and its application, principles of AC and DC generation, principles of magnetism, series and parallel connections of electrical components, operation and uses of electrical/electronic measuring instruments and principles of transformer construction/operations. Being the only module that cuts across

the entire engineering and related technical subjects, students' academic achievement in it is very crucial and the major determinant of their performance in other electrical/electronics subjects.

2.1.4 Teaching Methods

Teaching is an interactive process through which knowledge and skills are shared with students. Through this process, students' understanding and ability to manipulate the social, economic, political and physical environment are improved to enhance their survival. The primary purpose of teaching is the promotion of learning. Teachers cannot hope to promote learning if they are ignorant of the procedures, techniques and methods to be used in teaching.

Teaching method according to Nneji in Yinusa (2014) is the manner in which the learning content is presented to the learner. It involves the interaction of the teacher, learners and the subject matter. It is a way used by teachers to create learning environment and specify the nature of the activity in which the teacher and the learner must be involved during instructional delivery process (Ugwu, 2014). Chang in Odundo and Gunga (2013) asserted that the method used by teachers in sharing knowledge with students is a factor influencing learning achievement of students in all tiers of the education system. While appropriate instructional methods are likely to enhance learning achievement, inappropriate methods are known to stifle knowledge retention and realisation of learning objectives. Johanesse in Yinusa (2014) opined that an effective teaching method is believed to be a source of critical thinking or inspirational disposition on the part of the students.

According to Okoye in Amaechi and Thomas (2016) the following are outlined as the characteristics of teaching methods:

a. It should progress from simple activities to the more complex tasks.
b. It should possess qualities capable of arousing the interest and enthusiasm for active participation of the students.
c. It should be flexible to accommodate individual differences of the learners.
d. It should be structured in such a way that will satisfy the basic needs of the students.
e. It should be motivating for achievement without boredom
f. It should link classroom activities with real life activities.
g. It should be able to put into action all five senses (hearing, seeing, feeling, tasting and touching) for effective retention of knowledge and transfer of skills required.

Teaching methods according to O'Bannon in Ugwu (2014) can be categorised into two; teacher-centered approach and learner-centered approach.

Learner-Centered Approach (LCA)

Learner-centered approach encompasses all the instructional methods that shift the focus of instruction from the teacher to the students. Mkpa in Ursuala and Eluwa (2013) opined that LCA is a classroom technique in which consideration for the child is at the center of all plan in teaching and learning activities. It is aimed at developing

learners' autonomy and independence by putting responsibility for the learning path on the hands of students. LCA is based on the hypotheses that students who are given the freedom to explore areas based on their personal interests and who are accompanied in striving for solution by a supportive understanding facilitator not only achieved higher academic result but also experienced self confidence (Ahmed,2013). This implies that learner- centered approach is based on the meta-learning and constructivist theory of learning that emphasize the learners' crucial role in constructing meaning from new information and prior experiences. It puts students' interest first, acknowledging students' voice as central to the learning experience. In a learner-centered classroom, students choose what they will learn, how they will learn and how they will assess their own learning while teachers act as facilitators, guides, navigators and co-learners with students. The role of the teachers does not diminish the importance of the teacher but requires new knowledge and skills. UNESCO and ILO (2002) stated that in learner-centered environment, students interact with each other, the teacher, information resources and technology. The environment provides learning with coaching and scaffolding in developing knowledge and skills as well as a rich collaborative environment enabling the learner to consider diverse and multiple perspectives to address issues and solve problems. Child in Eze (2014) observed that learner-centered approach is a powerful pedagogy for improving learning achievement.

Teacher-Centered Approach

Teacher-centered approach is grounded in behaviourism and includes all the teaching methods that view the teacher as the expert and the dispenser of knowledge to students. It is a conventional and widely used method of teaching where the teacher does

most of the talking and intellectual work while the students are passive receptacle of the information provided. Ahmed and Azizi (2009) stated that teacher-centered approach places the teacher at the center of classroom activities including explanation and discussion. This implies that students' active participation is minimal until the teacher authorizes them.

Tanner in Odundo and Gunga (2013) found out that teachers dominate classroom talk and students talked only when called upon to answer questions. Cantrel in Okafor and Ile (2014) highlighted the characteristics of teacher-centered approach to include, leader-centered, leader-active, learner-passive and content emphasis. The instructional procedure on the teacher-centered approach includes among others, recitation, discussion, demonstration, lecturing, tutoring (Mayer in Ogbuanya and Usoro 2010). The author further stated that these instructional procedures have many limitations including that:

(a) Specific objectives of the lesson could not be reached.
(b) Teacher could not make lesson acceptable, interesting, motivating, novel and easily assimilated by students.
(c) Teachers could not mediate by helping students to activate cognitive structure which could help them process information in meaningful ways and become independent learners.
(d) Teachers could not alter substantially the capability of the students especially the low achieving students.

Supporting this view Bada (2005) affirmed that the use of teacher-centered teaching method in which the teacher is most active often creates frustration and learning

difficulties for some students which lead to poor performance. These do not indicate that the teacher-centered approach is without value, as it allows the teacher to quickly cover lots of information to students and is a useful strategy for recall or rote learning. However it is not the most effective approach for retention of learned information as well as higher academic achievement for many students especially for technical students, because the memorised information could be forgotten at anytime (Ogbuanya and Usoro, 2012).

2.1.5 Academic Achievement

The central purpose of teaching is to effect desirable changes in the students' behaviour. In doing this, the students must respond to the learning experiences to which they have been exposed. The response or feedback enables the teacher to determine whether instructional objectives have been achieved.

Achievement according to Hornby (2010) is the ability of somebody to gain or reach a set goal through effort, skill or courage. It implies the art or process of finishing something successfully. Ifeakor in Bajon (2015) defined achievement as a change in behaviour exhibited at the end of a given period of time or within a given time range. Ugwu (2014) asserted that the purpose of testing achievement is to help teachers and students evaluate and estimate the degree of success attained in learning a given concept. It is equally appropriate in determining the efficiency of instruction.

Academic achievement, therefore, is about how successfully a learner has mastered the materials of the learning objects (Tanah in Cyril, 2016). It is the extent to which students, teachers or institutions have achieved their educational goals. Atsumbe, Raymond and Ajunwa (2015) stated that academic achievement refers to knowledge or

skills attained by students in a school or institutions, subjects or courses designated, by a score obtained in achievement test. The authors further stated that academic achievement describes students' success by what students accomplish and do during the implementation of the curricular contents. Some of the purposes of academic achievement as outlined in Ekhasemomhe in Bajon (2015) include:

a. To determine the relative effectiveness of the programme in terms of students behavioural output.
b. To identify student's growth or lack of growth in acquiring desirable knowledge, skills attitudes and societal values.
c. To help teachers determine the effectiveness of their teaching technique and learning materials.
d. To help motivate students to learn more as they discover their progress or lack of progress in a given task.
e. To encourage students to develop sense of discipline and systematic study habits.
f. To acquaint parents or guardians with their children's academic performance.
g. To predict the general trend in the development of teaching-learning process.
h. To provide educational administrators with adequate information about teacher's effectiveness and school needs.

From the aforementioned, academic achievement measurement could be used for instructional, administrative, guidance and counselling as well as research purposes. Academic achievement in the present study can be explained in form of scores/ grades obtained from test or examination in the subject area. The achievement in examination is

based on taught curricullum content either for the end of each term, each year or for the end of the three year programme. At the end of the three year programme, academic achievement is acquired through the final achievement test in examination conducted by National Business and Technical Examination Board (NABTEB).

2.1.6 Retention

Every experience leaves behind it certain dispositions or trace which are retained. The ability to retain or remember facts takes place more effectively when learning experiences are passed to the learner through appropriate teaching method. (Child in Eze, 2014). In the same view, Buchi in Iwuji (2016) opined that understanding and retention of learned items are products of meaningful learning when teaching is effective and meaningful to students. This implies that the task before a teacher is to expose the students to variety of learning experiences that will actively involve their participation to enable them assimilate information. Marzona (2011) suggested that students are more likely to remember concepts if they discover them on their own as opposed to those taught directly. Supporting this view, Ogwo and Oranu (2006) stated that students enjoy and understand lesson if they are actively involved as opposed to being passive spectators.

The concept “retention” is the ability to consequently remember items/things learned or experienced by an individual at a later time (David in Iwuji, 2016). The author further stated that retention takes place when learning is coded into memory. The coding of information provides the index that may be consulted so that retention occurs without elaborate search in the memory lane. Retention according to Atsumber, Raymond and

Ajunwa (2015) is the ability to elicit performance and hold such performance after duration of time. It tells the worth of a student in subject areas in terms of skills and knowledge acquired over time. Armen (2009) opined that retention is the continued capacity to behave in a particular way after something has been learnt. The more teachers involve students in a lesson, the higher the expectation of the outcomes, Sweller and Clark (2006) opined that students learn and retain more when they can develop their own knowledge and meaning from their own experience. These attributes could be possible through meta-learning and constructivist teaching methods. This is in consistent with the Chinese educational paradigm, I hear, I forget, I see, I remember, I do, I understand. Retention as used in this study is the ability of basic electricity students to remember items or things they have learnt after duration of time.

2.2 Theoretical Framework

The theoretical framework of this study is guided by constructivist learning theory and cognitive apprenticeship theory.

2.2.1 Constructivist Learning Theory

Constructivism has its roots in the 18th century philosophies of Kant and Vico. It is a psychological theory of knowledge which argues that humans construct knowledge and meaning from their experience. Constructivist learning theory provides a framework through which the emergent ideas about teaching, learning and assessment can be unified. The constructivist's view of learning is reflected in the developmental theories of Piaget, Bruner, and Vygotsky among others.

Piaget's research on the development of children's cognitive function is regarded by many as the founding principles of constructivist theory. Piaget's theory portrayed children as a "lone scientists" creating their own sense of the world. The theorist stated that children even though quite young are sophisticated, active thinkers and theorists. Specifically, Piaget posited that the existing cognitive structures of the learner determined how information is perceived and processed. If the new information makes sense to the existing mental structure of the learner, then the new information item is incorporated into the structure (assimilation) if however, the data are very different from the existing mental structure of the learner, they are either rejected or transformed in ways that it fits into the structure of the learner,(accommodation). The learners have an active role in constructing their own knowledge in both of these ideas.

Piaget further observed that as children assimilate new information into their existing mental structure, their ideas gain complexity and power and their understanding of the world grows in richness and depth. The theorist equally observed that learning occurs through adaptation to interaction with the environment. Piaget assumes that learners come to classroom with ideas, beliefs and opinions that need to be modified by a teacher who facilitates this modification by devising activities and questions that create challenges to the learner.

This theory is related to the present study as it emphasizes allowing and encouraging the learner to construct an understanding of the world on its own. Piaget theory is also considered appropriate for this study since it can be used to explain the learning process when using learner-centered approach to teaching such as constructivism

and meta-learning which gives the basic electricity teacher the opportunity to motivate and encourage the students to think critically and creatively through active involvement and participation in class work. In the course of this, the teacher understands how the students think by listening carefully to their comments, paying attention to their ways of solving problems so as to be able to match teaching strategies to student's ability.

Similar to Piaget's theory is the Bruner theory which emphasised that learning is an active process in which learners construct new ideas or concepts based upon their prior knowledge and past experience. Bruner viewed human beings as information processors, thinkers and creators of ideas whose cognitive development is through the interaction and exploitation of the environment. Bruner believed that learning is effective when learners are given opportunity to discover facts by themselves. Bruner went on to suggest that intellectual ability is developed in stages through step-by-step changes on how the mind is used. Bruner, therefore, identified three principles to guide development of instructions which include;

(a) Instructions must be concerned with the experiences and context that make the students willing and able to learn (readiness).
(b) Instructions must be structured so that students can easily grasp it (spiral organisation).
(c) Instructions should be designed to facilitate extrapolation and or fill in the gaps (going beyond the information given).

Bruner's theory is related to this study as it detects that teachers should expose the students to an array of learning experiences for the students to develop their mental

abilities through activities inherent in the experiences. The learner-centered teaching approaches employed in the present study are such that will appeal to the students variously, providing them with opportunities to discover ideas and facts in the real-world setting through their own effort.

Substantiating the views of Piaget and Brunner, a social constructivist, Vygotsky (1978) developed social-cultural theory of learning which described learning as a social process and the origination of human intelligence in society or culture. The major theme of Vygotsky's theoretical framework is that social interaction plays a fundamental role in the development of knowledge. The theorist believed that formal and conceptual knowledge emerges from a repertoire of daily experience and interaction with adults and peers. Vygotsky sees teaching and learning as what cannot be judged by what the learner can do when working alone but rather how far ahead the learner can go when offered some assistance by a more experienced person. Vygotsky also believed that everything is learned on two levels – through interaction with others and exploration of Zone of Proximal Development (ZPD). Zone of Proximal development according to Vygotsky is the area of exploration for which the student is cognitively prepared, but requires help and social interactions to fully develop. The goal of Vygotsky theory is to identify the ZPD by asking children to solve problems, then given prompts and hints to see how they learn, adopt and use the guidance. The teachers watch, listen and take careful notes about how the children use the help and what level of support is necessary and then apply the information to plan instructional grouping, peer tutoring learning tasks, etc.

Vygotsky social constructivist theory is related to the present study as it emphasizes much on active learning, collaborative learning, scaffolding which help to provide teachers with the instructional tools to cope with the diversity of abilities and learning preferences amongst students in the classroom. The social constructivist theory as well helps the students to interact with one another, their teacher, asses themselves and monitor their learning experiences. Basic electricity teacher in constructivist (specifically collaboration) and meta-learning classroom provides the students with socially rich environment in which to explore knowledge domains with their fellow students and teachers as well as providing cognitive support systems to students.

Incidentally, the constructivist learning theory did not consider the teacher or an expert providing support that gradually decreases as the learner become more proficient. Rather it places much emphasis on students' prior knowledge or experience by giving the students opportunity to interact with one another, explore and work as a group. Hence, the need for the study to discuss cognitive apprenticeship.

2.1.2 Cognitive Apprenticeship

Apprenticeship system arose as a family institution for supplying existing crafts with artisans and as a means of propagating the heritage of the family. It was later replaced with formal education except in some aspects of education and in on-the-job training. Apprenticeship is a procedure by which young person acquire skills necessary to be proficient in a trade, craft, arts or profession under the tutelage of a master practitioner. It is a kind of vocational training given to a person who learns under an

expert by taking time with the trainer to learn the craft from the trainer's expertise for a period of time.

Cognitive apprenticeship has its roots in social learning theory and it coined by Collins, Brown and Newman in 1987. The theorists proposed that the contemporary classroom instructional method be combined with the modern pedagogical practice of engaging the students with problems in the context of real-world experience. The theory holds that the master of a skill often fails to take into account the implicit processes involved in carrying out complex skills when they are teaching the novice. To combat these tendencies, cognitive apprenticeship was designed among other things to bring these tacit processes into the open when students can observe, interact and practice them with the help of the teacher. Cognitive apprenticeship is the instructional innovation which was introduced to address the problem of inert knowledge. It focuses on learning through guided experience on cognition and meta-cognition rather than physical skills and processes that are the focus of traditional apprenticeship. It focuses on the development of learning and skills beyond the comprehension of subject matter content. In cognitive apprenticeship, teachers or instructors model the strategies and activities necessary to solve problems while providing appropriate scaffolds to support the students' own efforts. Coaching and correction are provided as the students work in increasingly complex problems and then, support is withdrawn as the students develop competency. In other words, learners must work with more experienced people and with time move from a position of observation to one of active practice. The general guidelines for applying cognitive apprenticeship theory in the classroom include:

(a) Identifying the processes of a task and explicitly demonstrating how the task can be accomplished.

(b) Ensuring that the abstract tasks are situated in authentic contexts.

(c) Diversifying the contexts and articulating common underlying concept to scaffold transfer.

Cognitive apprenticeship is relevant to the present study as it emphasises learning through-guided experience which entails that the teacher should demonstrate a task for students to observe. Furthermore, the students should be allowed to practice the task, while providing them with appropriate support, where necessary, to ensure that the task is accomplished successfully. Basic electricity being a skill-oriented subject requires that its instructional delivery should be such that will involve students' active participation while the teacher acts as a model, coach and a guide who helps the students to achieve their goals.

2.3 **Theoretical Studies**

The theoretical studies were discussed under the following sections; classroom application of constructivism, strategies for collaboration instructional approach, strategies for cognitive apprenticeship approach, meta-learning classroom environment and gender influence of academic achievement and retention on technology education.

2.3.1 Classroom Application of Constructivism

The central focus of constructivism is that knowledge is constructed by the individual and built on social context. In other words, knowledge is personally

constructed and reconstructed by the learner based on prior knowledge and experience. Mandorin in Ekon, Ekwueme & Merenikwu (2014) stated that constructivism is a strategy of learning based on the belief that knowledge is not a thing that can simply be given or transferred by the teacher in front of the classroom to the learners seated at their desk rather, knowledge should be constructed by the learners through an active developmental process. The author further stated that it allows the students to interact with themselves, explore and work in groups. Corroborating the view, Richardson in Susanta (2016) opined that individuals create or construct their new understanding or knowledge through the interaction on what they already know and believe, as well as the ideas, events and activities with which they come in contact.

Constructivist learning environment places much premium on student's prior knowledge or experiences. It demands that students are to be treated as individuals. No one's knowledge is an accurate reflection of reality, there is opportunity for discussion and critical thinking. According to Mauhoney (2014) students come into the classroom with their own experiences and cognitive structures. These preoccupied structures could be valid, invalid or incompetent. The learner will reformulate the existing structures only if new information or experiences are connected to knowledge already in memory. Memorised facts or information that has not been connected with the learner's prior experiences will be quickly forgotten. In view of this, Akpan and Beard (2016) opined that learning activities must begin by considering the role of student's current knowledge, how the knowledge is constructed and the role of the activities in building knowledge. The teacher's responsibility in the constructivist learning environment involves taking into account students' prior knowledge and to understand the nature of the concepts to be

learned. The learning outcome expected, conceptual demands made on the child and the strategies available to the teacher must be understood. (Olorundara in Onogowo, 2015). According to Audrey in Cey (2011), the characteristics of a constructivist classroom are as follows;

(a) The learner is actively involved
(b) The environment is democratic
(c) The activities are interactive and student centered
(d) The teacher facilitates a process of learning in which the students are encouraged to be responsible and autonomous.

The major responsibility of a teacher should focus on providing a realistic learning environment for their students by modeling, through experimentation, leading questions and scaffolding to elicit student's knowledge. Akpan and Beard further stated that a typical constructivist classroom environment is task oriented and designed to enhance hands-on and minds-on learning for all students similar to those encountered in the real world. Brooks and Brooks in Stefaniak (2013) suggested twelve strategies a teacher should exercise in order to move towards a more constructivist approach, namely:

(a) Encourage and accept students' autonomy and initiative
(b) Use raw data and primary sources, along with manipulative interactive and physical materials.
(c) Use cognitive terminology such as "classify, analyse predict and create"
(d) Allow students responses to drive lessons, shift instructional strategies and alter content.

(e) Inquire about students understanding of concepts before sharing their own understanding of those concepts.

(f) Encourage students to engage in dialogue, both with the teacher and with one another.

(g) Encourage student's inquiry by asking thoughtful, open-end questions and encouraging students to ask questions to each other.

(h) Seek elaboration of student's initial response.

(i) Engage students in experiences that might engender contradictions to their initial hypotheses and then encourage discussion.

(j) Allow wait time after posing questions

(k) Provide time for students to construct relationships and create metaphor

(l) Nurture students' natural curiosity through frequent use of the learning cycle model.

The learning cycle model according to Okwara-Kalu and Anusiem (2011) consists of identification of prior concepts, exploration/activities, discussion, dissatisfaction of prior concepts and application. Okwara-Kalu and Anusienu went further to explain each concept as follows:

***Identification of Prior Concepts*:** This involves, the teachers trying to find out students' prior knowledge or what they already know about the concept the teachers are about to teach. The teachers may choose to do so by asking some open ended questions or use any activity they think will help draw out the information required. Students' view should be treated with respect no matter how illogical it may be.

***Exploration of the Phenomenon*:** Having expressed their initial views held and organised, children also are helped and organised to explore the ideas about the concept. In this phase, the teacher is more or less a facilitator, encouraging students to gather appropriate information, conduct experiment and other activities that are necessary.

***Discussion of the Investigation*:** Students at this stage will discuss their findings. Each group will present report for discussion and correction. Every student should be made to participate in the discussion. The discussion will be learner-dominated, the teachers' work should be to direct or moderate the discussion. The teachers, once in a while may chip in information they considers vital to the study.

***Dissatisfaction with Prior Conceptions*:** Here, students are helped to reconcile prior conceptions or past knowledge on the topic taught, with the conceptions that emerged from their activities. The children may now feel dissatisfied with some of the prior notions. They should be encouraged to say those prior notions they have discarded and those they still cling to. If the prior notions they still cling to, are not consistent with those established in the lesson, they are made to return to stage two of the instructional sequences.

Application: The students are asked to relate their new conceptions to real life situations. They should be encouraged to draw real-life examples from their own background and also to better express their feelings about the usefulness of the new ideas or conceptions.

2.3.2 Strategies of Collaboration Instructional Approach

Instructional strategies are processes or techniques adopted by teachers to inject variety in their teaching, stimulate learning and maintain learners' interest in the teaching and learning process (Ogwo in Ogbuanya 2010). Gjergo and Samarxhius (2014) stated that collaboration instructional approach could be promoted by means of various activities such as: oral discussion, authentic learning, co-operative/group work, critical thinking and learning frames.

Oral Discussion: This is a tool in collaborative classroom that provides the learner the opportunity to share, clarify and view ideas for themselves and to one another .When properly designed and use thoughtfully, oral discourse promotes creativity and as well generates meaningful interaction and understanding among learners (Durmus in Okoye ,2017).

Authentic Learning: Authentic learning is a strategy that intends to make learning more meaningful by increasing connections between the classroom and the real-world (Calavers in Ogbuanya, 2010). It places the learner at the heart of real-life experience by allowing learners to explore, discuss and meaningfully construct concepts and relationships in contexts that involve real world problems that are relevant to the learner. Ukoha in Ogbuanya (2010) affirmed that the use of real objects, models, specimens, charts e.t.c. are capable of making instruction authentic as students could see the connections between the lesson and the real world. This makes the learner to retain and remember what was learnt for a long time.

Co-operative/ Group Work: This is the core of collaboration instructional approach because it avails the learners the opportunity to explore and optimize their potentials. It involves learners interacting in pairs or groups to discuss concepts or find solutions to problems, with the teacher acting as a facilitator, monitor, team-mates and consultants in order to achieve the desired outcome. Group work is based on the understanding that interactivity in small group provides quality performance that would have not been reached individually as it kindles the interest of the learners through motivation and team spirit with one another (Okeke and Okey, 2018).Group work or learning enhances critical thinking because in a bid to make meaningful and logical contribution students develop their thinking ability. The fast learner in the group always helps the slow learner to understand the subject matter being taught.

Critical Thinking: This is a strategy that allows the learner to incorporate the thoughts, ideas, questions, and opinion of their peers into the field of their own interpretations and thus develops a more complete conceptual framework. Teachers facilitates students in critical thinking by interacting with them in a positive ways such as asking questions, building appropriate challenges and experiences as well as offering new ways of thinking.

Learning Frames*:* This engages the students to focus learning within a controlled context. Learning frames engenders meaningful learning, through helping students to organize incoming information and building mental bridges between prior and new knowledge. While constructing frames, students are required to supply information into slots under the guidance of a teacher during instruction.

2.3.3 Strategies of Cognitive Apprenticeship Approach

Cognitive apprenticeship as formulated by Collins et al (1987) consists of six teaching strategies namely, modeling, coaching, scaffolding, articulation, reflection and exploration.

Modeling*:* This involves an expert demonstrating a task explicitly so that the novice can experience and build a conceptual model. Bandura (1997) posited that in order for modeling to be successful, the learner must be motivated to learn and must be able to accurately reproduce desired skill of the task at hand.

Coaching*:* This entails observing the novice task performance and offering feedback and hints to help the novice perform the task very well. The teacher oversees the students' task and may structure the task accordingly to assist the students' development.

Scaffolding**:** This refers to the supports the teacher provides to help the student perform a task. These supports can either take the form of suggestions or manipulative task.

Articulation: This includes any method of getting the students verbalise their thinking as they perform a particular task. This instructional strategy involves the teacher encouraging the students to vocalise what they are doing so that they can provide evidence to the teacher that they understood the material and are intentionally applying content knowledge to the task that they are completing.

Reflection*:* This allows students to compare their own problem-solving process with those of an expert and /or other students. A technique for reflection could examine and

compare the past experience of both experts and novices. The goal of reflection is for students to look back and analyse their performance with a desire for understanding and improving their performance.

***Exploration*:** This involves giving the students room for problem-solving. It allows the students to frame interesting problems by themselves and then initiates to solve these problems.

These six strategies were grouped into three according to Collins et al as cited in Chee (1995). The first group;- modeling, coaching and scaffolding represents the core and is designed to help students acquire an integrated sets of cognitive and meta-cognitive skills through observation and supported practice. The second group;- articulation and reflection are designed to focus students' observations of expert problem solving strategies. The final group;-exploration is intended to encourage learner's autonomy and problem-solving formulation. The above discussed strategies indicate the teacher's or expert's actions while the learner is engaged in acts of observation, practice and reflection. The main advantage of cognitive apprenticeship is that it put control over learning in the hand of the students and out of the teacher as well as making the student an active learner (Step in Ogwo and Oranu, 2006). However, the major limitation in using cognitive apprenticeship instructional approach is that it may take longer time in the beginning to model the process of thinking and outlining every essential step involved in task performance

2.3.4 Meta-Learning Classroom Environment:

Classroom is considered as an important site for learners' intellectual development. The interaction that occurs between the teachers and the learners and among learners helps to shape individual learner's intellectual development. With technological changes there is a growing literature on the need to understand more about how students learn, acknowledging that how students learn is not synonymous with teaching and that students may learn in different ways, at different times. Some learn by listening and sharing ideas, some learn by thinking through ideas, some learn by testing theories, some learn by synthesizing content and some learn by reasoning logically and intuitively. Bialika and Fadel (2015) stated that people differ in how well or how quickly they learn because they differ in cognitive knowledge and skills.

Cognitive psychologists like Gagne, Berliner and Brunner stated that learning is a cognitive process involving the learners' acquisition of new information, transforming their state of existing knowledge and checking the adequacy of that state of knowledge against the demand of the new situation. Learners who are aware and capable of taking control in learning are able to assess learning approach and adjust it according to the requirements of specific task. This is best achieved when learners are probably made aware of themselves and their learning through meta-cognition (Brazdil, Giraud-Carrier, Soares & Vilalta, 2007).

Meta-cognition is a concept in meta-learning that helps the teachers become familiar of the strategies for helping students regulate, monitor and guide their learning. Mahdavi (2014) opined that the aim of meta-cognition is to develop the sensitivity of students to learning situations, heighten students' awareness of the cognitive repertoire and the

factors that affect the learning process, teach strategies for learning and develop students' capacity to regulate as well as monitor their activities. According to Schraw (2006) learners may possess the requisite knowledge and skills for regulating, monitoring and guiding their learning but fail to use them because they are not meta-cognitively aware. Possessing meta-cognitive knowledge means an individual is aware of the extent the learning contents were understood and the factors that might affect the understanding of the learning contents (Lai, 2011).

Nelson and Naren's (1990) indentified critical steps on how a teacher can best use meta-cognition as follows:

(a) Make learning goals explicit and help students to plan strategies and ways of monitoring their progress towards achieving these goals.
(b) Encourage co-operative group work where set tasks require students to discuss their understanding, evaluate their own work and work as groups and reflect on their learning.
(c) Use self assessment in the classroom to promote meta-cognitive skills; learners can assess the quality of their work based on learning goals, and make adjustment accordingly.
(d) Use teacher and peer-scaffolded interactions to support meta-cognitive development and gradually encourage the transition from the external supported monitoring and control to more internalised meta-cognitive processes.

(e) Focus on developing learner's awareness of the strategies they use by encouraging the discussion of the strategies in the class. This could include when to use certain strategies, how they impact on their learning and why the strategies work.

(f) Encourage the transfer of strategies across different domains of the school curriculum.

(g) Support the learners' autonomy by allowing them to make choices on the level of difficulty of certain tasks. Avoid giving answers where possible, instead prompt the students to think for themselves and choose an appropriate strategy for the tasks.

In order to facilitate the use of meta-learning instructional technique for skill acquisition in technical and vocational education (basic electricity inclusive) Ogwo and Oranu in Eze, Ezenwafor and Molokwu (2013) stated that the teachers should be able to:

a) Discuss the instructional objectives with the students before starting each lesson.
b) Outline the thinking process skills involved in every aspect of the lesson and the best technique of assisting the students to think through them.
c) Use different attention-sustaining strategies to make students conscious of the task at hand.
d) Specify the various process evaluation tasks and questions needed for each stage of instruction.

The authors went further to show elements of meta-learning skills and some instructional strategies as follows.

Elements	**Instructional Strategies**
Planning	
Goal setting:	Chalkboard writing of instructional objectives or oral expression of them. Having a measurable instructional objective.
Focusing:	Defining the types of information (declarative, procedural and conditional) contained at each stage of instructional. - allowing students obtain clarifications on confusing concepts even when they may not seem to relate to the present lesson.
Information	Use of mnemonics
Gathering/Encoding	– avoid teleological and anthropomorphic questions. - Students are to repeat (verbatim) words or concepts that could prove difficult to remember. - Students should never be spoon fed with information that they can find themselves, i.e decreasing teacher direction.
Organizing:	- Relating new knowledge with familiar ones - Identify salient attributes of any concept or object. - students are made to use their own words to show how they understood a concept or procedure. - use of flow chart or spatial relations.

Executing

Analyzing:	Teachers should use demonstration method wherever possible to state the procedural knowledge in the given task; pointing out attributes of the materials used and any likely design error.
Synthesizing:	Students have to practice the demonstrated skills. Where materials can't go round; a sample of bright and dull students should be used.
Predicting:	Uncompleted projects could be given to students or wrongly constructed pieces could be used to find out how they would predict consequences.
Elaborating:	Students should be allowed to choose their projects or told to modify those given by the students. Every project should have detailed descriptions on constructional procedures and specials features.
Monitoring:	This skill is exercised alongside the others and guarantees the effective use of the other three skills; hence its effectiveness is usually inferred.
Timing:	There should be sufficient time between tasks and on any task in order to enable students develop insight on tasks' requirements. Practicing time should be regulated by the nature and difficulty level of tasks.
Attention (sustaining):	There are two types of attention: voluntary and involuntary. Involuntary attentions are somehow automatic as it is

	influenced by physical environment and the initial interest aroused by such external stimulus. Teachers could assist students in this by making lessons interesting in their presentation. Voluntary attention is a continuation of the involuntary. It is influenced by the psychological environment. Hence teachers should encourage students to have intrinsic value for their learning activities. This could be by de-emphasizing grades.
Style:	Teachers should be tolerant of students' different learning styles (divergent and convergent). They could equally encourage a mixture of both styles of any individual students.

Evaluation:

Reviewing:	Through carefully designed questions, students are expected to mention important points of the lesson. This is to show areas of misconception or difficulty.
Revising:	Teacher will revise the lesson in order to correct and improve on students' revision of the lesson.
Value Determination:	Students should criticize one another's work or their own based on earlier established criteria. They should be encouraged to see their works from another person's point of view.

Verifying: Tasks having more than one method should be used for students to verify their relative advantages. Take-home assignments have to be centered on verification of reached conclusions.

2.3.5 Gender Influence on Academic Achievement and Retention in Technology Education

Gender from cultural, political, economic and social context is a determined terminology that goes a long way to interpret those characteristics exhibited by individuals which make them either male or female (Dantata in Dike, 2008). It includes hierarchy and ranking of men and women distinctly in terms of power, wealth, previlege and other resources. Okeke (2015) stated that gender can be considered to be the society-constructed roles, responsibilities ascribed to male or female by different societies. The author further stated that gender guides how female or male think about themselves, how they interact with others and what positions they occupy in society as a whole. Gender is different from sex because sex describes the biologically determined physical distinctions between male and female which is universal (Irukwe in Ugboaja and Uzoka, 2011). In other words gender is a societal meaning assigned to male or female with a particular role that each should play.

The arbitrary assigning of roles and expectations to male and female within the African society has given rise to perceiving some courses as masculine in nature and some feminine in nature. There is a general belief among Nigerians that males are superior to females in terms of physical physique, cognition, logical reasoning and even academic achievement. (Anigbogu in Ezenwosu and Nworgu, 2013). For instance in

Nigeria, Ezenwafor and Nworgu, (2013) further stated that proficiency in mathematics, science and technology courses are male-dominated while proficiency in humanities, education and social sciences are female-dominated.

Corroborating the view, Nzewi in Ugwu (2004) stated that female upbringing tends to shape them away from science and technology courses. This has also accounted for the difference in enrollment of males and females in technology courses with more enrollments for males and fewer for females. Consequently, gender differentiations that exist in some science related subjects and technology subjects have lead to variations in academic achievement of male and female students.

There are different opinions as regards to gender influence on academic achievement as well as retention of learned information among students. For instance, Owodunni and Ogundola (2013), Oludipe and Oludupe (2010), Umar, Idris and Ezendu (2014) reported that gender has significant effect on student's academic achievements and retention. In contrast, Yinusuf, Gambari and Olumorin (2012), Abbas and Habu (2014), Dania (2014), Maishikafa (2010), Eze, Ezenwafor and Obidile (2016) reported that gender has no significant effect on students academic achievement and retention. Any observed differences may be as a result of one's socio-cultural orientation and opportunity. The contradictory findings have prompted the inclusion of gender as a moderating variable for this study.

2.4 Related Empirical Studies

This section reviewed some related empirical studies that have some relevance to the present study. These related empirical studies are treated under the following sub-headings;

- Studies on constructivist teaching method
- Studies on meta-learning teaching method

2.4.1 Studies on Constructivist Teaching Method.

Scholars that have conducted research on constructivist teaching method include the following among others:

Uwalaka and Oforma (2015) conducted a study on effect of constructivist teaching method on students' achievement in French listening comprehension. One research question and one hypothesis guided the study. Quasi-experimental, pre-test, post-test, non-equivalent control group design was used. The instrument for data collection was French Achievement Test (FAT) which was face validated by three experts each in language education, foreign languages and measurement and evaluation. Kuder-Richardson 20 (K-R20) was used to determine the internal consistency of the instrument which yielded reliability co-efficient of 0.86. Purposive sampling technique was used to select 45 senior secondary class II (SS2) students in four schools in Owerri North Local Government Area of Owerri Education Zone I of Imo State from the population of 350 SS2 French students in the zone. The instrument was pre and post-tested on the two groups (experimental and control groups) before and after a period of four weeks of teaching by the regular French teachers who taught in the selected schools. Mean and

standard deviation were used in answering the research questions while the analysis of covariance (ANCOVA) was used to test the hypotheses.

The findings of the study showed that there was a significant difference in the mean achievement scores of students taught listening comprehension using constructivist method and those taught with the conventional method. Based on the findings, some recommendations were made which included that teachers should adopt constructivist teaching method in teaching French listening comprehension since it has been found to improve students' achievement.

This study is related to the present study as both studies compared two teaching methods on students' academic achievement. However, the two studies differ in content coverage, area of the study, population of the study and subject area. While Uwalaka and Oforma's study examined the effects of constructivist teaching methods on student's achievement in French listening comprehension the present study compared constructivist and meta- learning teaching methods on students' academic achievement and retention in basic electricity.

Iji, Ochu, Adikwu and Atamonokhai (2017) carried out a study on effect of collaboration instructional strategy (CIS) on students' achievement in secondary school chemistry in Benue State. Two research questions and two hypotheses guided the study. Being a quasi-experimental design, Chemistry Achievement Test (CAT) was used as instrument for data collection. The CAT was validated by three experts in the department of Science Education, Federal University of Agriculture, Makurdi. The internal consistency of the instrument was determined using Kudar- Richardson 20 (K-R20)

which yielded a reliability co-efficient of 0.85.The population of the study was 6400 senior secondary class two (SS2) students of 301 government approved co-educational schools in Benue State. Purposive sampling technique was used in selecting 216 senior secondary class 2 (SS2) students in four schools out of six schools in the three educational zones of the State. Random sampling by tossing a coin was used to select two schools for experimental group while the remaining two schools served as control group.

The instrument was pre and post tested on the two groups (experimental and control groups) before and after a period of four weeks of teaching by their regular chemistry teachers in the selected schools. Mean and standard deviation were used to answer research questions while ANCOVA was used to test the null hypothesis at 0.05 level of significance.

The findings of the study revealed that students of CIS had significantly greater achievement mean score than those of traditional/ lecture method and that there was no significant difference in achievement mean score due to gender of students of CIS. Thus CIS was more effective in enhancing students' achievement than lecture method and was gender friendly. Based on the findings, the researchers recommended among others that training should be organized on the use of CIS for secondary school chemistry teachers. The study is related to the present study because both studies compared two teaching methods on students' achievement of which both studies centered on one similar method (collaboration) for one group. However, both studies differ in subject area, population, scope and location.

Similarly, Atsumbe. Owodunni, Raymond, and Uduafemhe, (2018) conducted a study on effect of scaffolding and collaboration instructional approaches on students' achievement in Basic Electronics. Two research questions and two hypotheses guided the study. A quasi-experimental, pre-test, post-test, non equivalent control design was adopted for the study .The instrument for data collection was Basic Electronics Cognitive Achievement Test (BECAT) which was face validated by two experts, one from Department of Industrial Technology and Education, University of Minna, the other from Department of Examination Development, National Examination Council Abuja. The BECAT was tested for reliability using Kudar-Richardson 20 (K-R20) and a reliability co-efficient of 0.88 was obtained. A sample of 105 students (77males and 28 females) from four schools was drawn using a purposive sampling technique from all the 122 senior secondary school class II (SSII) students of Basic Electronics in eight science and technical schools offering Basic Electronics in North-Central, Nigeria. The four colleges were grouped into two intact classes, two schools for experimental group 1 and the other two for experimental group II. The BECAT was pre and post tested on the two groups before and after a period of four weeks of teaching by their regular Basic Electronics teachers who taught in the selected schools.

Data collected were analysed using mean and ANCOVA for research questions and hypotheses respectively. The findings of the study revealed that the two approaches were effective for improving students' cognitive achievement. However, the collaboration instructional approach was more effective than the scaffolding instructional approach. The study also revealed that there was no significant difference between the

mean scores of male and female students when taught Basic Electronics using scaffolding and collaboration instructional approach.

Based on the findings, the study recommended among others that teachers of electronics and related trade subjects in secondary schools should incorporate collaboration instructional approach in the teaching of their subjects. The study is related to the present study in that both studies used collaboration instructional approach and the same subject area. However, both studies differ in population, content coverage and area of the study because the present study determined the comparative effectiveness of two teaching methods on students' achievement and retention of Basic Electricity in technical colleges in Anambra State while Atsumbe, Owodunni, Raymond and Uduafemhe's study compared the effect of two teaching methods on students' achievement of Basic Electronics in technical colleges in north-central, Nigeria.

2.4.2 Studies on Meta-Learning Teaching Method.

Scholars that have conducted research on meta-learning teaching method include the following among others:

Eze, Ezenwafor and Molokwu (2016) conducted a study on the effects of meta-learning teaching methods on the academic performance of building trade students in South-East States of Nigeria. Two research questions and two hypotheses guided the study. The pre-test, post-test quasi-experimental research design was adopted. The population of the study was 376 National Technical Certificate (NTC) year II building trade students' in 23 technical colleges (Federal and State) in the area. Purposive sampling technique was used to select a sample size of 120 students from four schools

based on the building trade students (male and female). The sample was grouped into two intact classes of 60 students (45 males and 15 females).

Twenty objective questions Building Trade Performance Test (BTPT) developed by the researchers and validated by three experts (two in technology education and one in measurement and evaluation from Nnamdi Azikiwe University, Awka) was used for pre-testing and post-testing of the two groups. Test-re-test method was used to establish the reliability of the instrument. The two sets of scores were correlated with the Pearson – product moment Correlation formula and a reliability co-efficient of 0.60 was obtained. The mean and standard deviation were used to analyse the research questions. The students' mean scores on the two tests were analysed using ANCOVA at 0.05 level of significance for the hypotheses.

It was found out that meta-learning method was more effective than the conventional teaching method since the mean difference of meta-learning method was greater than that of conventional teaching method. The study also revealed that the mean scores of male and female in meta-learning group were the same while the mean scores of male and female students differ in favour of males when compared across teaching methods/meta-learning and conventional teaching method).

The study is related to the present study in that both studies used meta-learning teaching methods in technical colleges. However, both studies differ in the population, scope, and subject area. While the present study was on basic electricity students of technical colleges in Anambra State, that of Eze, Ezenwafor and Molokwu was on building trade students of technical colleges in the South-East States of Nigeria.

A similar study conducted by Raymond and Hassan (2007) on the effects of meta-learning instructional approach on students' performance in Basic Electricity in technical colleges in Niger State. Two research questions and two hypotheses guided the study. A sample of 120 basic electricity students in technical colleges in Niger State was drawn from the population of 260 National Technical Certificate (NTC) Class II students in four technical colleges in the states (30 students from each school). Basic Electricity Achievement Test (BEAT) was the instrument used for data collection. The instrument was tested for internal consistency using Kuder –Richardson 20 formula which yielded reliability co-efficient of 0.75.

Being a quasi-experimental research design, a pre-test was administered to both groups (experimental and control group) to determine students entry level equivalence and thereafter, a post-test was administered after three weeks of instruction to both groups in Basic electricity. The pre-test and post-test results were analysed using mean and standard deviation.

The findings revealed that students in experimental group performed significantly better than their counterparts in control group. The study recommended among others that teachers of technical education should be sensitized on the relevance of meta-learning instructional method through workshops, conferences and seminars. Raymond and Hassan's study is related to the present study because both studies used meta-learning teaching method on NTC II basic electricity students of technical colleges but differs in area of the study, content coverage and method of data analysis. While Ogwo's study was carried out in Niger State using meta-learning instructional approach on

students' performance in basic electricity and data analysed using mean and standard deviation, the present study was carried out in Anambra State, using meta-learning and constructivist instructional approach, data analysed using mean and ANCOVA.

Offiah, Samuel and Esiena (2012) conducted a study on the effects of meta-cognitive learning cycle on critical thinking ability acquisition of senior secondary school chemistry students in Onitsha educational zone of Anambra State. Quasi-experiment, pre-test, post-test, non-equivalent treatment group was used. Three research questions and three hypotheses guided the study. The instrument for data collection was Wastson-Glaser Critical Thinking Appraisal Manual which reliability index was 0.96. Being a quasi-experimental design (two treatment groups and one control group) critical thinking ability test was administered on 182 senior secondary school class one (SS I) students before and after six weeks of teaching.

The data collected were analysed using mean and standard deviation for research questions and 2-way analysis of variance (ANOVA) for null hypotheses at 0.05 level of significance. The direction of the significance difference was established with Pair-wise post-Hoc Test Scheffe and least significant difference on the F-ratio.

The findings indicated that critical thinking ability test was highest for Meta-cognitive learning cycle (MLC) strategy followed by learning cycle (LC) group and lastly traditional group. The difference in the scores has no significant gender effect. It was recommended among others that teacher preparation programmes should introduce meta-cognitive learning cycle strategy in their science teaching methods classes.

This study is related to the present study in teaching approach, design, area for the study but differs in subject area, population, scope and method of data analysis. While Offiah, Samuel and Esiana's study analysed data collected from chemistry students in public secondary schools in Onitsha educational zone of Anambra State using 2-way ANOVA, the present study while using intact groups analysed data collected from basic electricity students of technical colleges in Anambra State using ANCOVA.

2.5 Summary of Review of Related Literature

The review of related literature discussed the concepts that are associated with the study such as constructivism, meta-learning, academic achievement, retention and teaching methods. Teaching methods were categorised into two- student-centered and teacher centered and discussed extensively.

The review also discussed among others constructivist theory and cognitive apprenticeship theory as the theories that are related to the present study. The review also indicated that so many studies have been conducted on gender influence on academic achievement and retention, constructivist teaching method as well as meta-learning teaching method on different subjects (sciences, arts and technical subjects).

Although the findings of these studies revealed that constructivist and meta-learning teaching groups have higher mean post-test scores than the conventional teaching group, indicating that constructivist and meta-learning groups are better than conventional teaching method in these subject areas, none of these studies was conducted to compare constructivist and meta-learning teaching methods on students' academic achievement and retention in Basic electricity at technical college level.

Thus, the present study compared the effectiveness of constructivist and meta-learning teaching method on students' achievement and retention in basic electricity in technical colleges in Anambra State. The finding of the study revealed which of these two learner-centered approaches to teaching (constructivist and meta-learning) is more effective in enhancing students' achievement and retention particularly in basic electricity.

CHAPTER THREE

METHOD

This chapter describes the method that was used in carrying out the research. It is organized under the following sub-headings; research design, area of the research study, population of the study, sample and sampling techniques, instrument for data collection, validation of the instrument, reliability of the instrument, experimental procedure, control of extraneous variables and method of data analysis.

3.1 Research Design

The study adopted quasi-experimental research design. Specifically, pre-test, post-test, delay post-test, non-equivalent treatment group design was adopted for the study. According to Gall, Gall and Borg in Ogbuanya and Akinduro (2017), quasi-experimental research design permits the use of intact classes. The design was adopted because, it is not possible for the researcher to randomly sample the subjects and assign them to groups without disrupting the academic programme and the time table of the technical colleges involved in the study. Hence, the design was considered to be quite suitable for conducting the study.

3.2 Area of the Study

This study was carried out in Anambra State of the South-Eastern Zone of Nigeria. Anambra State is one of the most densely populated State in Nigeria and is known for determination in entrepreneurship. The rationale for using the State for the study is because of the poor performance of students in basic electricity as reported in the Chief Examiner Report (see Appendix A pg.115) and as such, there is a dearth of

technicians in the area despite the large number of industries located in the State where these students will easily attach themselves for industrial training during their schooling period or secure employment after graduation.

3.3 Population of the Study

The population of the study comprised the entire 560 National Technical Certificate (NTC), Year II Basic Electricity Students in all the 12 technical colleges in Anambra State in the 2018/2019 academic year. The distribution of the population according to colleges is presented as Appendix B (pg.116). The justification for using NTC II is that they have been exposed to the course in their NTC I and will be more matured than NTC I students and may have acquired more experience in the subject of the study. NTC III students were not used for the study because they were approaching their final examination in NABTEB at the time of the study and as such may not be much disposed to participate in the study.

3.4 Sampling and Sampling Technique

Purposive sampling technique was used to select four technical colleges based on the number of Basic Electricity Students (male and female), their age, availability of teaching facilities and professional qualified teachers. A total number of 108 students were selected for the study. The sample was grouped into four intact classes. Two intact classes were randomly assigned experimental group E1a and E1b while the remaining two intact classes were randomly assigned experimental groups E2a and E2b. Government Technical College Umuchu and Government Technical College Utuh were the experimental group 1_a and 1_b respectively while Government Technical College

Umunze and National Science and Technical College Nnewi were the experimental group 2_a and 2_b respectively as shown in Appendix C. Pp.117.

3.5 Instrument for Data Collection

The instrument for data collection for the study was Basic Electricity Achievement Test (BEAT) for measuring achievement and retention of Technical College Students in Basic Electricity (see appendix D and E, Pp. 118 and 121). Items of the instrument were developed by the researcher from the NABTEB past question papers. The instrument consisted of 40 multiple-choice questions based on the NABTEB curriculum content for Basic Electricity for National Technical Certificate (NTC) level (see Appendix P. p.172). The 40 questions have four options and each correct answer has 2.5 point, while each incorrect answer has 0 point. Thus the total correct answers to the questions scored 40 x 2.5=100 points.

The test items covered resistors (16 items), capacitors (16 items) and inductors (8 items). The rationale for choosing the content is that the contents (resistors capacitors and inductors) constitute the major passive components of any electronics circuits and there is need for students to be well grounded on the components. Some of the BEAT items were drawn from NABTEB past questions (2005-2016) and some were developed by the researcher to cover the contents.

The contents covered include; Identification of resistors, Types of resistors, Determination of resistor values using colour codes. Identification of capacitors, capacitance, working voltage, types of capacitors. Factors affecting capacitance of a

capacitor, Inductors;- types and functions, Inductance, Factors affecting inductance of an inductor.

3.6 Validation of the Instrument

The instrument was validated for its content and face validity by three experts, two in the department of technology education and one in measurement and evaluation, all from Nnamdi Azikiwe University, Awka. Each of the three experts were given a copy of the research topic, purpose of the study, research questions, hypotheses, lesson plan, BEAT and table of specifications and were requested to check the test items for clarity, suitability of the language, coverage of the content area, relevance of the items to the research questions and any other point of interest outside the ones indicated which the experts may consider relevant. The advice of the experts helped to modify the set of test items for the study before approval by the supervisor (see Appendix O.p.169).

Table of Specifications

Items in the basic electricity achievement test (BEAT) covered knowledge, comprehension, application, analysis and synthesis levels of Bloom's (1971), taxonomy of educational objectives. The weights were based on the unit of coverage. The relative weights of emphasis on the test items are resistor 20%, identification of resistance values of resistors 20%, capacitor 40% and inductor 20%. The table of specifications was developed based on the topics (see Appendix F, Pp.122)

Item Analysis

Item analysis was carried out on the 40 items contained in the instrument by administering it to 30 NTC II Students from Government Technical College Ofagbe,

Delta State which was not part of the study population. The items focused on two indices namely the item difficulty level and the discrimination index.

1. *Item difficulty level*: This is the measure of how easy or difficult a test item appears. It is determined by the percentage of candidates that got the right answer out of the total respondents. The formular for calculating the item difficulty is shown on Appendix G, p.123.

According to Iwuji in Eze, Ezenwafor and Molokwu (2015), an ideal test item is one whose index is of 50 percent difficulty level.An item whose difficult index is between 25 percent to 75 percent could be allowed in an achievement test, where the aim is to have a high proportion of a class achieve mastery.

2. *Discrimination Index***:** The degree to which an item discriminates between very high knowledge (high achiever) and low achiever is the discrimination power of the item. For an effective item, the index is supposed to be positive and high. This implies that more students in the upper group (high achievers) got the item right than those in the lower group (low achievers). A negative discrimination index indicates a defective item. The formular for calculating the discrimination index is shown on Appendix G, p123.

Procedure for Calculation

The students' scripts were arranged in order of merit with the highest score being on top and the lowest score below.

1. The number of students used for the pilot testing was 30.This number was multiplied by 0.27 and the result is 8.1, which rounded up to 8.
2. Eight scripts were counted from the top as these formed the upper eight students (RH), while another eight scripts counted from the bottom which represents the lower eight scripts (RL). The remaining 14 scripts represented students between RH and RL and were not used for the exercise.
3. The respective values of RH and RL for each item were substituted in the formular for computing discrimination indices for the items.

Final Selection of Items

In the final selection of the items for the BEAT instrument, the following conditions were considered;

a. Items which difficulty indexes fall between 25 and 75 were selected and used.
b. Any item with negative index was removed and not used.
c. Any item which discrimination index fall below 0.20 was not used (Iwuji in Eze Ezenwafor and Molokwu 2015).

Initially, there were 40 items. After validation, the 40 items were trial tested but still retained based on the values of difficulty and discrimination indices. Appendix G, p.123 is the analysis table of the 40 questions.

3.7 Reliability of the Instrument

The reliability of the instrument was determined by administering BEAT to a trial group of intact class of 30 NTC II Basic Electricity students of Government Technical College Ofagbe, Delta State. Reliability co-efficient of the score was established using Kuder-Richardson 20 Formula which yielded a coefficient index of 0.87 (See Appendix H, p.124).

3.7.1 *Experimental Procedure*

Before the commencement of the study, the researcher inquired and obtained permission from the Head of Department of electrical and the principals in the 12 technical colleges in Anambra State to allow the study to be carried out in their schools and to find out if they have the required number of resources that will be needed to conduct the experimental treatment (see Appendix N.p.165) The researcher also did a preliminary survey to ascertain the number of technical colleges in Anambra State that were offering Basic Electricity as there were schools that may not be offering Basic Electricity. Thus, the number of students in Basic Electricity options (both male and female) according to their level/class was determined. Based on the information from the preliminary field survey, the researcher purposively selected four technical colleges out of the 12 technical colleges in the State. These four technical colleges were allocated to the two experiment groups (E1a, E1b, E2a and E2b). The experiment lasted for 16 weeks and the process for conducting the experiment is symbolized as follows;

Group A: Q1 X1 Q2 Q3

……..

Group B: Q1 X2 Q2 Q3

Where X1 = Constructivist teaching group

X2 = Meta- learning teaching group

Q1 = Pre-test for both groups

Q2 = Post-test for both groups

Q3 = Delayed Post-test for both groups

….. = Non-equivalent treatment group

Week 1:

In the first week, the researcher went to Government Technical College Umuchu to brief the basic electricity teacher that taught the students in experimental group E1a, on how to administer the experimental treatment using constructivist teaching method with the already prepared researcher's lesson plan. The researcher explained the purpose of the study to the teacher, and introduced the concept of constructivist teaching method. The researcher also described how to conduct the pre-test, post-test and the delayed post-test using the BEAT to the teacher .

Furthermore, the researcher gave the score sheet to the teacher and explained how to score and enter the score of each student. After the briefing session, the researcher provided the instructional materials needed for the treatment. The researcher gave out

prepared lesson plans on the constructivist teaching method to the teacher to take home and study.

Week 2:

In the second week, the researcher went to Government Technical College Utuh to brief the teacher that taught students in the experimental group E1b on how to administer the experimental treatment using constructivist teaching method with already prepared researcher's lesson plan. The researcher explained the purpose of the study to the teacher, and introduced the concept of constructivist teaching method. The researcher also described how the pre-test post-test and delayed post-test will be conducted using BEAT to the teacher.

Furthermore, the researcher gave the score sheet to the teacher and explained how to score and enter the scores of each student. After the briefing session, the researcher provided the instructional materials that were needed for administrations of the treatment. The researcher thereafter gave out the prepared lesson plans on constructivist teaching method to the teacher to take home and study.

Week 3:

In the third week, the researcher went to Government Technical College Umunze to brief the teacher that taught students in experimental group E2a on how to administer the experimental treatment using meta-learning teaching method with the already

prepared researcher's lesson plan. The researcher explained the concept of meta-learning and the strategies of meta-learning teaching method.

Furthermore, the researcher described to the teacher how the pre-test and post-test will be conducted using BEAT. The researcher also gave out the score sheet to the teacher, explained how the teacher will score and enter the score of each student. After the briefing session, the researcher provided the instructional materials that were needed for administration of the treatment. The researcher thereafter gave out the prepared lesson plans on meta-learning teaching method to the teacher to take home and study.

Week 4

In the fourth week, the researcher went to Nigeria Science and Technical College, Nnewi to brief the teacher that taught students in experimental group E2b on how to administer the experimental treatment using meta-learning teaching method with the already prepared researcher's lesson plan. The researcher explained the concept of meta-learning and the strategies of meta-learning teaching method.

Furthermore, the researcher described how the pre-test and post-test will be conducted using BEAT to the teacher. The researcher also gave out the score sheet to the teacher, explained how the teacher will score and enter the score of each student. After the briefing session, the researcher provided the instructional materials that will be needed for the administration of the treatment. The researcher thereafter gave out the prepared lesson plans on meta-learning teaching method to the teacher to take home and study.

Week 5 to 8:

In the fifth to eight week, the researcher went back to Government Technical College Umuchu, Utuh, Umunze and Nnewi to conduct model micro-teaching with the teachers on the use of constructivist and meta-learning teaching methods respectively. Oral evaluation was used to ensure that the teacher have acquired the methods or strategies in the meta-learning and constructivist teaching methods. Where explanations were required or concepts not clearly understood, the researcher clarified.

Week 9:

Pre-testing of Students for the Study by School Teacher.

The pre-testing of the research participants were carried out by the school teachers through the administration of BEAT. The responses of the participants were scored and recorded by the teachers and later the scores handed over to the researcher.

Week 10 to 13:

Administrations of treatment by School Teacher

The Basic Electricity teachers administered the treatment to all the research participants selected for the study by teaching the three selected topics in Basic Electricity using the teaching methods in the school under study, Experimental group EIa –Constructivist teaching methods (Government Technical College Umuchu), Experimental group E1b - Constructivist Teaching Method (Government Technical College Utuh), Experimental group E2a – Meta-Learning (Government Technical College Umunze) and Experimental group E2b – Meta-Learning (Nigerian Science and Technical College Nnewi) . The three topics (Resistors, Capacitor and Inductor) covered identification of various types of Resistors, Functions/Application of various types of

Resistors. Determination of resistor values using colour codes, Concept of capacitors and capacitance, working voltage, factors affecting capacitance of a capacitor, simple calculations involving capacitance, inductors-: types and functions, inductance, factors affecting inductance of an inductor. These topics were taught for four weeks. Lesson plans and instructional materials for the treatments are shown in Appendices I, J and K, p. 125 - 151.

Week 14:

Post-testing of Students for the Study

At the end of the four weeks of treatment, the same BEAT (but reshuffled) were administered to the two groups by the research assistants. At the end, each experimental group had two sets of scores, pre-treatment achievement scores and post-treatment achievement scores.

Week 15 - 16:

Delay Post-testing of students for the study

Two weeks after the post-test, the BEAT was administered as delayed post-test during a class lesson to find out whether students retained what they were taught in Basic Electricity. This delayed post-test was re-arranged (BEAT) and administered to the students. The essence of the re-arrangement was to distract the students from realizing that they had responded to the instrument before. The administration of the delayed post-test was done by the research assistants (class teachers). The following precautions were taken in the course of the experiment;

a) The experimental groups were taught the same topic by their teachers.
b) Attendance was taken at the beginning of every teaching session so that scores of students who missed any of the session was not used during data analysis.
c) To prevent the students from being familiar with the questions of the pre, post and delayed post-test; the test items were re-arranged and the colour of the test papers changed.
d) The time allowed for answering the pre, post and delayed post-test was the same. At the end of the treatment, the data obtained from the experimental groups was analysed.

3.7.2 Control of Extraneous Variables

There are some variables that if not checked by the researcher may interfere with the dependent variables and thus produce distorted results that may falsify findings and conclusion. These variables are called extraneous variables. The following measures were employed to control some of the extraneous variables identified in the study.

***Initial group differences*:** Randomization is one of the techniques used to control initial group differences in experimental studies. However, in the current study, randomization was not done since the process can alter normal school activities. In place of that, intact classes were used. Thus, to control the initial differences of subjects in these intact classes, analysis of covariance (ANCOVA), statistical tool was used for data analysis.

Experimental bias: The use of the same group of students for the experiment could make the students become sensitized that they are being used for a research study.

This could make them fake most of their actions. Such action can introduce experimental bias in the study. In order to prevent this bias, four different technical colleges with their basic electricity teachers as research assistants were used. In other words, the schools' teachers were trained on how to administer the treatment to the experimental groups. In this way, there will not be bias as a result of the presence of the researcher as well as interaction between students of the two groups. Both experimental groups were in different locations so, no group felt that a new thing was done on them while others were held constant.

Teacher variable: In quasi experimental study, teacher variable could affect the result of the research. Teacher variable occurs when one teacher is made to teach one experimental group and another to teach the other experimental group with their individual lesson notes. Since no two teachers can have the same knowledge and skills in teaching the groups with their lesson notes, one group will likely be at advantage over the other. To control the teacher variables in this study, the four research assistants (class teachers) for each intact class used the lesson plans prepared by the researcher.The research assistants were also exposed to micro-teaching to ensure that they understood the rudiments of the experiments. The researcher briefed the research assistants on how to make judicious and effective use of these lesson plans for the groups.

Duration of teaching: This is the period of lesson for the subject per week. For this study, the period of teaching was four weeks for all groups. The normal period allowed for the subject per week was used. In other words, double periods of 40 minutes each per week was used. This is to ensure that both groups are taught within the same

length of time. If one group has a longer period of teaching, students in that group could be at an advantage over the other groups in terms of knowledge and skill gained.

Time between pre-test and post-test: If the time lag between treatment and the post-test is too long, there could be the influence of forgetfulness or maturation on students performance in the post-test. In order to avoid such influence, the post-test was conducted immediately after the treatment. The short duration will help to minimize the effect of maturation and history.

3.8 Method of Data Collection

Data for the study were collected using Basic Electricity Achievement Test (BEAT) through the research assistants who were the regular Basic Electricity teachers in the sampled schools. The BEAT was used to generate three sets of scores; pre-test score (to ascertain the initial knowledge of the group before the treatment), post-test score (to ascertain the group achievement score after exposure to the treatment) and the delayed post-test score (to ascertain the group retention). The three sets of scores generated were used for data analysis.(see Appendix L . p. 157)

3.9 Method of Data Analysis

The test scores of the pre-test, post-test and delay post-test for the groups were collected and used in the analysis. The statistical package for social sciences version 23 (SPSS 23) was used for the analysis of data. The research questions were answered using Mean while the null hypotheses were tested using Analysis of Covariance (ANCOVA) at 0.05 level of significance (see Appendix M p.169). The ANCOVA serves as a means for controlling the extraneous variables from the dependent variables thus dealing with the

threats of initial differences across the groups and increasing the precision of the experimental results (Oviawe, 2010)

For the research questions, gain in the mean scores after the treatment indicated that the treatments have effect on the students' academic achievement while gain/loss in the retention scores indicated that the students retained or lost some scores. For testing the null hypotheses, where the p-value was greater than or equal to the significance level (0.05), the null hypothesis was accepted but where the p-value was less than the significance level (0.05) the null hypothesis was rejected.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Results

This chapter presents the data collected and analysed for the study. The data and results of the analysis are presented in tables according to the research questions and hypotheses that guided the study.

Answer to Research Questions

The answers to research questions were arrived at using mean and standard deviation.

Research Question 1

What is the effectiveness of constructivist teaching method on academic achievement mean scores of technical college students in Basic Electricity when compared with those of students taught with meta–learning teaching method.

Data in Table 4.1.1 presents answer to research question 1.

Table 4.1.1

Mean and standard deviation scores of students' achievement mean scores in Basic Electricity for constructivist and meta-learning group.

Group	N	Pre-test		Post-test		Mean gain
		$\bar{x}$	SD_1	$\bar{x}$	SD_2	$\bar{x}$
Constructivist	57	24.00	6.00	77.56	6.44	53.56
Meta-learning	51	32.25	7.84	75.47	8.65	43.22

Note: N= number of students, SD_1 = standard deviation for pre-test, SD_2 = standard deviation for post-test, $\bar{x}$ = mean.

Data presented in Table 4.1.1 show that the pre-test, post-test achievement mean scores of constructivist group are 24.00 and 77.56 with the standard deviation of 6.00 and 6.44.The mean gain is 53.56.The meta-learning group has a pre-test and post-test achievement mean scores of 32.25 and 75.47 with standard deviation of 7.84 and 8.65. The mean gain is 43.22. However, for each of the groups, the post-test achievement mean

scores are higher than the pre-test achievement mean score with constructivist group having the higher mean gain. The result indicates that constructivist teaching method improved students' achievement better than meta-learning teaching method.

Research Question 2

What is the effectiveness of constructivist teaching method on retention mean scores of technical college students in Basic Electricity when compared with those of students taught with meta-learning teaching method.

Data in Table 4.1.2 present answer to research question 2.

Table 4.1.2

Mean and standard deviation scores of students' retention mean scores in Basic Electricity for constructivist and meta-learning group.

Group	N	Post-test		Delay Post-test		Mean loss
		$\bar{x}$	SD_2	$\bar{x}$	SD_3	$\bar{x}$
Constructivist	57	77.56	6.44	76.95	5.53	-0.61
Meta-learning	51	75.47	8.65	74.98	9.06	-0.49

N= Number of students, SD_2 = standard deviation for post-test, SD_3 = standard deviation for delay post-test, $\bar{x}$ = mean.

Table 4.1.2 shows that the post-test and delay post test retention mean scores of constructivist group are 77.56 and 76.95 with standard deviation of 6.44 and 5.53. The mean loss is - 0.61. The meta-learning group has a post-test and delay post-test mean scores of 75.47 and 74.98 with standard deviation of 8.65 and 9.06 respectively. The mean loss of the meta-learning group is - 0.49. This shows that each of the groups has a mean loss with constructivist teaching group having a higher mean loss. This indicates that students taught with meta-learning teaching method seem to have retained knowledge more than students taught with constructivist teaching method.

Research Question 3

What is the effectiveness of constructivist teaching method on academic achievement mean scores of male and female technical college students in Basic Electricity?

Data in Table 4.1.3 present answer to research question 3.

Table 4.1.3

Mean and standard deviation of male and female students' academic achievement mean score in Basic Electricity for constructivist group.

Group	N	Pre-test		Post-test		Mean gain
		$\bar{x}$	SD_1	$\bar{x}$	SD_2	$\bar{x}$
Male	44	24.32	6.14	78.25	6.25	53.93
Female	13	22.92	5.56	75.23	6.76	52.31

Data in Table 4.1.3 reveal that males in the constructivist group have pre-test and post-test achievements mean scores of 24.32 and 78.25 with a standard deviation of 6.14 and 6.25. The mean gain is 53.93. The females have pre-test and post-test achievement mean scores of 22.92 and 75.23 with a standard deviation of 5.56 and 6.76. The mean gain of females is 52.31. This shows that both males and females in constructivist group have mean gain with males having higher mean gain. The slight difference in mean score seems to show that males in constructivist teaching groups achieved more than their female counterparts.

Research Question 4

What is the effectiveness of meta-learning method on academic achievement mean scores of male and female technical college students in Basic Electricity?

Data in Table 4.1.4 present answer to research question 4.

Table 4.1.4

Mean and standard deviation of male and female students' academic achievement mean score in Basic Electricity for meta-learning group.

Group	N	Pre-test		Post-test		Mean gain
		$\bar{x}$	SD_1	$\bar{x}$	SD_2	$\bar{x}$
Male	35	32.46	7.80	75.54	8.40	43.08
Female	16	31.81	8.18	75.31	9.46	43.50

Data presented in Table 4.1.4 show that males in meta-learning group have a pre-test achievement mean score of 32.46 with a standard deviation of 7.80 and a post-test achievement mean score of 75.54 with a standard deviation of 8.40. The mean gain is 43.08. The females have a pre-test achievement mean score of 31.81 with standard deviation of 8.18 and a post-test achievement mean score of 75.31 with a standard deviation of 9.46. The mean gain is 43.50. This shows that both males and females in meta-learning group have mean gain with the females having higher mean gain. The slight difference in the mean gain score seems to indicate that females in meta-learning teaching group have performed better than their male counterparts.

Research Question 5

What is the effectiveness of constructivist teaching method on retention mean scores of male and female technical college students in Basic Electricity?

Data in Table 4.1.5 present answer to research question 5.

Table 4.1.5

Mean and standard deviation of male and female students' retention mean scores in Basic Electricity for Constructivist group.

Group	N	Post-test		Delay Post-test		Mean gain/loss
		$\bar{x}$	SD_2	$\bar{x}$	SD_3	$\bar{x}$
Male	44	78.25	6.25	77.41	5.73	-0.84
Female	13	75.23	6.76	75.38	4.68	0.15

Note: N=Number of students, SD_2=Standard deviation for post test, SD_3= standard deviation for delay post-test, $\bar{x}$=mean.

Table 4.1.5 shows that males in constructivist group has a post-test retention mean score of 78.25 with a standard deviation of 6.25 and delayed post test retention mean score of 77.41 with a standard deviation of 5.73.The mean loss is -0.84. The females have a post-test retention mean score of 75.23 with a standard deviation of 6.76 and a delayed post test of 75.38 with a standard deviation of 4.68. The mean gain is 0.15. This shows

that males in constructivist group have knowledge loss while their female counterparts have knowledge retention.

Research Question 6

What is the effectiveness of meta-learning teaching method on retention mean scores of male and female technical college students in basic electricity?

Data in Table 4.1.6 present answer to research question 6.

Table 4.1.6

Mean and standard deviation of male and female students' retention mean scores in Basic Electricity for Meta-learning group.

Group	N	Post-test		Delay Post-test		Mean gain/loss
		$\bar{x}$	SD_2	$\bar{x}$	SD_3	$\bar{x}$
Male	35	75.54	8.40	75.06	9.23	-0.48
Female	16	75.31	9.46	74.81	8.98	0.50

Data in Table 4.1.6 show that males in meta-learning group have a post-test retention mean score of 75.54 with a standard deviation of 8.40 and a delay post-test retention mean score of 75.06 with a standard deviation of 9.23. The mean loss is -0.48. The females have a post-test retention mean score of 75.31 with a standard deviation of 9.46 and a delay post-test retention score of 74.81 with a standard deviation of 8.98. The mean gain is 0.50. This shows that males in meta-learning group have knowledge loss while their female counterparts have knowledge retention.

Research Question 7

What is the interaction effect of teaching methods (constructivist and meta-learning) and gender on technical college students' academic achievement mean scores in Basic Electricity?

Data in Table 4.1.7 present answer to research question 7.

Table 4.1.7
Mean and standard deviation on interaction effects of teaching methods and gender on achievement mean scores of students in Basic Electricity

Group	N	Pre-test		Post-test		Mean gain
		$\bar{x}$	SD_1	$\bar{x}$	SD_2	$\bar{x}$
Constructivist						
Male	44	24.32	6.14	78.25	6.25	53.93
Female	13	22.92	5.65	75.23	6.76	52.31
Meta-learning						
Male	35	32.46	7.80	75.54	8.40	43.08
Female	16	31.81	8.18	75.31	9.46	43.50

Table 4.1.7 shows that males in constructivist group have pre-test achievement mean score of 24.32 with a standard deviation of 6.14 and a post-test achievement mean score of 78.25 with a standard deviation of 6.25. The mean gain is 53.93. The females have a pre-test achievement mean score of 22.92 with a standard deviation of 5.65 and a post-test achievement mean score of 75.23 with a standard deviation of 6.76. The mean gain is 52.31. Table 4.1.7 also shows that males in meta-learning group have a pre-test achievement mean score of 32.46 with a standard deviation of 7.80 and a post-test achievement mean score of 75.54 with a standard deviation of 8.40. The mean gain is 43.08. The females have a pre-test achievement mean score of 31.81 with a standard deviation of 8.18 and a post-test achievement mean score of 75.31 with a standard deviation of 9.46. The mean gain is 43.50. This shows that the mean gain for males in constructivist group is higher than their female counterparts. Also the mean gain for females on meta-learning group is higher than their male counterparts. The slight difference in the mean gains for each group seems to show that males in constructivist group performed better than their female counterparts while females in meta-learning teaching group are performed better than their male counterparts.

Research Question 8

What is the interaction effect of teaching methods and genders on technical college students' retention mean scores in Basic Electricity?

Data in Table 4.1.8 present answer to research question 8.

Table 4.1.8

Mean and standard deviation on interaction effect of teaching methods and gender on retention mean scores of students in Basic Electricity.

Group	N	Post-test		Delay Post-test		Mean Gain/Loss
		$\bar{x}$	SD_2	$\bar{x}$	SD_3	$\bar{x}$
Constructivist						
Male	44	78.25	6.25	77.41	5.73	-0.84
Female	13	75.23	6.76	75.38	4.68	0.15
Meta-learning						
Male	35	75.54	8.40	75.06	9.23	-0.48
Female	16	75.31	9.46	74.81	8.98	0.50

Data in Table 4.1.8 show that males in constructivist group have a post-test retention mean score of 78.25 with a standard deviation of 6.25 and a delay post-test retention mean score of 77.41 with a standard deviation of 5.73. The mean loss is -0.84. The females have a post test retention mean score of 75.23 with a standard deviation of 6.76 and a delay post-test mean score of 75.38 with a standard deviation of 4.68. The mean gain is 0.15. The table also shows that males in meta-learning group have a post-test retention mean score of 75.54 with a standard deviation of 8.41 and delay post-test retention mean score of 75.06 with a standard deviation of 9.23. The mean loss is -0.48. The females have a post-test retention mean score of 75.31 with a standard deviation of 9.46 and a delay post- test retention mean score of 74.81 with a standard deviation of 8.98. The mean gain is 0.50. This shows that males in constructivist group have knowledge loss while their female counterparts have knowledge retention. Also, the males in meta-learning group have knowledge loss while their female counterparts have knowledge retention. The difference in the mean gain for each group seems to indicate that both constructivist and meta-learning teaching method are better for knowledge retention in basic electricity among females than males.

Test of Hypotheses

The results of the test of null hypotheses are presented in Table 4.1.9 to 4.1.16.

Hypothesis 1

There is no significant difference between the academic achievement mean scores of technical college students taught Basic Electricity using constructivist teaching method and those taught using meta-learning teaching method.

To test this hypothesis, the academic achievement mean scores of students taught with the two teaching methods were analysed using ANCOVA and the result of the analysis as summarized in Table 4.1. 9.

Table 4.1.9

ANCOVA summary of teaching methods on students' academic achievement mean scores in Basic Electricity

Source	Sum of squares	df	Mean of squares	F-cal	Sig.	Remark
Teaching method	544.118	1	544.118	12.298	.001	Rejected
Error	4557.167	103	44.244			
Total	639448.000	108				

Data in Table 4.1.9 show that F ratio of 12.198 with 1 degree of freedom and p-value of .001 is obtained for teaching methods on students' academic achievement mean scores in basic electricity, since the p-value of .001 is less than 0.05 level of significance. This shows that there is a significant difference between the academic achievement means scores of technical college students taught Basic Electricity using constructivist teaching method and those taught using meta-learning teaching method. The null hypothesis is therefore rejected.

Hypothesis 2:

Significant difference does not exist between the retention mean scores of technical college students taught Basic Electricity using constructivist teaching method and those taught using meta-learning teaching method.

To test this hypothesis, the retention mean scores of students taught with the two teaching methods were analysed using ANCOVA and the result of the analysis is summarized in Table 4.1.10

Table 4.1.10

ANCOVA Summary of teaching methods on students' retention mean scores in Basic Electricity

Source	Sum of squares	df	Mean of squares	F-cal	Sig.	Remark
Teaching method	491.722	1	491.722	10.945	.001	Rejected
Error	4627.481	103	44.927			
Total	630038.00	108				

Table 4.1.10 shows that the F ratio of 10.942 with 1 degree of freedom and p-value of .001 is obtained for teaching methods on students' retention mean scores in basic electricity, since the p-value of .001 is less than 0.05 level of significance. This shows that significant difference exists between the retention mean scores of technical college students taught Basic Electricity using constructivist teaching method and those taught using meta-learning teaching method. The null hypothesis is therefore rejected.

Hypothesis 3.

There is no significant difference between the academic Achievement mean scores of male and female Technical College Students taught Basic Electricity using Constructivist Teaching Method.

To test this hypothesis, the academic achievement mean scores of male and female students taught Basic Electricity using constructivist teaching method were analysed using ANCOVA and the result of the analysis is summarized in Table 4.1.11

Table 11

ANCOVA summary of gender on students' academic achievement mean scores in Basic Electricity using constructivist teaching method.

Source	Sum of squares	df	Mean of squares	F-cal	Sig.	Remark
Gender	43.008	1	43.008	1.755	.191	Accepted
Error	1323.488	54	24.509			
Total	345221.00	57				

Table 4.1.11 shows that the F-ratio of 1.755 with 1 degree of freedom and p-value of .191 is obtained for gender on students' academic achievement mean scores when taught basic electricity using constructivist teaching method. Since the p-value of .191 is greater than 0.05 level of significance. This shows that there is no significant difference between the academic achievement mean scores of male and female technical college students taught basic Electricity using constructivist teaching method. The null hypothesis is therefore accepted.

Hypothesis 4

Significant difference does not exist between the academic achievement mean score of male and female technical college students taught Basic Electricity using meta-learning teaching method.

To test this hypothesis, the achievement mean scores of male and female students taught Basic Electricity using meta-learning teaching method were analyzed using ANCOVA and the result of the analysis is summarized in Table 4.1.12.

Table 4.1.12

ANCOVA summary of gender on students' academic achievement mean scores in Basic Electricity using meta-learning teaching method.

Source	Sum of squares	df	Mean of squares	F-cal	Sig.	Remark
Gender	.026	1	.026	.000	.984	Accepted
Error	3163.927	48	65.915			
Total	294227.00	51				

Table 4.1.10 shows that the F-ratio of .000 with 1 degree of freedom and p-value of .984 is obtained for gender on students' academic achievement mean scores when taught basic electricity using meta-learning teaching method, since the p-value of .984 is greater than 0.05 level of significance. This shows that a significant difference does not exist between the academic achievement mean scores of male and female technical college students taught Basic Electricity using meta-learning teaching method. The null hypothesis is therefore accepted.

Hypothesis 5

There is no significant difference between the retention mean scores of male and female technical college students taught Basic Electricity using constructivist teaching method.

To test this hypothesis, the retention mean scores of male and female students taught Basic Electricity using constructivist teaching method were analyzed using ANCOVA and the result of the analysis is summarized in Table 4.1.13.

Table 4.1.13

ANCOVA summary of gender on students' retention mean scores in Basic Electricity using constructivist teaching method

Source	Sum of squares	df	Mean of squares	F-cal	Sig.	Remark
Gender	17.804	1	17.804	.808	.373	Accepted
Error	1189.536	54	22.028			
Total	339206.00	57				

Table 4.1.13 shows that the F-ratio of .080 with 1 degree of freedom and p-value of .373 is obtained for gender on students' retention mean scores when taught Basic Electricity using constructivist teaching method, since the p-value of .373 is greater than 0.05 level of significance. This shows that there is no significant differences between the retention mean scores of male and female technical college students taught Basic Electricity using constructivist teaching method. The null hypothesis is therefore accepted.

Hypothesis 6

Significant difference does not exist between the retention mean scores of male and female technical college students taught Basic Electricity using meta-learning teaching method.

To test this hypothesis, the retention mean scores of male and female students taught Basic Electricity using meta-learning teaching method were analysed using ANCOVA and the result of the analysis is summarized in Table 4.1.14.

Table 4.1.14

ANCOVA summary of gender on students' retention mean scores in Basic Electricity using meta-learning teaching method.

Source	Sum of Squares	df	Mean of squares	F-cal	Sig.	Remark
Gender	.035	1	.035	.000	.983	Accepted
Error	3437.191	48	71.608			
Total	290832.00	51				

Table 4.1.14 shows that the F ratio of .000 with 1 degree of freedom and p-value of .983 is obtained for gender on students' retention mean scores when taught Basic Electricity using meta-learning teaching method, since the p-value of .983 is greater than 0.05 level of significance. This shows that significant difference does not exist between the retention mean scores of male and female technical college students taught basic electricity using meta-learning teaching method. The null hypothesis is therefore accepted.

Hypothesis 7

There is no significant interaction effect of teaching methods (constructivist and meta-learning) and gender on students academic achievement mean scores in Basic Electricity

To test this hypothesis, the interaction effect of gender and teaching methods on students' academic achievement mean scores in Basic Electricity were analysed using ANCOVA and the data were summarized in Table 4.1.15.

Table 4.1.15

ANCOVA summary of interaction effect of gender and teaching methods on students' academic achievement mean scores in Basic Electricity.

Source	Sum of squares	df	Mean of squares	F-cal	Sig.	Remark
Gender* Teaching method	30.002	1	30.002	.678	.412	Accepted
Error	4557.167	103	44.244			
Total	639448.000	108				

Table 4.1.15 shows that the F ratio of .678 with 1 degree of freedom and p-value of .412 is obtained for interaction effect of gender and teaching methods on students' academic achievement mean scores in basic electricity, since the p-value of .412 is greater than 0.05 level of significance. This shows that there is no significant interaction effects of teaching methods and gender on students' academic achievement mean scores in basic electricity. The null hypothesis is therefore accepted.

Hypothesis 8

There is no significant interaction effect of teaching methods (constructivist and meta-learning) and gender on students retention mean scores in Basic Electricity**.**

To test this hypothesis, the interaction effect of gender and teaching methods on students' retention mean scores in Basic Electricity were analysed using ANCOVA and the data were summarized in Table 4.1.16.

Table 16

ANCOVA summary of interaction effect of gender and teaching methods on students' retention mean scores in Basic electricity

Source	Sum of squares	df	Mean of squares	F-cal	Sig.	Remark
Gender*Teaching method	10.598	1	10.598	.236	.628	Accepted
Error	4627.481	103	44.927			
Total	630038.000	108				

Table 4.1.16 shows that the F ratio of .236 with 1 degree of freedom and p-value of .628 is obtained for gender and teaching methods on students' retention mean scores in Basic Electricity, since the p-value of .628 is greater than 0.05 level of significance. This indicates that there is no significant interaction effects of teaching methods and gender on students' retention mean scores in Basic Electricity. The null hypothesis is therefore accepted.

4.2 Discussion of Findings

The results of this study were discussed under the following sub-headings:

1. Effectiveness of teaching methods on technical college students' academic achievement in Basic Electricity.

2. Effectiveness of teaching methods on technical college students' retention in Basic electricity.

3. Effectiveness of teaching methods on technical college students' academic achievement in Basic Electricity based on gender.
4. Effectiveness of teaching methods on technical college students' retention in Basic Electricity based on gender.

5. Interaction effect of teaching methods and gender on technical college students' academic achievement in Basic Electricity.

6. Interaction effect of teaching methods and gender on technical college students' retention in Basic Electricity.

4.2.1 Effectiveness of Teaching Methods on Academic Achievement of Technical College Students in Basic Electricity

The result of this study showed that constructivist teaching method has significant effect on students' academic achievement in Basic electricity than meta-learning teaching method. The group exposed to constructivist teaching method performed better with a

mean gain of 53.56 than the group exposed to meta-learning teaching method with mean gain of 43.22. However, the findings indicated that the difference in mean gain is significant. With the F ratio of 12.298 and p-value of .001 which is less than 0.05 level of significance, the null hypothesis which stated that there is no significance difference between the academic achievement mean scores of technical college students taught Basic electricity using constructivist teaching method and those taught using meta-learning teaching method was rejected. This implies that there was a significant difference between the academic achievement mean scores of technical college students taught Basic Electricity using constructivist teaching method and those taught using meta-learning teaching method. The finding is in line with the findings of Atsumbe, Owodunni, Raymond and Udaafemhe (2018) who reported that collaborative instructional method is effective for improving students' cognitive achievement. In the same vein, the result of this study concurs with the views of Okeke and Okey (2018) who asserted that collaboration encourages students to learn more of the materials as their interest is kindled through motivation, team spirit and interaction with one another.

4.2.2 Effectiveness of Teaching Methods on Technical College Students Retention in Basic Electricity

The result of this study showed that meta-learning teaching method had significant effect on students' retention in Basic electricity. The group exposed to meta-learning teaching method had a lower retention mean loss of -0.49 than the group exposed to constructivist teaching method with retention mean loss of -0.61. However, the findings indicated that the difference in mean loss was significant, with the F ratio of 10.945 and p-value of 0.001 which is less than 0.05 level of significance. The null

hypothesis which stated that significant difference did not exist between the retention mean scores of technical college students taught basic electricity using constructivist teaching method and those taught using meta-learning teaching method was rejected. This implies that significant difference existed between the retention mean scores of technical college students taught Basic Electricity using constructivist teaching method and those taught using meta-learning teaching method. The finding is in consonance with the assertion of Lemka, Buaka and Gabrys (2015) who stated that meta-learning enhances understanding and adaptation of learning content on a higher level than merely acquiring subject knowledge. The finding is also in line with the findings of Eze, Ezenwafor and Molokwu (2015) who reported that meta-learning teaching method could improve students' retention.

4.2.3 Effectiveness of Teaching Methods on Academic Achievement Mean Scores of Technical College Students in Basic Electricity Based on Gender

The result obtained from the study showed that male students exposed to constructivist teaching method had a mean gain of 53.93 while the female students had a mean gain of 52.31. On the other hand, male students exposed to meta-learning teaching method had a mean gain of 43.08 while female students had a mean gain of 43.50. This showed that male students exposed to constructivist teaching method had a higher mean gain than their female counterparts, but a lower mean gain than their female counterpart exposed to meta-learning teaching method. However, the findings indicated that gender differences were not significant since the p-values of .191 and .984 for the two tables respectively were greater than 0.05 level of significance. This implied that there was no significant difference between the academic achievement mean scores of male and

female technical college students taught Basic Electricity using constructivist teaching method and those taught using meta-learning teaching method. This is in line with the finding of Dania (2014) who reported that gender has no significant effect on students' academic achievement. The finding is in disagreement with the findings of Emeli (2012) which revealed that there was significant difference in the achievement of male and female students. The disagreement with the present study could be as a result of the fact that previous studies focused on using AUTOCAD in the teaching of technical drawing while the present study focused on using constructivist and meta-learning teaching method in teaching Basic Electricity.

4.2.4 Effectiveness of Teaching Methods on Technical College Students' Retention in Basic Electricity Based on Gender.

The result of the study showed that male students exposed to constructivist teaching method had a mean loss of -0.84 while their female counterparts had a mean gain of 0.15. On the other hand, male students exposed to meta-learning teaching method had a mean loss of -0.48 while their female counterparts had a mean gain of 0.50. This showed that female students exposed to constructivist and meta-learning teaching method had a mean gain while their male counterparts had a mean loss. However, the findings indicated that gender differences were not significant in students' retention mean scores, since the p-values of .373 and .983 for Tables 13 and 14 respectively was greater than 0.05 level of significance. This implies that significant difference did not exist between the retention mean scores of male and female students taught Basic Electricity using constructivist teaching method and those taught using meta-learning teaching method. The finding is in agreement with the finding of Eze, Ezenwafor and Obidile (2016) which

reported that gender has no significant effect on students' retention. In the same view, the results of this study agree with the findings of Abbas and Habu (2014) which revealed there was no significant differences in the retention mean scores of male and female students.

4.2.5 Interaction Effect of Teaching Methods and Gender on Technical College Students Academic Achievement in Basic Electricity.

Result obtained on the interaction effect of teaching methods and gender on the academic achievement mean scores of technical college students in Basic Electricity, showed that the mean gain of male and female students taught Basic Electricity using constructivist teaching method is higher than the mean gain of those taught Basic electricity using meta-learning teaching method. This seems to indicate that teaching methods and gender interact to affect students' achievement in Basic Electricity. However, the interaction effect was not significant based on the data collected. With an F ratio of .678 and p-value of .412 which are greater than 0.05 level of significance, the null hypothesis of no significant interaction effect of teaching method and gender on students' academic achievement mean scores in basic electricity was not rejected. Although the statistical analysis of this study showed that teaching methods and gender did not have significant interaction effects on technical college students' academic achievement in Basic Electricity. The observed differences could be due to chance. This finding is in agreement with Eze, Ezenwafor and Obidile (2016) who reported that gender and teaching methods had no significant interaction effect on students' academic achievement.

4.2.6 Interaction Effect of Teaching Methods and Gender on Technical College Students' Retention in Basic Electricity.

Result obtained on the interaction effect of teaching methods and gender on retention mean scores of technical college students in Basic electricity showed that the mean gain of female students taught using constructivist and meta-learning teaching method was higher than their male counterparts. However, the confirmatory analysis showed that there was no significant interaction effects of teaching methods and gender on students' retention mean scores in Basic electricity. With an F ratio of .236 and p-value of .628 which is greater than 0.05 level of significance, the null hypothesis of no significant interaction effect of teaching methods and gender on students' retention was not rejected. The slight difference in the mean gain of male students and their female counterparts could be as a result of students' disposition to learn. Both male and female students had equal opportunity to participate actively but, may be thatthe female students were more determined to learn than their male counterparts. Though the male students made considerably good effort based on their mean gain. The finding is in support of Yinusuf, Gambari and Olunorin (2012) who revealed that teaching methods and gender have no significant interaction effect on students' retention ability. In the same view, the findings of Gana (2015) showed that there was no significant interaction effect of teaching methods and gender on students' retention.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATION

This chapter presents the summary of findings, conclusion drawn from the study, implication of the study, recommendations, limitation of the study and suggestion for further studies.

5.1 Summary of Findings

Based on data analysed the following were revealed.

1. Constructivist teaching group had a higher achievement mean gain than meta-learning teaching group.
2. Constructivist teaching group had a higher retention mean loss than meta-learning teaching group.
3. Male students taught with constructivist teaching method had a higher achievement mean gain than their female counterparts.
4. Female students taught with meta-learning teaching method had a higher achievement mean gain than their female counterparts.
5. Male students taught with constructivist teaching method had a retention mean loss while their female counterparts had a retention mean gain.
6. Male students taught with meta-learning teaching method had a retention mean loss while their female counterparts had a retention mean gain.
7. The interaction effects of teaching methods and gender on students achievement mean score shows that male and female students taught with constructivist teaching method had achievement mean gain than those taught with meta-learning.
8. The interaction effects of teaching methods and gender on students' retention mean score showed that male students taught with constructivist teaching method had a retention mean loss while their female counterparts had a retention mean gain. Similarly male students taught with meta-learning teaching method had a retention mean loss while their female counterparts had a retention mean gain.

9. There was a significant difference between the academic achievement mean scores of technical college students taught basic electricity using constructivist teaching method and those taught using meta-learning teaching method.
10. Significant difference existed between the retention mean scores of technical college students taught basic electricity using constructivist teaching method and those taught using meta-learning teaching method.
11. There was no significant difference between the academic achievement mean scores of male and female technical college students taught basic electricity using constructivist teaching method.
12. Significant difference did not exist between the academic achievement mean scores of male and female technical college students taught basic electricity using meta-learning teaching method.
13. There was no significant difference between the retention mean scores of male and female technical college students taught basic electricity using constructivist teaching method.
14. Significant difference did not exist between the retention means scores of male and female technical college students taught basic electricity using meta-learning teaching method.
15. There was no significant interaction effect of teaching methods and gender on students' academic achievement mean scores in Basic Electricity.
16. There was no significant interaction effect of teaching methods and gender on students' retention mean scores in Basic Electricity.

Conclusion

Based on the findings of this study, which revealed that constructivist teaching method (specifically collaboration instructional approach) and meta-learning teaching method had significant effect on students' academic achievement in Basic Electricity, it was concluded that constructivist teaching method is more effective than meta-learning teaching method in improving academic achievement of technical college students in Basic Electricity. In addition, meta-learning teaching method happens to be more effective for enhancing retention ability of technical college students in Basic Electricity

than constructivist teaching method because technical college students taught Basic Electricity using meta-learning teaching method had a mean gain while their counterparts taught using constructivist teaching method had a mean loss.

More so, constructivist teaching method and meta-learning teaching method was not sensitive to gender in improving students' academic achievement and retention ability in Basic Electricity respectively. Therefore, it was concluded that irrespective of gender, constructivist teaching method (specifically collaboration instructional approach) is more effective for improving academic achievement of technical college students in Basic Electricity while meta-learning teaching method is more effective for enhancing retention ability of technical college students in Basic Electricity.

Implications of the Study

The results of this study have some implications for technical education especially in the teaching and learning of Basic Electricity in Anambra State. One of the major findings of this study is that there was a significant difference between the academic mean scores of students taught Basic Electricity using constructivist teaching method and those taught using meta-learning teaching method. The implication of this is that if technical college students are consistently taught Basic Electricity using constructivist teaching method (specifically collaboration instructional approach), their academic achievement will increase over time. Thus, there is need to integrate constructivist teaching method in teaching and learning of Basic Electricity in technical colleges in Anambra State for significant improvement in students' academic achievement in both internal and external examinations as well as in the world of work.

The findings of this study also revealed that there was significant difference between the retention mean scores of technical college students taught Basic Electricity using constructivist teaching method and those taught using meta-learning teaching method. The implication of this is that when Basic Electricity teachers adopt constructivist teaching method (specifically collaboration instruction approach) alone students will achieve more but at most times will not retain the knowledge mastered. Therefore in using constructivist teaching method, meta-learning teaching method should

as well be incorporated at times so that students will retain the knowledge mastered from the instruction.

Furthermore, the result revealed that significant difference does not exist between the academic achievement mean scores and retention mean scores of technical college students taught Basic Electricity using constructivist teaching method and those taught using meta-learning teaching method based on gender. The implication of this is that when Basic Electricity teachers adopt constructivist and meta-learning teaching methods, gender of students will have no effect on their academic achievement and retention ability. Therefore, in using constructivist teaching method (specifically collaboration instructional approach) and meta-learning teaching method to teach Basic Electricity in technical colleges in Anambra State, attention should not be given to the gender of students.

Recommendations

Based on the findings of this study, the following recommendations are made.

1. Teachers of Basic Electricity should adopt a teaching method of incorporating collaborative instructional approach with meta-learning teaching method in teaching of Basic Electricity in order to enhance knowledge mastery and retention among students.
2. Teachers of basic electricity should train, encourage and motivate students on how to apply meta-cognitive strategies in learning Basic Electricity so as to improve their retention ability.
3. Government and other stakeholders in technical colleges should sensitize technical education teachers on the efficacy of meta-learning and constructivist teaching method through conferences, seminars and workshops.
4. Supervisory agency for technical education in the State should emphasis the use of constructivist and meta-learning teaching methods in basic electricity curriculum.
5. Curriculum planners of technical college programmes should collaborate with Basic Electricity experts to develop a workable basic electricity curriculum that

will accommodate teachers' integrating collaboration and meta-learning teaching method in instructional delivery.

Limitations of the Study

The conclusions made with respect to this study are however subjected to the following limitations:

1. Some students dropped out of the study before and during the experiment. Some did only two out of the three tests (pre, post and delay post test). The test scores of this category of students were dropped thereby reducing the sample size.
2. The variation in the number of students in a group could affect students' confidence in doing the task assigned to their group.

Suggestion for Further Studies

The present study did not cover every trade, geographical area and every aspect of constructivist teaching method. Therefore the researcher suggests that;

1. The study could be replicated using other trades like Electrical Installation.
2. The study could be carried out in another State of the federation.
3. The study could be replicated to include students' interest.
4. The study could be conducted using meta-learning teaching method and another approach in constructivism like concept-mapping.

REFERENCES

Abbas, M.G & Habu, G (2014). Effect of gender-related differences in academic achievement and retention of senior secondary school students taught geometry using problem-solving approach. *The Eurasia Proceedings of Education and Social Sciences 1*, 484-488

Abubakar, M.I (2002). Effects of cognitive apprenticeship instructional methods on Auto-Mechanic students. *AUJ.T 16(2),* 89-98.

Adeyemi, B.A & Ajibabe, Y.A (2011). The comparative effects of simulation games and brainstorming instructional strategies on junior secondary school students' achievement in social studies. *African Journal Online 5 (3),* 64-80.

Adunola, O (2011). The impact of teachers' teaching method on the academic performance of primary school pupils in Ijebu-Ode Local Government Area of Ogun State. Retrieved from www.boosterbooks.wordpress.com on 26/4/2017.

Ahmed, F & Azizi, J. (2009). Students' perception of the teachers teaching of literature communicating and understanding through the eyes of audiences. *European Journal of Social Studies 7 (3)* 17-39.

Ahmed, K.A (2013). Teacher-centered versus learner-centered teaching style. *The Journal of Global Business Management 9(1),* 22-34.

Akpan, J.P & Beard, L.A (2016). Using constructivist teaching strategies to enhance academic outcome of students with special needs. *Universal Journal of Educational Research 4 (2),* 392-398. Retrieved from htto://www.hipub.org on 22/03/2018.

Amaechi, C. (2012). Assessment of self-regulated learning as a panacea for acquisition of science process skills by chemistry students in secondary schools. *Contemporary Journal of Educational Research, 4(1),* 161-174.

Amechi, O. J & Thomas, C.G (2016). Strategies for effective teaching and learning of practical skills in technical and vocational training programmes in Nigeria. *International Journal of Scientific Research in Engineering and Technology, 5* (14) Retrieved from http.//www.ijsret.org on 2/03/2018.

Anyichie, A.C and Onyedika, S.C. (2012). Effects of self-regulated learning strategy on secondary school students academic achievement in solving mathematical work problems in Nigeria. *International Multi-Disciplinary Journal of Ethiopia 6(4),* 302-323.

Atsumbe, B N, Raymond, E, & Ajunwa, J. (2015).Effects of animation on students' academic achievement and retention in basic electronics at technical college level in benue state Nigeria. *International Journal of Mathematics, Science and Technology 3799 380-387.* Retrieved from http://hdl.handle.net/10500/22407on 23/3/2018.

Atsumbe, B.N, Owodunni, S, Raymond, E & Uduafemhe, M (2018).Effects of collaborative instructional approaches on students' achievement in basic electronics. EURASIA *Journal of Mathematics, Science and Technology 14(8) 1-17.*Retrieved from http://www.ejmste.com on 23/3/2019

Ayomike, C.S (2014). Comparative effectiveness of the teaching methods on students' psychomotor performance in brick/block laying and concreting in Delta State technical colleges. *Unpublished PhD Dissertation*, Faculty of Education. Nnamdi Azikwe University, Awka.

Bada, S.O (2015). Constructivism learning theory: a paradigm for teaching and learning. *Journal of Research and Method in Education, 6(1) 66-70*. Retrieved from www.iosr.journals.org 22/03/2018.

Bajon, R.H (2015). Effect of mode of laboratory work on senior secondary students. Unpublished M.Sc Thesis Faculty of Education, University of Nigeria, Nsukka,

Bialik, M & Fadel, C. (2015). *Meta-Learning for the 21st century: What should students learn*. Boston. Center for Curriculum Design.

Brazdil, P., Giraud-Carrier, C., Soares, C. & Vilalta, R (2007). *Meta-Learning: applications to data minding.* Springer Berlin.

Cey, T. (2001). *Moving towards constructivist classroom.* Retrieved from http://etad.usak.ca>ceyt>ceyt on 5th June 2017

Chee, Y.S (1995). Cognitive apprenticeship and its application to the teaching of smalltalk in a multimedia interactive learning environment. *Instructional Science 23,* 133-161

National Business and Technical Examination Board (2017) *May/June 2013/2017 NTC Examination Result Analysis Report.* Benin City.

Collins, A, Brown, J.S & Newman, S.E (1987). *Cognitive Apprenticeship: Technical Report 403.* USA: Bolt Beranek and Newman Inc.

Cyril, M.U (2016). Effects of multimedia instruction on retention and academic achievement of basic machining skill in mechanical craft practice. *International Journal of Education and Information Technology, 2 (1) 1-7*. Retrieved from http://www.aiscience.org/journal/ iject.70390030 pdf on 22/03/2018.

Dancis, J. (2009). A Hybrid, small group guided discovery method of instruction. Retrieved from http://en. wikipedia.org/ wiki/discoverylearning on 6/6/2017

Dania, P.O (2014). Effects of gender on students' academic achievement in secondary school social studies. *Journal of Education and Practice 5(21) 78-84*. Retrieved from http://www.iist.org 30/03/2018.

Dike, B.C. (2008). *The effect of problem solving strategy and lecture method on socio-cultural beliefs hindering science learning at the junior secondary school in FCT Abuja*. Unpublished M.Sc Thesis Faculty of Education, Ahmadu Bello University, Zaria

Duyilemi, A.N & Bolajoko, A.O. (2014). Effects of constructivist learning strategies on senior secondary school students' achievement and retention in Biology. *Mediterranean Journal of Social Studies, 5 (27),* 637-633

Egedegbe,E.(2016).Influence of method of teaching on secondary school students' academic achievement in chemistry. *International Journal of Trend in Research and Development,3 (3),* 66-73

Ekon, E. E, Ekwueme, C.O & Merenikwu, A (2014). Effects of five-phase 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 States of Nigeria. *Scientific and Academic Publishing. 4(3) 74-77* Retrieved from doi.10.5927.20140403.03 on 6/6/2017.

Emeli,E (2012).Determination of the effectiveness of AUTOCAD in teaching technical drawing at River State University of Science and Technology Port Harcourt. *Unpublished MSc Thesis,* Faculty of Education, Nnamdi Azikiwe University, Awka

Emelikwu, S.O (2011). Assessing the relative effectiveness of three teaching methods in the measurements of student's achievement in mathematics. *Journal of Emerging Trends in Educational Research and Policy Studies,* (JETERAPS) *3(4)* ,479-486.

Eze, C.P (2014). *Effects of guided-discovery on students' academic achievement and retention of concepts in block/brick laying and concreting in Technical Colleges in Anambra State*. Unpublished Ph.D Dissertation Faculty of Education Nnamdi Azikiwe University,Awka.

Eze, T.I. Ezenwafor, J.I & Molokwu, L.I (2016). Effects of meta-learning teaching method on the academic performance of building trade students in technical colleges in south-east Nigeria. *International Journal of Vocational and Technical Education, 7 (10),* 101-108.

Eze, T.I., Ezenwafor, J.I & Obidile, J.I (2016). Effect of gender on student's academic performance and retention in financial accounting in Technical Colleges. *British Journal of Education, Society and Behavioural Science 18(4)1-9*

Ezenwosu, S.U & Nworgu, L.U (2013). Efficacy of peer tutoring and gender on students' achievement in biology. *International Journal of Scientific and Engineering Research 4 (12),* 944-950.

Ezeudu, F.O (2013). Influence of concept maps on achievement and retention of senior secondary school students on organic chemistry. *Journal of Education and Practice 4 (19),*35-44.

Federal Republic of Nigeria (2014). *National Policy on Education.* Lagos: NERDC Press

Flavel, J.H (1979). Metacognition and cognition monitor: a new era of cognitive development enquiry. *American Psychologist 34,* 906-911

Fritsher, L. (2008). *Constructivist about.com guide* Retrieved from http://phobias.com/od/glossary/g/cosntructivism /def.html on 28/03/2018.

Froyd, J.E (2007). Evidence for the efficacy of student–active learning pedagogies. Retrieved from http://ctc.tamu. edu/prorammes/fic.php on 22/09/2017

Fui, K.S (2011). Implementation of constructivist approach among chemistry students-teachers in teaching chemistry during their teaching practice. Malaysia: University Technology. Retrieved from www.fp.utmmy/ epusatsumer/pdffia/ptkg/hdtwp on 5thJuly 2017.

Gana, C.S. (2015). Effects of computer-assisted instruction with animation on the achievement and retention of students of Colleges of Education Minna in Quantum Physics. *Journal of Nigerian Association of Teachers of Technology, 10(4),* 77-86.

Ganyampfu, E.M (2013). Teaching methods and students academic performance. *International Journal of Humanities, Social Studies, Inventory 2 (9),* 29-35.

Gjergo, E & Samarxhius, S (2014). Basic principles of collaborative learning. *European Scientific Journal* Retrieved from eujournal.org>esj>article>viewfiles on 13/8/2018

Glaser, C. & Bruostain, J.C (2017). Improving fourth grade students' composition skills: effects of strategy instruction and self regulation procedures. *Journal of Education Psychology, 99(2),* 297-310.

Hayme, W.J (2003). Effects of take home test and study question on retention: learning in technology education. *Journal of Education* 14 (2) Retrieved from http://www.scholar/:b.vt.edu"/eour/ ijer/1472/hyme /html on 20th October, 2006

Hester, B., Anouk, S.D., & Danny, D.N.M (2012). *Effective strategies for self-regulated learning. A Meta-Analysis.* Gion: Groning Institute

Hornby, S.A (2010). *Oxford advanced learners dictionary 6th Edition.* London: Oxford University Press

Houghton, M. (2009). *The American heritage dictionary of the English language.* USA: Houghton Mifflin Company.

Igbo, J.N & Ihejieme, M.A (2014). Gender differences, delinquent behaviours and academic achievement of secondary students in Nigeria. *International Journal of Latest Research in Science and Technology 3(4),* 2278-5299.

Igboko,K.O & Ibeneme, O.T (2006). Effects of some cognitive constructivist instructional approaches on student's achievement and retention in the study of introductory technology in Nigeria. *Journal of Science Teachers Association of Nigeria 41(172),* 37-43

Iji, C.O (2010). Approach on senior students secondary school geometry. *Journal of Science Teachers Association of Nigeria 3(2),* 45-50.

Imogie, I.A (2014). 100 years of western education in Nigeria. The wobby tripod of growth, progress and shortcomings in university education in the Journey So far. *A keynote address*. Faculty of Education. University of Benin, Benin City.

Iwai, U. (2011). The effect of meta-cognitive reading strategies: pedagogical implication for EFL/ESL Teachers. *The Reading Matrix, 11(2),* 150-159.

Kimeka, M. (2007). *Constructivist approach: improving social studies skills academic achievement.* Unpublished M.Sc. Thesis, Department of Special Education, Mary Grove College.

Kirschner, P.A. Sweller, J. & Clark, R.E (2006). Why minimal guidance during instruction does not work: an analysis of the failure of constructivist, discovery, problem-based, experimental and inquiry based teaching. *Education Psychologists, 41 (2*) 86-95.

Lai, E.R. (2011). Meta-Cognition. *A Literature Review Journal of Educational Psychology 82 (3) 525-538*.Retrieved from http:www.pearsonassessments.com/research.

Lai,N (2012).Approaches to learning: Literature review. *International Baccalaureate Organisation*. Retrieved from https://www.ibo.org>ib.research>approaches.learning on 21/7/2018.

Lemka, C., Budka, M. & Gabrys, B. (2015). Meta-Learning: A survey of trends and technologies. *Artificial Intelligence Review 44(1),* 117-130

Lucas, B. Spencer, E., Claxton, G. (2012). How to teach vocational pedagogy: a theory of vocational education Retrieved from https://www.educationinnovations.org on 19th October, 2017.

Mahdavi, M. (2014). An overview: metacognition in education. International *Journal of Multidisciplinary and Current Research, 2, 529-534* Retrieved from http:.ijmcr.com on 25/04/2018

Mahoney, M.J (2004). What is constructivism and why is it growing? *Contemporary Psychologist, 49,* 360-363.

Maishikafa, G. (2010). *Effects of meta-cognition teaching strategies on academic performance, school low Achiever in Physics* Unpublished M.Tech Thesis, Department of Science Education. Federal University of Technology, Minna.

Marzona, R. (2011). Enhanced Discovery Learning. *Educational psychology, 101(1),* 46-53.

Mehrdad, N (2016). A Brief History of Meta-cognition and Principles of Meta-cognitive Instruction in Learning. *Journal of Humanities, Arts Medicine and Sciences 2(2),* 61-64.

Nayak, R.K (2013). A study on *effect of constructivist pedagogy on students achievement in mathematics at elementary level*. Retrieved from www.ncert.nic.in>pdf-files on 14th August, 2017,

Nelson & Narens, T.O (1990). Metamemory: a theoretical framework and new findings. *Psychology of Learning and Motivation 26,* .

Oboh, C.O & Umeh, A.E.O (2013). Innovative instructional strategies in teaching and learning process (ICT in Focus). *Nigerian Journal of Teacher Education and Teaching 11 (1),* 131-145

Odundo, P.A & Gunga, S.O (2013). Effects of application of instructional methods on learner achievement in business studies in secondary school in Kenya. *International Journal of Education and Research 1(5)* Retrieved from www.ijern.com on 21/01/2018.

Offiah, F.C. & Akusoba, E.U (2001). Effectiveness of meta-cognitive learning cycle on science instruction for secondary school chemistry students. *Journal of the Science Teacher Association of Nigeria, 1(1),* 23-29

Ogbu, J.E (2011). Effects of integration application of interaction pattern of student's cognitive achievement in basic electricity Retrieved from http://iis-db-stanford.edu on 5th July 2017

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.

Ogbuanya, T.C & Usoro, A.D (2012). Effects of automated technical drawing computer-assisted drafting technique of students' academic achievement, interest and gender on technical drawing. *International Journal of Educational Science and Research (1),* 5-16.

Ogbuanya, T.U & Usoro, A.D (2010). Relative effectiveness of advanced organiser on cognitive skills and retention of technical students in technical drawing. *Journal of Vocational and Adult Education, 7 (1),* 45-67.

Ogbuanya,T.U & (2010).Effects of multiple intelligence - based instructional approach on students' cognitive achievement in technical college electronics technology. *Journal of Vocational and Adult Education 7(1),*1-13

Oguguo, B.C.E. (2015). Effects of constructivist method of teaching on students' achievement in financial accounting. issues and challenges for accountancy education development. *Knowledge Review, 33(2),*1-7

Ogwo B.A & Oranu, R.N (2006). *Methodology in formal and non-formal technical/vocational education.* Nsukka: University of Nigeria Press Ltd.

Ogwo, B.A (2006). Gender differential effects of meta-learning instructional strategies on students' achievement in metal-work technology. *Journal of Vocational and Adult Education, 5 (1),* 1-10.

Okeke, O.C (2015). *Comparative effects of project and lecture method on secondary school students' achievement in economics.* Unpublished M.Ed Thesis, Faculty of Education, University of Nigeria, Nsukka.

Okeke,M.N& Okey,K.O (2018).Impact of collaboration learning strategy on the academic achievement of senior secondary school chemistry students in Obio-Akpor local government area .*International Journal of Education and Evaluation 4(2),* 11-18

Okoye,P.I (2017).*Effects of constructivist instructional methods on students academic performance and retention in automechanics in technical colleges* Unpublished PhD Dissertation Faculty of Education, Nnamdi Azikiwe University,Awka.

Okwara-Kalu, C.E & Anusiem, A.U (2011). Implementation of constructivist approach in the classroom. An innovation for quality education. *The Educational Psychologist 5 (1),* 129-138.

Oludipe, B. & Oludipe, I.D (2010). Effect of constructivist –based teaching strategy on academic performance of students in integrated science at the junior secondary school level. *Educational Research and review 5 (7),* 347-353 Retrieved on 23th August 2017 from http://www.acadenicjournal.org/ERR2

Omeje, H.A (2011) Effects of project based learning instructional techniques on interest and retention of low ability students in woodwork. *The Journal of Nigerian Association of Teachers of Technology* (NATT) *7(3),* 29-33.

Ongowo, R.O (2015). Secondary school teacher's perception of a biology constructivist learning environment in gen district, Kenya. *International Journal of Educational Research and Technology 4 (2),* 1-6. Retrieved from www.soeager.com/ijert.html on 17/04/2018.

Oviawa, J.I., Ezeji, S.C.O.A & Uwameiye, R. (2015). Comparative effects of three instructional method on student's performance in building technology in nigeria polytechnics. *European Scientific Journal, 11(12),* 274-285.

Oviawe, J.I (2008). Effect of peer tutoring assisted instruction on students' academic achievement in introductory technology. FCT education secretariat. *Journal of Curriculum Studies and Instruction 1 (1)* 77-84.

Owodunmi, A.S & Ogundola, I.P (2013). Gender differences in the achievement and retention of nigeria students exposed to concept of electronic works trade through reflective inquiry instructional technique. *British Journal of Education, Society and Behavioural Science, 3 (4),* 585-599. Retrieved from www.sciencedomain.org on 25/04/2018.

Piaget, J. (1985). *The equilibrium of cognitive structure; the central problem of intellectual development.* Chicago: University of Chicago Press.

Prince, M.J & Felder, R.M (2006). Inductive teaching and learning method. definitions, comparison and research bases. *Journal of Engineering and Education, 95 (2),* 123-138.

Raymond,E & Hassan, A.M (2007).Effects of meta-learning instructional approach on students performance in technical education. *Journal of Vocational and Adult Education, 6 (10),* 83-90

Schraw, G., Crippan, K.J & Hartley, k. (2006). Promoting self regulation in science education: metacognition as part of a broader perspective on learning. *Research in Science Education 36,* 111-139.

Scridev, K.V (2013). Effects of constructivist approach on students perception of nature of science at secondary level. *Artha Journal of Science, 12(1),* 49-66. Retrieved from http://dx.doi.org/10.12774/ajss.24.

Stefaniak, J.E (2013). *The use of cognitive apprenticeship to teach learner-centered instructional strategies in an undergraduate learning environment.* Unpublished Ph.D dissertation, Graduate school Wayne State University Detroit Michigan. Retrieved from http://digitalcommons. wayne.edu. oa-dissertation on 25/04/2018.

Susanta, R.C (2016). A Study on the effect of constructivist approach on the achievement in mathematics of ix standard students. *Journal of Humanities and Social Studies, 21(2),* 35-40. Retrieved from www.isory journal.org on 6/23/2017

Uduafemhe,M.E (2015).Comparative effects of scaffolding and collaborative instructional approaches on secondary school students' psychomotor achievement in basic electronics in North-central Nigeria. *IOSR Journal of Engineering 5(6),* 23-31.

Ugboaja, C. I & Uzoka, N.R (2011). Gender differences in the perception and participation of Junior Secondary School students in Agricultural Science. *The educational psychologist 5(1),* 116-122.

Ugwu, T.U (2014). *Effect of guided inquiry methods on students' achievement and interest in basic science.* Unpublished M.Sc Thesis, Faculty of Education, University of Nigeria, Nsukka.

Ultanir, E. (2012). An epistemological glance at the constructivist approach: constructivist learning in dewey Piaget and Montessori. *International Journal of Instruction 5(2),*195-212 Retrieved from https://eric.ed.gov /?id=ED533 on 7th August 2017

UNESCO & ILO (2002). *Technical and vocational education and training for 21st century recommendation.* Paris: UNESCO.

Ursuala, N.A & Eleuwa, M.O (2013). Effects of learner-centered teaching method on academic achievement of slow learners. *Journal of Theoretical and Empirical Studies in Education, 3(1),* 179-185.

Uwalaka, A.J. & Oforma, G.C (2015). Effect of constructivist teaching method on students' achievement in French listening comprehension in Owerri North L.G.A of Imo States. *Nigeria Journal of Education and Practice 6 (26),* 52-56 retrieved from www.ijste.org on 25/04/2018

Vygotsky. L. (1978). *Mind in society: the development of higher psychological processes.* Cambridge: Harvard University Press.

Wachanga, S.W, Githae,R.W & Keraro,F.N (2015).Effects of collaborative concept mapping teaching approach on secondary school students' motivation to learn biology in Nakuru North Country, Kenya. *Journal of Educational Policy and Entrepreneurial Research 2 (8),* 1-17. Retrieved from www.jeper.org on 12/9/2018

Winters, T. (2013). *A Framework for facilitating Meta-Learning as part of subject Teaching.* Retrieved from http:// conference.pixel-online.net>166.ITL28-FB-winters-FOE2013.pdf on 6th August 2017

Woolfolk, A (1998). *Educational psychology*. Needham Height M.A: Allyn and Bacon.

Yinusa, A.F (2014). Assessment of teaching strategies adopted for effective implementation of science subject and trade module curriculum in Nigeria. *Technical Colleges Journal of Education and Social Research, 4(6*), 391-396.

Yusuf, M.O., Gambari, A.I & Olumoria, C.O., (2012). Effectiveness of computer-supported cooperative learning strategies in learning physics. *International Journal of Social Studies and Education, 2(2),* 94-109

Zumbrunna, S. Tadlock, J. & Roberts, E.D (2014). Encouraging self-regulated learning in the classroom: a review of the literature. *Metropolitan Educational Research Consortium*, Virgina: Commonwealth University

Appendix A

National Technical Certificate Examination Performance Statistics on Basic Electricity trade of all the Government Technical Colleges in Anambra State from 2013-2017.

Table1: Data on Students' Performance in May/June NABTEB Basie Electricity (2013-2017).

Year	**Number of Students**	**A1-C6**	**%**	**P7-F9**	**%**
2013	223	118	52.9	105	47.1
2014	365	209	57.3	156	42.7
2015	370	170	46.0	200	54.0
2016	377	207	54.9	170	45.1
2017	431	225	52.2	206	47.8

Source: *NABTEB Headquarters Benin-Edo State,(2018)*

Appendix B

Table 2: Population distribution of NTC II Basic Electricity Students in Technical colleges in Anambra State.

S/N	Names of Schools	Male	Female	Total
1	G.T.C Onitsha	47	29	76
2	G.T.C Nkpor	38	16	54
3	G.T.C Ihiala	30	11	41
4	G.T.C Ossomala	18	7	25
5	St John Science and Technical College Alor	37	19	56
6	G.T.C Umunze	30	7	37
7	G.T.C Umuleri	22	8	30
8	G.T.C Enugu-Agidi	36	12	48
9	Nigerian Science and Technical College Nnewi	22	18	40
10	G.T.C Umuchu	27	8	35
11	G.T.C Utuh	24	9	33
12	Federal Science and Technical College Awka	58	27	85
	Total	389	171	560

Source: *Data collected from the basic electricity teachers of the technical colleges (2018)*

Appendix C.

Sample Distribution According to Schools.

S/N	Names Of School	Groups	Male	Female	Total
1	Government Technical college Umuchu	Experimental (E1a)	26	7	33
2	Government Technical College Utuh	Experimental (E1b)	18	6	24
3	Government Technical college Umunze	Experimental (E2a)	16	7	23
4.	Nigeria Science and technical College Nnewi	Experimental (E2b)	19	9	28
	Total	79	29		108

Appendix D

Basic Electricity Achievement Test

Part 1: Student Gender

Instruction: Please tick (√) in the option for gender below as it applies to you.

Gender: Male ☐ Female ☐

Part II: Basic Electricity Achievement Test

Instruction: Enter only the letter for the correct answer for all the questions in the spaces provided.

1. Which of the following is a variable resistor? (A) Wire-wound resistor (B) Carbon resistor (C) Rheostat (D) Fixed resistor.
2. The power rating of a resistor could be identified through its ------(A) Ohmic value (B) Type (C) Size (D) Tolerance value.
3. The numerical value of violet colour used as fixed resistor is------(A) 6 (B) 7 (C) 8 (D) 9.
4. The component which show electrical resistance are called---------(A) Battery (B) Capacitor (C) Inductor (D) Resistors.
5. The resistance of a carbon resistor coloured red, violet, and brown is------- (A) 27ohms (B) 280ohms (C) 270ohms (D) 280ohms.
6. The instrument used for measuring resistance in a circuit is called---------(A) Ammeter (B) Watt-meter (C) Ohmeter (D) Volt-meter.
7. The type of resistor commonly used in radio and electronic gadgets is-----(A) Rheostat (B) Wire-wound (C) Carbon-moulded (D) High stability.
8. The following are types of resistors except---------- (A) Wire-wounded (B) Moulded-carbon (C) Rheostat (D) Eureka.
9. The resistance value of a resistor colour coded with brown, black and brown is------(A) 10Ω (B) 100Ω (C) 1000Ω (D) 10000Ω.
10. Colour coding of resistor is used to determine the------ (A)Rating of the resistor (B) Value of the resistor (C) Make of resistor (D) Type of the resistor.
11. The third band of colour coded resistor represents----- (A)Tolerance (B) Second digit (C) Multiplier (D) Third digit.
12. A resistor made by a wire around a ceramic rod is-----(A) Carbon-film (B)Wire-wound (C)Thermistor (D) Carbon-composition.
13. The amount of wattage a resistor is determined by----- (A)Value (B)Voltage (C)Current (D) Size.
14. A resistor of nominal value 240Ω, has the colour code (A)Red, yellow and black (B) Red, orange and black (C) Red, black and yellow (D) Brown, yellow and black.
15. The fourth band of colour coded resistor represents--- (A)Multiplier (B) Fourth digit (C) Tolerance (D) Fair colour.

16. Which of the following colours has tolerance value in a resistor colour coding (A) Blue, brown and gold (B) Yellow, green and black (C) Grey, violet and white (D) Green, black and silver.
17. The ability of a capacitor to store electric charge is known as------ (A) Farad (B) Capacitor (C) Capacitance (D) Dielectric.
18. The symbol (┃▌) represents-------- (A)Cell (B) Switch (C)Capacitor (D) Battery.
19. The unit measurement of capacitance is---------- (A) Kelvin (B) Hertz (C) Farad (D) Coulomb.
20. Breakdown voltage is an operating characteristics of---------- (A)An inductor (B) A capacitor (C) A resistor(D) A transformer.
21. The unit of measurement of electric charge is--------- (A) Ampere (B) Volt (C) Walt (D) Coulomb .
22. The following are the three operating characteristics of a capacitor except---------- ------(A) Working voltage (B) Capacitance (C) Electric charge (D) Conductance.
23. Capacitors are named according to-------(A) The dielectric used (B) Their function (C) Their type (D) Their place of manufacture.
24. The function of a electrolytic capacitor in a power supply circuit is----------(A) Tuning (B) Timing (C) Coupling (D)Filtering.
25. A capacitor having a capacitance of 80µF is connected across a 500Vdc supply, the charge is----- (A) 0.04C (B) 0.004C (C)0.0004C (D) 4.00C.
26. The energy generated in a 100µF capacitor at 200V is-------(A)0.01J (B) 0.02J (C) 2.00J (D) 4.00J.
27. When two conductive plates are moved close together, capacitance will----------(A) Increase (B) Decrease (C) Remain the same (D) Vary downwards.
28. The name given to the material separating a capacitor plate is---------- (A) Air (B) Dielectric (C) Conductor (D) Insulator.
29. If the size of the conductive plates is increased, capacitance will---------- (A) Increase (B) Decrease (C) Remain the same (D) change
30. A capacitor blocks---------- (A) Ac voltage (B) Direct voltage (C) Alternating current (D) Direct current.
31. A small disc capacitor marked 100 has a value of--------- (A)100µF (B) 0.000IF (C) 100PF (D) 100F.
32. A large electrolytic capacitor marked 100 has a value of---------(A) 100µF (B) .0000IF (C) 100PF (D) 100F.
33. Another word used to represent an inductor is---------(A) Wire (B)Coil (C) Transformer (D)Conductor.
34. An inductor stores energy in its----------(A)Electric field (B)Magnetic field (C)Core (D)Wires.
35. Inductance is measured in---------(A)Hertz (B)Coulomb (C)Henry(D)Ampere.
36. If the diameter of a coil is increased, the inductance will-------(A)Increase (B)Decrease (C)Remain the same (D) vary downwards.

37. Which of the inductors is very suitable for radio- frequency applications (A) Ferrite-rod inductor (B)Iron-core inductor (C)Air-core inductor (D) Toroidal inductor.
38. The property of a coil which opposes changes in current by means of energy storage in the magnetic field is called --------(A)Conductance (B)Reactance (C)Inductance (D)Impedance.
39. An inductor will block ----------(A)Alternating Voltage (B)Direct Voltage (C)Alternating Current (D)direct current.
40. The following are examples of fixed inductor except----(A)Ferrite-rod inductor (B)Iron-core inductor (C)Air-core inductor (D)Toroidal inductor

Appendix E

Marking/Scoring Guide for the BEAT

1.	C	21.	D
2.	C	22.	D
3.	B	23.	A
4.	D	24.	C
5.	C	25.	D
6.	C	26.	C
7.	A	27.	A
8.	D	28.	B
9.	B	29.	A
10.	B	30.	B
11.	C	31.	C
12.	B	32.	A
13.	D	33.	B
14.	A	34.	B
15.	C	35.	C
16.	D	36.	A
17.	C	37.	C
18.	C	38.	D
19.	C	39.	C
20.	B	40.	D

Appendix F

Table of Specification for BEAT

	CONTENTS	**Knowledge 30%**	**Comprehension 35%**	**Application 10%**	**Analysis 13%**	**Synthesis 12%**	**Total**
Week 1	Resistors (20%)	4, 6,	2, 7, 8, 12, 13, `	-	-	1,	8
Week 2	Determination of Resistance values (20%)	10,	3,	-	5, 9, 11, 14, 15,	16,	8
Week 3	Capacitors (40%)	17, 18, 20, 24, 28, 30,	19,21,23,27,29,	25,26,31,32,	-	22,	16
Week 4	Inductors 20%	33,38,39,	34,35,36,	-	-	37,40	8
		12	14	4	5	5	40

Appendix G

Final Selection of Items

Table 2: Item Analysis.

Test Items	Difficulty Index $P = \frac{R \times 100}{T}$	Discrimination Index $DI = \frac{R_h - R_L}{N}$	Test Items	Difficulty Index $P = \frac{R \times 100}{T}$	Discrimination Index $DI = \frac{R_h - R_L}{N}$
1	45	0.68	21	34	0.62
2	54	0.45	22	50	0.47
3	44	0.40	23	54	0.45
4	60	0.42	24	60	0.54
5	40	0.49	25	35	0.44
6	70	0.42	26	38	0.54
7	66	0.64	27	44	0.40
8	72	0.41	28	60	0.52
9	36	0.49	29	55	0.44
10	61	0.38	30	48	0.65
11	50	0.47	31	36	0.49
12	66	0.64	32	54	0.45
13	70	0.38	33	61	0.48
14	45	0.68	34	50	0.32
15	72	0.51	35	70	0.43
16	55	0.44	36	45	0.32
17	68	0.56	37	50	0.34
18	57	0.32	38	65	0.42
19	70	0.40	39	69	0.52
20	61	0.56	40	52	0.47

Where P = Item difficulty level

R = Number of students who got the answer correctly

T = Total number of candidates who attempted the items

RH = Number of students in the upper group who got the item right

RL = Number of students in the lower group who got the

item right

N = Number of the students who responded to the item.

Appendix H

Calculation of Internal Consistency of Reliability Co-Efficient of BEAT Using Kuder-Richardson fomular 20.

Scores	P	Q	PQ
55	0.55	0.45	0.2475
50	0.5	0.5	0.25
60	0.6	0.4	0.24
65	0.65	0.35	0.2275
70	0.7	0.3	0.21
65	0.65	0.35	0.2275
60	0.6	0.4	0.24
50	0.5	0.5	0.25
75	0.75	0.25	0.1875
75	0.75	0.25	0.1875
60	0.6	0.4	0.24
65	0.65	0.35	0.2275
70	0.7	0.3	0.21
60	0.6	0.4	0.24
70	0.7	0.3	0.21
60	0.6	0.4	0.24
55	0.55	0.45	0.2475
65	0.65	0.35	0.2275
65	0.65	0.35	0.2275
50	0.5	0.5	0.25
50	0.5	0.5	0.25
75	0.75	0.25	0.1875
65	0.65	0.35	0.2275
70	0.7	0.3	0.21
75	0.75	0.25	0.1875
60	0.6	0.4	0.24
70	0.7	0.3	0.21
65	0.65	0.35	0.2275
60	0.6	0.4	0.24
50	0.5	0.5	0.25
64.97126			6.8175

USING K-R20

$r=n/(n-1)[1-(\sum pq/SD^2]$

r =30/(30-1)[(1- 6.8175/64.97126)=0.8736

r=0.8736

Appendix I

Lesson Plan on Basic Electricity Based on Meta-Learning Teaching Method (MTN)

Lesson Plan One

Lesson Plan I (Week One)

Subject: Basic Electricity

Class: NTC II

Date:

Duration: 2 Periods (40 Minutes each)

Average Age: 15 years

Topic: Resistor

Specific Objectives: By the end of the lesson, the students should be able to do the following;

1. The component which show electrical resistance is called
   (A)Battery(B)Capacitor(C)Inductor(D)Resistor.
2. Draw a symbol of a resistor
3. Which of the following is a unit of resistance.
   (A)Ohm (B)Ampere(C)Voltage (D)Watts
4. Identify different types of resistors from a circuit board.
5. The type of resistor commonly used in radio and electronic gadgets is
   (A)Rheostat(B)Wire-wound(C)carbon moulded (D)High stability

Content Outline:- Identification of various types of resistors, functions/applications of various types of resistors.

Instructional Materials: Circuit board containing different types of resistors, chart showing the symbol and types of resistors, Chalk board illustration.

Instructional Method: Meta-learning. (MTM).

Entry Behaviour: Students have done conductors and insulators in their junior secondary class.

Instructional Procedure

Step	Content/Task Development	Teacher's Activity	Student's Activity	Performance Assessment
1.	Set Induction and Review of entry behavior	The teacher points out the materials in the classroom that are conductors and insulators, stating their general properties to differentiate them. Meta-learning Instructional strategy(MEINST):Revising and Focusing	The students listen, and help in pointing out the materials belonging to conductor and insulator. MEINST: Focusing and Analysing	Students differenciates between conductor and insulator
1.	Statement of specific objectives	The teacher writes the instructional objectives and explains how students will be assisted to achieve the objectives. (MEINST) Goal Setting (Reminding students to be conscious of their learning process).	The students seek clarification on the objectives and think on how to achieve the objectives MEINST: Information gathering and focusing	
2.	Resistor: Definition, Symbol and Unit of Resistance	The teacher shares samples of resistor to students, asks them to identify the sample. After which the teacher asks the students the following question: Define a resistor, Draw the symbol of a resistor. What is the unit of resistance. MEINST: Information gathering,	The students identify the sample and answer the teachers' questions. MEINST: Synthesising, Encoding,	Students identify the sample, defines a resistor, stating the unit of resistance and drawing the symbol of a resistor.

		Elaborating		
3.	Identification of types of Resistors	The teacher shares circuit boards containing different types of resistor, hangs a chart showing types of resistors on the wall and asks students to view the chart and identify types of resistors on the circuit board. MEINST: Organizing, Timing	Students seek clarification and identify the different types of resistors. MEINST: Synthesing, Predicting	Students identify types of resistors from the circuit boards as teacher gives them clues
4.	Functions and Application of resistors.	The teacher defines a resistor, stating types of resistor, explaining them and stating their applications. MEINST: Elaborating, Analysing	The students listen, write down the points and ask question where necessary. MEINST: Attention, Synthesisng	
	Summary	The teacher stresses the major points of the lesson MEINST: Reviewing, Revising.	The students clarify the jotted points in their notebooks. MEINST: Value determination, Verifying	Self assessment of what they have learnt from the lesson
	Evaluation	The teacher asks the students questions based on the specific objectives.	The students listen and answer the questions	Students answer questions in the specific objectives
	Assignment and Title of next lesson	The teacher outlines the topic of the next lesson after discussing the home assignment.	The students copy the title of next lesson and predict the objectives	Relating assignment with the day's lesson.

Lesson Plan Two

Week 2: Lesson 2

Subject: Basic Electricity

Class: NTC II

Date:

Duration: 2 periods (40 Minutes each)

Average Age: 15 years

Topic: Determination of resistor value using colour codes

Specific Objectives: By the end of the lesson, the students should be able to do the following

1. Identify colours in a given resistor
2. The third band of colour-coded resistor represents (A) Tolerance (B) Second digit (C) Multiplier (D) Third digit.
3. Determine the value of a given resistor using colour codes.
4. Memorise the colour codes of resistor by reciting them.

Content Outline: Calculation of the value of resistors using colour coding.

Instructional Materials: Chart showing resistor colour codes,

samples of resistors and chalk board illustration.

Instructional method: MTM

Entry Behaviour: The students have seen a resistor in their previous lesson and can identify it.

Instructional Procedure

Step	Content/Task Development	Teacher's Activity	Student's Activity	Performance Assessment
1.	Set Induction and Review of entry	The teacher mentions points in the previous lesson that are	The students clarify difficulties experienced	Students are asked questions

	behaviour	relevant to the lesson. MEINST: Revising and Focusing	on the take home assignment. MEINST: Verifying and Analyzing	to enable them recall the previous lesson
2.	Statement of instructional objectives	The teacher writes and explains the instructional objectives, tells the students how the objectives could be achieved. MEINST: Goal setting (Reminds the students to be conscious of their learning process)	The students comment on the objectives and mode of their achievement of the objectives. MEINST: Focusing and Information gathering.	
3.	Identification of colours on resistors	The teacher distributes samples of resistor to the students and asks them to identify the colours on the resistor. MEINST: Focusing and Information gathering	The students view the resistors carefully and identify the colours on the resistors. MEINST: Focusing,Predicting	Students identify colours on the resistors given to them
4.	Identification of colour bands of resistor.	The teacher hangs a chart showing the colour bands and colour codes on the wall. Asks the students to identify the bands looking on the chart. The teacher corrects and reinforces the students where necessary. MEINST: Timing and Information gathering	The students listen carefully, compares the chart with the sample of the resistors they are holding and answer the teacher's question. MEINST: Attention and Analysing.	Students Identify the colour bands of resistors.
5.	Determination of resistor value using colour codes	The teacher asks the students to determine the value of the resistor given to them. The teacher then does the calculations using the chart on the wall.	The students, listen ask questions where necessary, determine the value of the resistors and present	Students determine value of resistors given to them

		MEINST: Organizing, Time, Information gathering	their answers the teacher. MEINST: Value determination, Analyzing	
6.	Summary	The teacher writes down and reads the mnemonics that the students will use to remember colour codes of resistor. Ask the students to recite the mnemonics. The teacher then summarizes the major points MEINST: Elaborating, Revising, Reviewing	The students listen, write down the mnemonics and recites it and clarify jotted pointsin their notes MEINST: Synthsising, Verifying, Focusing	Self assessment of what they have learnt from the lesson.
	Evaluation	The teacher asks the students questions based on the specific objectives	The students listen and answer the teacher's questions.	Students answer questions in the specific objectives.
	Assignment and title of the next lesson	The teacher outlines the topic of the next lesson after giving the students home assignment	The students copy the title of the next lesson and predict the objectives.	Students relate assignment with the day's lesson

Lesson Plan Three

Week 3: Lesson 3

Subject: Basic Electricity

Class: NTC 1I

Date:

Duration: 2 periods (40 minutes each)

Average Age: 15 years

Topic: Capacitor

Specific Objectives: By the end of the lesson, the students should be able to do the following.

1. Identify capacitors in a given circuit board.
2. The ability of a capacitor to store electric charge is known as
   (A)Farad (B) Capacitance (C)Dielectric (D)Tolerance
3. The following are the three operating. characteristics of a capacitor except
   (A)Working voltage (B) Capacitance (C) Electric charge (D) Conductance
4. Mention factors affecting the capacitance of a capacitor
5. State at least three types of capacitor
6. Calculate the capacitance or energy stored in a capacitor using the formular $C = \frac{Q}{V}$.

Content Outline: Concept of capacitors and capacitance. Types of capacitors, functions of capacitors and constructional details, identification of working voltage of a capacitor.

Instructional Materials: Circuit board containing different types of capacitors, samples of capacitors and chalkboard illustrations.

Instructional Method: MTM

Entry Behaviour: The students have done electronic components in their previous lesson..

Instructional Procedure

Step	Content/Task Development	Teacher's Activity	Student's Activity	Performance Assessment
1.	Set induction and Review of the previous	The teacher reviews previous lesson to refresh students' minds. MEINST: Revising, Value, determination, Information gathering.	The students refer to their notebooks to clarify teacher's revision of previous knowledge pointing out area of difficulty on their assignment. MEINST: Revising	Students answer questions based on the previous lesson
2.	Statement of instructional objectives	The teacher writes and explains the instructional objectives, tells students how they are to be assisted in achieving the objectives. MEINST: Goal setting	The students pay attention and ascertain the manner for achieving the stated objectives. MEINST: Focusing, Information gathering	
3.	Identification and definition of capacitors.	The teacher distributes samples of capacitors to students and asks them to identify the sample. The teacher defines a capacitor, writing it on the chalkboard as the teacher draws the symbol of capacitor. MEINST: Elaborating	The students observe the samples and answer the question. Writes down teachers' explanations. MEINST: Attention and synthesizing.	The students identify a capacitor.
4.	Types of Capacitor	The teacher distributes circuit board containing different types of	The students listen, study the circuit board carefully and identify types of capacitors.	Students identify types of capacitors.

		capacitors and asks the students to identify types of capacitors from the circuit board. MEINST: Information gathering, Timing	MEINST: Focusing, Predicting	
5.	Capacitance and working voltage	The teacher asks the students to examine the body of the capacitors and mention the values printed on the capacitors. The teacher then defines capacitance and working voltage. MEINST: Information gathering, Analysing	The students listen, examine the capacitors critically and answer the questions. MEINST: Attention, Focusing, Information gathering	Students mention the values printed on the capacitors.
6.	Factors affecting capacitance of a capacitor	The teacher draws the constructional details of a capacitor and asks students to identify the parts of the capacitors, stating how each part could affect capacitance of a capacitor. The teacher then states and explains the factors affecting capacitance of a capacitor using the diagram on the chalkboard. MEINST: Timing, Style, Analysing.	The students listen, ask questions where necessary, answer questions, and write down the points made by the teacher. MEINST: Information gathering, Synthesising	The students identify the parts of a capacitor and state how they affect capacitance of a capacitor.

7.	Calculation of capacitance of a capacitors	The teacher writes two problems involving calculation of capacitance and asks students to solve then using the equation given to them. The teacher gives them clues and asks them to present their answers after some time. MEINST: Timing ,Information gathering	The students solve the problems given to them, present their answers to the teacher and copy the teacher's calculations in their notebook. MEINST: Focusing, Value determination	The students solves the problems on the chalkboard and presents their answers to the teacher
	Summary	The teacher stresses on the major points of the lesson. MENINST: Revising, Revising	The students clarify the jotted points on their note books and ask questions where necessary. MEINST: Verifiying, Focusing	Self assessment of what they have learnt from the lesson.
	Evaluation	The teacher asks questions based on the specific objectives	The students listen and answer the questions	Students answer questions from the specific objectives
	Assignment and title of the next lesson	The teacher outlines the topic of the next lesson after giving the students take home assignment	The students copy the assignment and the title of the next lesson and predict the objectives of the next lesson	Students relate the take home assignment with the day's lesson.

Lesson Plan Four

Week 4: Lesson 4

Subject: Basic Electricity

Class: NTC II

Date:

Duration: 2 periods (40minutes each)

Average Age: 15 years

Topic: Inductor

Specific Objectives: By the end of the lesson the students should be able to do the following:

1. Identify an Inductor.
2. Another word used to represent an inductor is (A) Wire (B)Coil (C)Transformer (D)Conductor
3. An inductor stores energy in its (A) Electric field (B)Magnetic field (C)Cores (D)Wires
4. An inductor will block (A) Alternating Voltage (B) Direct Voltage (C) Alternating Current (D) Direct Current.
5. The following are types of inductor except (A)Ferrite-rod inductor (B)Iron-core inductor(C)Carbon-film inductor (D)Toroidal inductor
6. Mention the factors affecting the inductance of an inductor.

Content Outline: Inductor;- types and functions, inductance and factors affecting inductance.

Instructional Materials: Samples of inductors and board illustration.

Instructional Method: MTM

Entry Behaviour: The students have seen circuit board containing electronic components in their previous lesson.

Instructional Procedure

Step	Content/Task Development	Teacher's Activity	Student's Activity	Performance Assessment
1.	Set induction and Review of the previous knowledge	The teacher reviews previous lesson to refresh students' minds. MEINST: Focusing, Revising	The students listen, respond to teacher's review questions. Pointing areas of difficulty on their assignment. MEINST: Verifying Analysing	Students answer questions from the previous lesson
2.	Statement of Instructional Objectives	The teacher writes the instructional objectives of the chalkboard and tells the students how they will achieve the objectives. MEINST: Goal setting (Reminding the students on their role on affecting their learning)	The students pay attention gather information on what they are expected to achieve and. Think on how they will achieve it. MEINST: Attention, Information gathering, Focusing, Analysing	
3.	Inductors: Identification and definition	The teacher distributes samples of inductor to the students, asks them to identify the sample. After sometime the teacher asks the students the following questions; What is an inductor, state another name for an inductor. Draw the symbol of an inductor.	The students exchange the components as they view them and identify the component. The students answer questions, write down points made by the teacher and ask questions where	Students identify and define an inductor drawing its symbol on the chalkboard.

		MEINST: Information gathering, Organizing.	necessary. MEINST: Synthesising, Predicting	
4.	Types and functions of an inductor	The teacher asks the students to identify the physical differences in the samples of inductors given to them. The teachers then mentions types of inductors, describes them and state their functions. MEINST: Elaborating	The students critically view the samples of inductor given to them and state the differences observed. The students jot down the points made by the teacher. MEINST: Attention, Focusing	Students state the differences in the samples of inductor given to them.
5.	Inductance and factors affecting inductors	The teacher asks the students to define inductance and as well the factors affecting inductance of an inductor. The teacher then gives his/her own definition stating the factors affecting inductance using the parameters in the formular. MEINST: Information gathering, Elaborating.	The students pay attention and answer the questions. The students also jot down the points made by the teacher. MEINST: Attention, Predicting	Students define inductor and state the factors affecting inductance..
	Summary	The teacher stresses on the major points of the lesson. MEINST: Revising, Reviewing	The students clarify the jotted points on their note and ask questions where necessary. MEINST: Verifying, Focusing.	Self assessment of what they have learnt from the lesson..
	Evaluation	The teacher asks the students questions based on the specific objectives.	The students listen and answer the questions	Students answer questions and seek for

				clarifications
	Assignment	The teacher outlines the topic of the next lesson after giving them assignment	The students copy assignment and title of the next lesson and predict the objective of the next lesson	Students relates the take home assignment with the day's lesson

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Appendix J

Lesson Plan on Basic Electricity Based on Constructivist Teaching Method (Specifically Collaboration Instructional Approach)

Lesson Plan One

Lesson Plan I Week One

Subject: Basic Electricity

Class: NTC I1

Date:

Duration: 2 Periods (40 Minutes each)

Average Age: 15 years

Topic: Resistor.

Specific Objectives: By the end of the lesson, the students should be able to do the following:

1. The component which show electrical resistance is called
   (A)Battery(B)Capacitor(C)Inductor(D)Resistor.
2. Draw a symbol of a resistor
3. Which of the following is a unit of resistance.
   (A)Ohm (B)Ampere(C)Voltage (D)Watts
4. Identify different types of resistors from a circuit board.
5. The type of resistor commonly used in radio and electronic gadgets is
   (A)Rheostat(B)Wire-wound(C)carbon moulded(D)High stability

Content Outline:- Identification of various types of resistors, functions/applications of various types of resistors.

Instructional Materials: Circuit board containing different types of resistors, chart showing the diagram of symbol and types of resistors, Chalkboard illustration.

Instructional Method: Collaboration

Entry Behaviour: The students have done conductors and insulators in their junior secondary class.

Instructional Procedure

Step	Content/Task Development	Teacher's Activity` `	Student's Activity	Instructional Strategy/skill
1.	Identification of Prior knowledge	The teacher asks the students the following questions: Have you seen a resistor. Describe a resistor. What type of circuit element does a resistor belongs to.	The students listen, think of the prior knowledge and answer the questions.	Critical thinking
2.	Resistor: Definition Symbol and unit of resistance	The teacher shares the students into small group (not more than seven considering their abilities and gender) and appoints a student as group head. The teacher distributes samples of resistor to the groups. Asks them to observe the components. After some time the teacher asks the students the following questions; Identify the component. What is a resistor. Draw a symbol of a resistor. What is the unit of resistance.	The students observe the component individually and as a group, exchange ideas and answer the questions.	Group work, Authentic learning, Critical thinking,
3.	Identification of types of resistors	The teacher hangs a chart showing types of resistors on the wall and asks students to view the chart, interact as a group, and identify types of resistors on the circuit board	The students examine and compare the chart and the circuit board collectively, exchange ideas and identify	Authentic learning Oral discussion

			types of resistor on the circuit board.	
4.	Functions and Applications of resistors	The teacher asks each group to state the function of a resistor. After sometime the teacher asks them to state the applications of resistors.	The students listen, interacts and answer the questions.	Oral discussion \Critical thinking
	Summary	The teacher explains the major points of the lesson	The students ask questions jot down points on their note books.	Oral discussion
	Evaluation	The teacher asks questions based in the specific objectives to each group	The students listen interact and answer the question	Oral discussion, Critical thinking
	Assignment	The teacher outlines the topic of the next lesson and give the students an assignment	The students seek for clarification where necessary and write down the assignment and the topic of the next lesson.	Learning Frames

Lesson Plan Two

Week 2: Lesson 2

Subject: Basic Electricity

Class: NTC I1

Date:

Duration: 2 periods (40 Minutes each)

Average Age: 15 years

Topic: Determination of resistor value using colour codes.

Specific Objectives: By the end of the lesson, the students should be able to

1. Identify colours in a given resistor
2. The third band of colour-coded resistor represents
   (A) Tolerance (B) Second digit (C) Multiplier (D) Third digit.
3. Determine the value of a given resistor using colour codes.
4. Memorise the colour codes of resistor by reciting them.

Content Outline: Calculation of resistors using colour coding.

Instructional Materials: Chart showing resistor colour codes, samples of resistors and board illustration.

Instructional Method: Collaboration.

Entry Behaviour: The students have seen a resistor in their previous lesson and can identify it.

Instructional Procedure

Step	Content/Task Development	Teacher's Activity	Student's Activity	Performance Assessment
1.	Identification of prior knowledge.	The teacher asks the students the following questions, Have you noticed the different colours on a resistor.	The students listen. think on the prior knowledge and answer the questions.	Critical thinking
2.	Identification of colours on resistor	The teacher shares the students into small groups (not more than seven considering their abilities and gender) and appoints a group head. The teacher distributes samples of resistors to the groups, asks them to observe the resistors and identify the colours on the resistors allowing them to interact with one another..	The students observe the resistors, interact as group and mention the colours identified on the resistors	Group work, Authentic learning
3.	Identification of colour bands of resistors	The teacher hangs a chart showing colour bands and colour codes of resistors on the wall. Asks the students to view and compare the chart with the resistors given to them. The teacher then asks the students to identify the colour bands of a resistor	The students examines and compare the chart with the resistors given to them as they interacts, exchange ideas as a group, and answers the question.	Oral discussion, critical thinking
4.	Determination of resistor values using colour codes	The teacher asks the students to determine the value of the resistors given to them following the illustration on the chart as the teacher visits each group to guide and monitor	The students listen, ask questions where necessary, determine the value of the resistor and presents their group answers one	Critical thinking, group work

		them.	after the other.	
	Summary	The teacher summarises the lesson by using the chart to determine the value of a given resistors. The teacher also gives the students memory code to remember the colour codes.	The students listen, asks questions and jot down points in their notebooks.	Oral discussion
	Evaluation	The teacher asks the students questions based on the specific objectives	The students listen, interacts and answer the questions	Oral discussion, group work
	Assignment	The teacher outlines the topic of the next lesson and gives the students an assignment.	The students listen, ask questions and write down the assignment and the topic of the next lesson	Learning Framing

Lesson Plan Three

Week 2: Lesson 3

Subject: Basic Electricity

Class: NTC I1

Date:

Duration: 2 Periods (40 minutes each)

Average Age: 15 years

Topic: Capacitor

Specific Objectives: By the end of the lesson, the students should be able to do the following.

1. Identify capacitors in a given circuit board.
2. The ability of a capacitor to store electric charge is known as
   (A)Farad (B) Capacitance (C)Dielectric (D)Tolerance
3. The following are the three operating. characteristics of a capacitor except
   (A)Working voltage (B) Capacitance (C) Electric charge (D) Conductance
4. Mention factors affecting the capacitance of a capacitor
5. State at least three types of capacitor
6. Calculate the capacitance or energy stored in a capacitor using the formular $C = \frac{Q}{V}$.

Content Outline: Concept of capacitors and capacitance. Types of capacitor, functions of capacitor and constructional details. Identification of working voltage of a capacitor.

Instructional Materials: Circuit board containing different types of capacitors, samples of capacitors and chalkboard illustrations.

Instructional Method: Collaboration

Entry Behaviour: The students have done electronic components in their previous lesson.

Instructional Procedure

Step	Content/Task Development	Teacher's Activity	Student's Activity	Performance Assessment
1.	Identification of Prior knowledge.	The teacher asks the students the following questions: Have you seen a capacitor. What is a capacitor.	The students listen, think on the prior knowledge and answer the question.	Critical thinking
2.	Identification and definition of capacitors	The teacher shares the students into simple groups (not more than seven in a group considering their abilities and gender) and appoints a group head. The teacher distributes samples of capacitors to the students and asks them to identify the samples. After some time, the teacher asks the students the following questions: what is the function of a capacitor. Draw a symbol of a capacitor	The students listen to the teacher, study the components carefully, interact with one another, exchange ideas, and answer the questions.	Group work, Authentic learning
3.	Types of capacitors	The teacher distributes circuit board containing different capacitors and asks each group to identify types of capacitor from the circuit board.	The students listen, study the circuit board carefully, exchange ideas and identify types of capacitors	Group work, Authentic learning
4.	Capacitance and working voltage	The teacher asks the students to examine the body of the capacitors and note the values printed on body of the capacitors. After sometimes the teacher asks the students to state what those values represents as the teacher walks round the groups	The students listen, examine the capacitors critically as a group to note the values, ask questions for clarification and answer the questions	Critical thinking, Oral discussion

5.	Factors affecting capacitance of a capacitors	The teacher draws the constructional details of a capacitor, ask the students to identify the parts of the capacitor as well as state how these parts affect the capacitance of a capacitor. The teacher gives the students clues to guide them in answering the questions	The students listen to the teacher, study the diagrams very well, interact in groups and individually as they make attempt to answer the question.	Group work Oral discussion Critical thinking
6.	Calculation of capacitance of a capacitor	The teacher gives each group problems involving calculation of capacitance, asks each group to solve the problem. The teacher visits each groups giving them clues. After sometime, asks each group to present their answers.	The students interact and solve the problems as a group. Ask questions where necessary and present their answers as a group.	Oral discussion, Group work
	Summary	The teacher summaries the lesson by explaining the major points and asking the group head or a student from each group to explain what he/she understood from the lesson.	The students listens, interact, write down points and answer question as group member gives him/her clues.	Oral discussion
	Evaluation	The teacher asks questions based on the specific objectives	The students listen, interact and answer questions.	Oral discussion, Group work.
	Assignment	The teacher outlines the topic of the next lesson and give the students an assignment	The students listen ask questions and write down the assignment and he topic of the next lesson	Learning Framing

Lesson Plan Four

Week 4: Lesson 4

Subject: Basic Electricity

Class: NTC I1

Date:

Duration: 2 Periods (40 Minutes each)

Average Age: 15 years

Topic: Inductor

Specific Objectives: By the end of the lesson, the students should be able to do the following:

1. Identify an inductor
2. Another word used to represent an inductor is (A) Wire (B)Coil (C)Transformer (D)Conductor
3. An inductor stores energy in its (A) Electric field (B)Magnetic field (C) Cores (D)Wires
4. An inductor will block (A) Alternating Voltage (B) Direct Voltage (C) Alternating Current (D) Direct Current.
5. The following are types of inductor except (A)Ferrite-rod inductor (B)Iron-core inductor(C)Carbon-film inductor (D)Toroidal inductor
6. Mention the factors affecting the inductance of an inductor.

Instructional Materials: Samples of inductors and board illustration.

Instructional Method: Collaboration

Entry Behaviour: The students have seen circuit board containing electronic components in their previous lesson.

Instructional Procedure

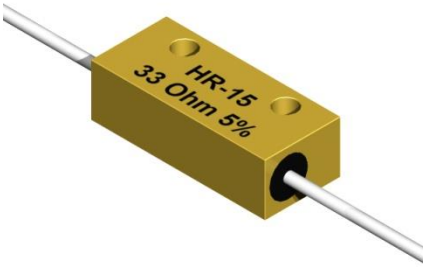
Step	Content/Task Development	Teacher's Activity	Student's Activity	Performance Assessment
1.	Identification of Prior Knowledge	The teacher asks the following questions: Have you seen an inductor. What is an inductor. What is the function of an inductor.	The students listen, think on the prior knowledge and answer the questions.	Critical thinking.
2.	Inductors: Identification and Definition	The teacher shares the students to small group (not more than seven considering their abilities and gender) and appoints a group head. The teacher distributes samples of inductor to the students, asks them to identify the sample. After some time the teacher asks the students the following questions. What is an inductor, what is another name for an inductor. Draw a symbol of an inductor.	The students exchange the components, interact with one another and answer the questions.	Authentic learning, Group work.
3.	Types and functions of an inductor	The teacher asks the groups to examine and compare the physical differences between the	The students move around, exchange and compare the samples of the inductors,	Group work, Critical thinking

		samples of inductors given to them. The teacher then asks the students to mention types of inductors and state the function of an inductor.	exchange ideas and answer the questions,	
4.	Inductance and Factors affecting inductance	The teacher asks the students to define inductance and state the factors affecting inductance considering the physical features of an inductor	The students critically view the inductor, interact as a group and answer the questions	Oral discussion, Critical thinking, group work
	Summary	The teacher summarizes the lesson by explaining the major points and asking the group head or one person from each group to explain what he/she understood from the lesson.	The students listen, asks questions, write down points on their note book	Oral discussion, critical thinking
	Evaluation	The teacher asks the students questions based on the specific objectives	The students listen, interacts, exchange ideas and answer the questions.	Critical thinking, Oral discussion, group work
	Assignment	The teacher outlines the topic of the next lesson and gives the students an assignment	The students ask questions and write down the assignments and the topic of the next lesson	Learning Framing

Appendix K

Instructional Material for the Treatment

Types of Resistor



Wired Wound Resistor

Metal Film Resistor

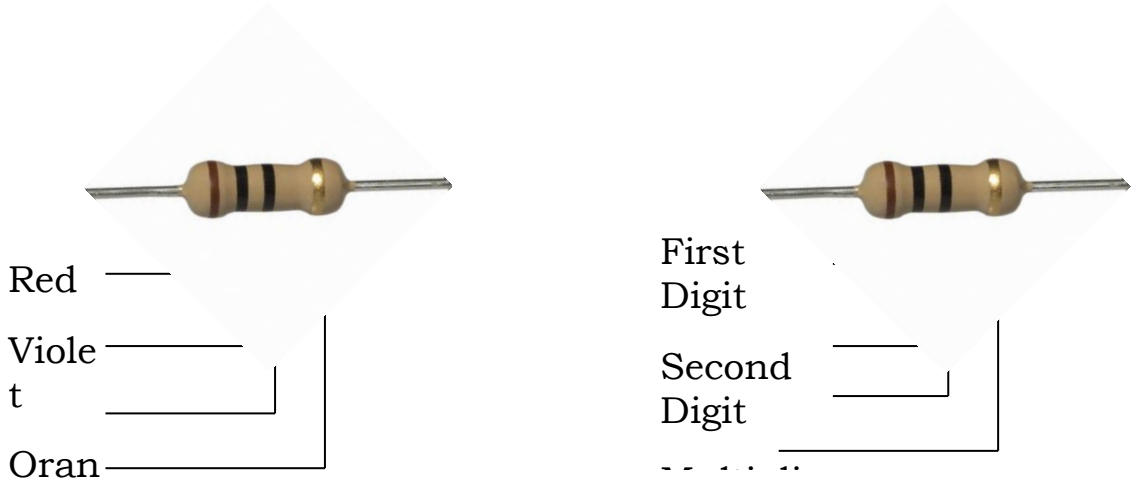
Trimmer Resistor

Potentiometer Resistor

Carbon Film Resistor

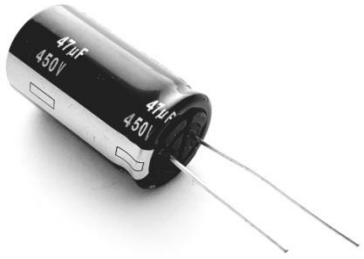
COLOUR CODE FOR RESISTANCE DESIGNATION (4 BAND SYSTEM)

Colour	Band I First Digit	Band II Second Digit	Multiplier	Tolerance
Black	0	0	X1	-
Brown	1	1	X10	$\pm$ 1%
Red	2	2	X100	$\pm$ 2%
Orange	3	3	X 1000	$\pm$ 3%
Yellow	4	4	X 10000	$-$ %
Green	5	5	X 100000	$\pm$ 0.5%
Blue	6	6	X1000,000	$\pm$ 0.25%
Violet	7	7	X10000000	$\pm$ 0.1%
Grey	8	8	-	-
White	9	9	-	-
Gold	-	-	X 0.1	$\pm$ 5%
Silver	-	-	X 0.01	$\pm$ 10%
Blank	-	-	-	$\pm$ 20%



$$27 \times 1000 = 27{,}000\ \Omega + 5\%$$

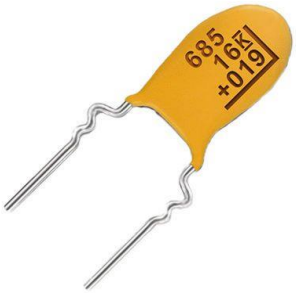
Types of Capacitors



Radial Electrolytic Capacitor

Axial Electrolytic Capacitor

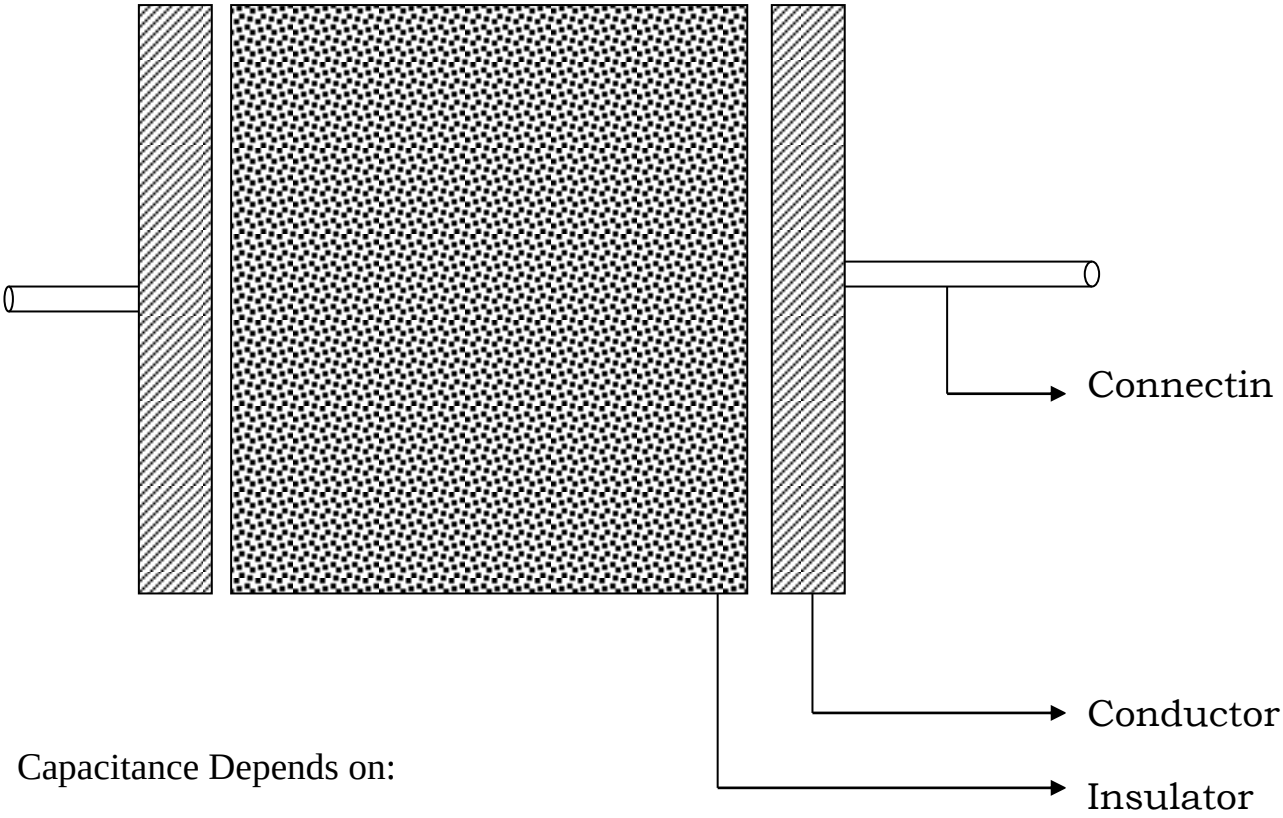
Mica Capacitor



Tantalum Electrolytic Capacitor

Tantalum Capacitors

CONSTRUCTIONAL FEATURES OF A CAPACITOR

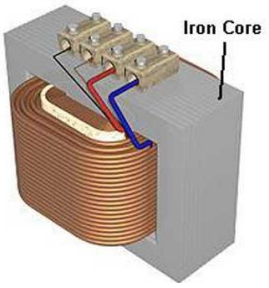


Capacitance Depends on:

1. The Area of the Plate (A)
2. The Spacing Between the Plates (d)
3. The Nature of the Dieletric

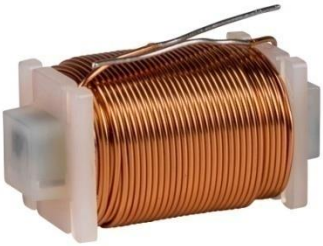
Types of Inductor

Air Core Inductor



Iron Core Inductors

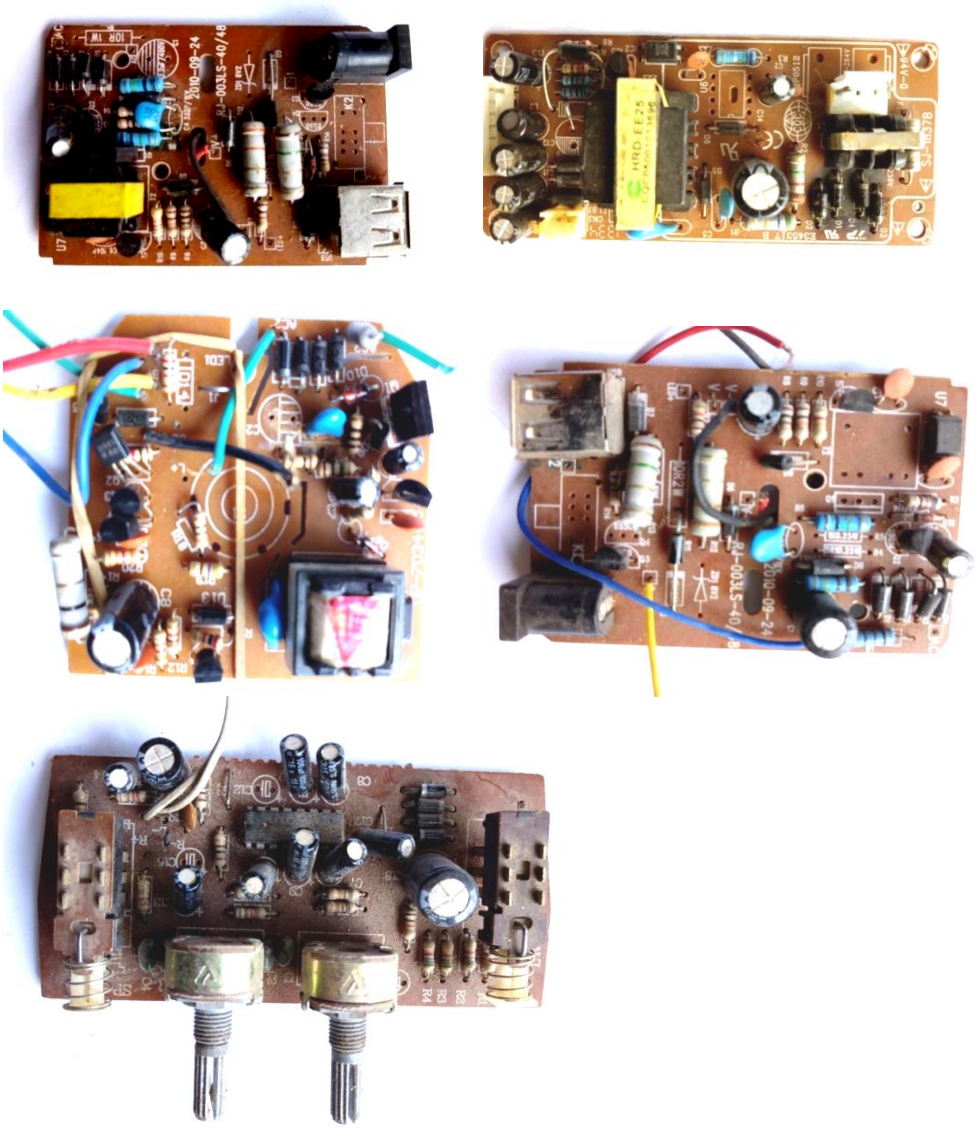
Ferrite Core Inductor



Laminated Core Inductor

Toroidal Inductor

CIRCUIT BOARD SHOWING RESISTOR, CAPACITORS AND INDUCTORS



Appendix L

Performance Scores for the Experimental Groups.

Score Sheet for Meta-learning Teaching Methods at Government Technical College Umunze

	Male			Female		
S/N	Pre Test	Post Test	Delay Post Test	Pre Test	Post Test	Delay Post Test
1.	33	73	73	28	75	75
2.	45	75	85	35	88	90
3.	25	65	73	43	90	90
4.	30	70	75	33	80	85
5.	45	75	80	20	63	70
6.	35	80	80	15	83	85
7.	40	90	96	23	70	75
8.	30	75	75			
9.	30	80	80			
10.	25	73	78			
11.	35	85	96			
12.	33	80	88			
13.	38	90	90			
14.	23	75	78			
15.	20	78	80			
16.	35	90	95			

Score Sheet for Meta-learning Teaching Method at Government Technical College Nnewi.

S/N	Male			Female		
	Pre-Test	Post-Test	Delay Post Test	Pre-Test	Post-Test	Delay Post-Test
1.	30	75	83	25	65	75
2.	40	75	75	35	70	73
3.	20	73	80	30	78	83
4.	23	68	75	43	90	90
5.	25	75	83	38	78	83
6.	38	85	85	40	80	90
7.	28	80	85	38	65	70
8.	28	58	73	35	65	73
9.	40	70	78	28	65	73
10.	48	75	75			
11.	30	68	75			
12.	25	80	80			
13.	45	85	88			
14.	25	68	78			
15.	23	70	75			
16.	30	50	70			
17.	33	75	80			
18.	43	80	83			
19.	40	80	85			

Score Sheet for Constructivist Teaching Method at Government Technical College Umuchu

	Male			Female		
S/N	**Pre-Test**	**Post-Test**	**Delay Post-Test**	**Pre-Test**	**Post-Test**	**Delay Post-Test**
1.	25	70	75	28	78	85
2.	23	65	70	25	75	80
3.	28	78	83	28	80	80
4.	20	78	96	25	70	75
5.	35	85	90	35	83	85
6.	15	70	73	18	70	78
7.	30	78	75	20	83	85
8.	25	80	78			
9.	23	80	83			
10.	18	73	80			
11.	20	78	88			
12.	33	85	90			
13.	25	88	93			
14.	20	75	75			
15.	23	75	80			
16.	25	75	80			
17.	23	73	90			
18.	20	75	80			
19.	33	85	96			
20.	38	93	98			
21.	23	80	85			
22.	33	90	90			
23.	28	85	98			
24.	30	80	88			
25.	28	78	85			
26.	30	88	90			

Score Sheet for Constructivist Teaching Method At Government Technical College Utuh

S/N	Male			Female		
	Pre-Test	**Post-Test**	**Delay Post-Test**	**Pre-Test**	**Post-Test**	**Delay Post-Test**
1.	23	75	78	20	68	75
2.	15	70	73	13	65	80
3.	30	78	85	18	75	83
4.	20	80	85	25	78	83
5.	25	80	90	23	80	85
6.	33	75	80	20	68	75
7.	13	70	78			
8.	28	75	80			
9.	30	83	90			
10.	25	73	96			
11.	18	78	85			
12.	15	75	80			
13.	23	75	85			
14.	20	80	90			
15.	15	73	80			
16.	28	88	96			
17.	15	78	88			
18.	20	73	83			

APPENDIX M
SPSS Analysis Output

PRETEST POSTTEST DELAYED POSTMPRE * METHODS OF TEACHING

Methods of Teaching		Pretest	Posttest	Delayed	Postmpre
CONSTRUCTIVIST TEACHING	Mean	24.0000	77.5614	76.9474	53.5614
	N	57	57	57	57
	Std. Deviation	6.00892	6.43933	5.53373	5.28481
	Std. Error of Mean	.79590	.85291	.73296	.69999
	Skewness	.174	.482	.207	.099
META TEACHING	Mean	32.2549	75.4706	74.9804	43.2157
	N	51	51	51	51
	Std. Deviation	7.84307	8.64952	9.06309	9.11332
	Std. Error of Mean	1.09825	1.21117	1.26909	1.27612
	Skewness	.023	-.336	-.252	-.193
Total	Mean	27.8981	76.5741	76.0185	48.6759
	N	108	108	108	108
	Std. Deviation	8.04885	7.60005	7.44196	8.96392
	Std. Error of Mean	.77450	.73132	.71610	.86255
	Skewness	.365	-.195	-.350	-.700

Group Statistics

Methods Of Teaching		Gender Of Subjects	N	Mean	Std. Deviation	Std. Error Mean
CONSTRUCTIVIST TEACHING	PRETEST	MALE	44	24.3182	6.13709	.92520
		FEMALE	13	22.9231	5.64892	1.56673
	POSTTEST	MALE	44	78.2500	6.25477	.94294
		FEMALE	13	75.2308	6.75961	1.87478
	DELAYED	MALE	44	77.4091	5.72761	.86347
		FEMALE	13	75.3846	4.68221	1.29861
META TEACHING	PRETEST	MALE	35	32.4571	7.79647	1.31784
		FEMALE	16	31.8125	8.18306	2.04577
	POSTTEST	MALE	35	75.5429	8.39588	1.41916
		FEMALE	16	75.3125	9.46375	2.36594
	DELAYED	MALE	35	75.0571	9.22893	1.55997
		FEMALE	16	74.8125	8.98309	2.24577

a. t cannot be computed because at least one of the groups is empty.

Tests of Between-Subjects Effects

Dependent Variable: POSTTEST

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1623.240[a]	4	405.810	9.172	.000
Intercept	22811.771	1	22811.771	515.586	.000
PRETEST	1413.514	1	1413.514	31.948	.000
GENDER	24.651	1	24.651	.557	.457
METHODS	544.118	1	544.118	12.298	.001
GENDER * METHODS	30.002	1	30.002	.678	.412
Error	4557.167	103	44.244		
Total	639448.000	108			
Corrected Total	6180.407	107			

a. R Squared = .263 (Adjusted R Squared = .234)

Tests of Between-Subjects Effects

Dependent Variable: DELAYED

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1298.482[a]	4	324.621	7.226	.000
Intercept	23568.305	1	23568.305	524.591	.000
PRETEST	1152.556	1	1152.556	25.654	.000
GENDER	8.782	1	8.782	.195	.659
METHODS	491.722	1	491.722	10.945	.001
GENDER * METHODS	10.598	1	10.598	.236	.628
Error	4627.481	103	44.927		
Total	630038.000	108			
Corrected Total	5925.963	107			

a. R Squared = .219 (Adjusted R Squared = .189)

Tests of Between-Subjects Effects

Dependent Variable: POSTTEST

METHODS OF TEACHING	Source	Type III Sum of Squares	df	Mean Square	F	Sig.
CONSTRUCTIVIST TEACHING	Corrected Model	998.547[a]	2	499.273	20.371	.000
	Intercept	12195.783	1	12195.783	497.603	.000
	PRETEST	907.070	1	907.070	37.010	.000
	GENDER	43.008	1	43.008	1.755	.191
	Error	1323.488	54	24.509		
	Total	345221.000	57			
	Corrected Total	2322.035	56			
META TEACHING	Corrected Model	576.779[b]	2	288.389	4.375	.018
	Intercept	10538.092	1	10538.092	159.874	.000
	PRETEST	576.196	1	576.196	8.741	.005
	GENDER	.026	1	.026	.000	.984
	Error	3163.927	48	65.915		
	Total	294227.000	51			
	Corrected Total	3740.706	50			

a. R Squared = .430 (Adjusted R Squared = .409)

b. R Squared = .154 (Adjusted R Squared = .119)