

## **CHAPTER ONE**

### **INTRODUCTION**

#### **Background to the Study**

Globally, educational systems are under great pressure. It needs to adopt innovative methodologies and to integrate New Information and Communication Technologies (NICTs) in the teaching and learning process. So as to prepare students with the knowledge and skills needed in this 21<sup>st</sup> century (Kaint, 2009). Visual projection method of instruction is essential for teaching and learning of practical electronics works in this 21<sup>st</sup> century. This visual projection method of instruction for teaching and learning of practical electronics works in a new innovation.

Practical electronics works (PEW) is one of the course areas in Vocational Technical Education and Training (VTET). The course is offered at the senior levels National technical certificate I –III (NTC I - III) in technical colleges in Nigerian education system. The course has both the potential for sustainable technological and economic growth of any country that has made serious efforts in planning, delivering and enhancing learners' potentials in the course (Federal Republic of Nigeria (FRN), 2013). Okoye and Achigbo (2010) observed that practical electronics works is one of the subjects considered very vital in achieving global economic goals. According to them, the subject has both the potential for sustainable technological growth and inherent advantage to other engineering and technological areas. This demands that practical electronics works study should be handled with care, renewed commitment and increased resources. Johassen (2008) stressed that

practical electronics works as a course of study, is the skill and knowledge needed by all citizens to thrive and survive in a society that is dependent on technology for handling information and solving complex problems.

Despite the numerous benefits accruable through the course, the National Business and Technical Examination Board (NABTEB) Chief Examiner's annual report shows that the trend in students' achievements in practical electronics works is not encouraging when compared with other related options in vocational and technical education courses. For example, out of 1752 students enrolled in practical electronics works for the period of 2004-2013 (10 years), 619 or 38.4 percent of the students obtained the required grade that can offer them admission into higher institution while 1133 students or 61.6 percent failed the examination and as such can not secure admission into higher institution. This shows that fewer than expected number of students passed the course in the National Business and Technical Examination Board (NABTEB) and internal examination in practical electronics works (see, Appendix A, p.131). The question now is; are instructional methods used for teaching the students responsible for this low level of achievement in practical electronics works?

Indeed, incidences of students' poor achievement in NABTEB examinations over the past decade, between 2004 and 2013 have continued to be a source of concern to practical electronics works teachers and managers of education in Nigeria. Further to poor achievement in practical electronics works examination, according to NABTEB Chief Examiner annual report (see, Appendix B, p.132), enrolment record also indicates that enrolment trend fall below 1.6 percent annual growth rate. The enrolment trend in practical electronics works as against other areas of technical education field (options)

is not satisfactory (see, Appendix B, p.132). Aina (2010) opined that the reason for failure of students in science and technology courses in Nigeria stem from the culture and attitudes of teachers and students. For instance, Aina stated, that science requires students' participation and independency in learning, that in teaching science, the child should be viewed as an active learner and not a passive one because children learn best by doing. Further, Aina expressed that this practice to Nigerian child, is yet to come, because much emphasis is placed on certificates, which ought not be but rather consider the different learners' ability in the class.

New Information and Communication Technologies (NICTs) integration is understood as the usage of technology seamlessly for educational process like transacting curricular content, students working on technology to perform authentic tasks and developing technology supported products. Howstuff (2008) saw visual projection method of instruction (one of the new innovative technology) as the use of teaching materials and techniques that do not depend mainly upon the printed words to convey meaning. It is also called instructional media and works through sight and sound. Examples of such materials include still and motion pictures, videotapes, recordings, museum exhibit and multimedia computer software. One's ability to remember what one learns can increase vastly through a combination of seeing and hearing information.

When used, visual projection devices enable teachers to supplement their lesson with pictures that can be projected onto a screen. In practical electronics works study, those subject matters or topics considered difficult, visual projection method of instruction can be adopted to enhance effective

learning outcome and challenge students' innovative ideas expecting the most from their excellent achievements. For example, printed circuit board can be projected to the screen through carefully planned procedures and stages necessary for effective production and communication. Opaque projectors, overhead projectors, film strip, slide projectors and liquid crystal display projectors are most widely used projectors. With some audio-visual aids, such as screen and projectors, the instructor can reach large group with materials that could otherwise be visible to only a few persons at a time.

According to Schunk (2008), guided discovery method of instruction involves constructing and testing hypotheses rather than passively reading or listening to teacher presentation. Guided discovery is as problem based inquiry and inductive reasoning because students move from specific topic to formulate rules and principles. In guided discovery method of instruction which involves group of students with different abilities working together to achieve both group and individual goals, students work through assignments until all group members successfully understand and complete the assignments (Kirschner, Sweller & Clark, 2006).

According to Reid, Zhang and Chen (2003), research on discovery learning has moved from concept discovery learning toward authentic discovery learning, which is characterized by designing scientific experiment. In teaching practical electronics works, the authors suggested that guided discovery method of instruction should be adopted in order to encourage learners to develop abilities and skills needed in building self confidence that should challenge any future endeavour in the field of the learners' study.

According to Thomas (2008), the practical value of constant project in practical electronics works should be encouraged as project-based method of instruction which can also be termed project learning involves completing complex tasks that result in a realistic product or presentation to an audience. Although, Thomas found that students gain in factual learning could be equivalent or superior to those students in traditional classroom instruction. Beckett (2009) observed that project-based learning creates opportunities for students to exercise their academic listening, comprehension and note taking skills. Beckett further stated that project-based learning allows students to take an integrated approach to language, content and skills teaching. Petersen (2008) found that project-based learning creates opportunities for students to practice listening, speaking, reading and writing skills which enables them to see their classroom learning needs.

Teaching is becoming one of the most challenging professions in Nigeria where knowledge is expanding rapidly and much of it is available to students as well as teachers at the same time. Hence, there is need to examine different methods of instruction for purpose of determining the most effective method that would enhance students' achievement in practical electronics works in technical colleges.

Student's achievement has become a hot topic in education today, especially with increased accountability for classroom teachers. The ultimate goal for any teacher is to improve the ability level and prepare students for adulthood/higher knowledge. Defining students achievements and factors that impact progress is critical to becoming a successful teacher (Darling-Hammond, 2006).

According to Tienken and Wilson (2009), student's achievement measures the amount of academic contents a students learns in a determined amount of time. Each grade level has learning goals or instructional standard that educators are required to teach. Standards are similar to a "to do list" that you can use to guide your instruction. Students achievements will increase when quality instruction is used to teach instructional standard. For instance, you have a "to do list" that involves three tasks: dropping off cleaning, filling your gas tank and studying for a final result. Questions you may ask yourself are: in what order do I accomplish my task? How am I going to get each task finished? Should I study at the library where it is quieter or at home where I may be distracted? Is it worth it to purchase gas a few block from home at higher price or drive a short distance to save money? Your goal is to get your "to-do-list" finished in the most efficient and timely way possible.

Furthermore, Tienken and Wilson have it that, when teaching, you must use the same process when addressing instructional standards. Questions you should ask to successfully complete your "to-do-list" or learning standards in a timely and efficient way include: what type of students do I have? How am I going to teach the standard? Will they understand the vocabularies? How long do I think it will take for student to fully learn the materials? The researchers concluded thus, successful instruction of standards result in student achievement. However, knowing the "what and the how" is just the first step to successful student achievement as well understanding the factors that can impact a student ability to learn is equally important. Therefore, practical electronics works instructors should always consider the above mentioned requirements when instructing/teaching their students.

### **Statement of the Problem**

The expectation that students who go through technical education as a course of study are exposed to practical skills, right work attitude and knowledge in various areas in the study. It is then worrisome that students who offer practical electronics works as a course of study still find themselves among the unemployed whereas students who go through technical education programme should be employed or create employment at the end of their training.

Despite the observation recorded by Okoye and Achigbo (2010) that practical electronics works is very vital in achieving the global economic goals and sustainable technological growth. Evidence from NABTEB Chief Examiner report (2004 – 2013) has it that students' that offer practical electronics works in technical colleges achieve poorly in both internal and external examinations which is to a great disadvantage to any nation. An average of 61.6 percent of the candidate who registered and sat for the examination for the period in question failed to obtain the grade of A1 – C6 or such grade that would enable them secure position in the area of practical electronics works for further study.

Indeed, there is poor achievement in this relevant field of technical education. The poor achievement recorded could have been due to the instructional methods adopted by the instructors. It then becomes imperative to employ other methods of instruction in practical electronics works to arouse students' achievement. The problem of this study put as a question, is: What is the best instructional method for improving the achievement of students offering practical electronics works as a course of study in both external and internal examinations. Available literature indicated that, no research has been carried

out on the effects of selected instructional methods on students' achievement in practical electronics works in the area of study.

### **Purpose of the Study**

The purpose of this study was to determine the effects of selected instructional methods (visual projection, guided discovery and project-based instructional methods) on students' achievement in practical electronics works. Specifically, the study sought to:

- 1) Determine the mean achievement scores of NTC II students in practical electronics works before the application of the experimental treatment of visual projection, guided discovery and project-based methods of instruction.
- 2) Determine the mean achievement scores of NTC II students taught practical electronics works using visual projection, those taught using guided discovery and those taught using project-based methods of instruction respectively.
- 3) Determine which of these three methods of instruction (visual projection, guided discovery and project-based methods of instruction) yielded best students' achievement in practical electronics works.
- 4) Determine whether differences exist in the mean achievement scores of NTC II students taught practical electronics works using visual projection and those taught using guided discovery methods of instruction.
- 5) Determine whether differences exist in the mean achievement scores of NTC II students taught practical electronics works using visual projection and those taught using project-based method of instruction.



- 6) Determine whether differences exist in the mean achievement scores of NTC II students taught practical electronics works using guided discovery and those taught using project based methods of instruction.
- 7) To find out whether there is any difference in the mean achievement scores of NTC II students in the experimental groups and those in the control group.

### **Significance of the Study**

It is hoped that the findings from this research work when published would be of benefit to government, curriculum planners, education planners and ministries of education at various levels, science and technical education department, Managers of schools, practical electronics works instructors and students offering practical electronics works at various education levels.

The results from this study would be of benefit to the government in that it will ignite the government into providing adequate fund for the purchase of suitable instructional materials for teaching and learning practical electronics works and also making sure through the inspectors/supervisors that the instructors make proper use of the provided materials. The government will further see the need in organizing regular refresher courses and trainings of instructors in the area of practical electronics works for affective and efficient use and implementation of instructional materials in technical colleges.

The finding of the study would enable curriculum and education planners plan quality curriculum and other activities that will focus on whole child adoption of the learning environment in the area of practical electronics works. This can be done by ensuring that the content in the course of study in practical

electronics works suits students environment and expectations while evolving the teacher in the planning and implementation of curriculum exercises.

The finding of this study would enable ministry of education and departments of science and technical education at various levels to develop suitable and acceptable policies for effective teaching and learning of practical electronics works in technical colleges. The study will also reveal to them the importance of organizing regular refresher courses and workshops that will help improve instructors' professional knowledge and skill leading to quality teaching, learning and assessment technique that will enhance achievement of students in practical electronics works.

The finding of this study would hopefully make practical electronics works instructors and managers of schools to be aware of the suitable instructional methods/materials to be adopted in the teaching and learning practical electronics works in a particular area/unit of study.

The finding of this study would likely motivate, improve and attract students keen participation, thereby leading to an improved achievement of students in practical electronics works in technical colleges. This is because suitable instructional methods that are practically oriented are used by the instructors in teaching and learning practical electronics works.

### **Scope of the Study**

The study was delimited to three methods of instruction via visual projection, guided discovery and project-based methods of instruction, and used NTC II students of technical colleges (Government Technical College, Onitsha, Government Technical College, Nnewi, Government Technical College, Umunze, and Government Technical College, Nkpor) all in Anambra State offering practical electronics works. The NTC III and NTC I students were not included in the study because the NTC III students were preparing for their final examination while NTC I students were fresh in the course of study in practical electronics works.

The three methods of instructions were separately adopted to teach the techniques for troubleshooting, common fault in various stages in television receiver and instruments used for troubleshooting. The study did not extend to troubleshooting (fault finding) in measuring devices, transmission line propagation, aerial and component testing in television receiver.

### **Research Questions**

The following research questions guided the study:

1. What are the mean achievement scores of NTC II students taught practical electronics works before the application of the experimental treatments of visual projection, guided discovery and project based methods of instruction?
2. What are the mean achievement scores of NTC II students taught practical electronics works using visual projection, guided discovery and project based methods of instruction respectively?

3. Which of these three methods of instruction (visual projection, guided discovery and project-based methods of instruction) yielded best students' achievement in practical electronics works?
4. What is the difference in the mean achievement scores of NTC II students taught practical electronics works using visual projection and those taught using guided discovery methods of instruction?
5. What is the difference in the mean achievement scores of NTC II students taught practical electronics works using visual projection and those taught using project based methods of instruction?
6. What is the difference in the mean achievement scores of NTC II students taught practical electronics works using guided discovery and those taught using project based methods of instruction?
7. What is the difference in the mean achievement scores of NTC II students in the experimental groups and those in control group?

### **Hypotheses**

The following null hypotheses were tested at 0.05 Level of significance.

- 1) NTC II students taught practical electronics works using visual projection method do not differ significantly in their mean achievement score from those taught using guided discovery method of instruction.
- 2) NTC II students taught practical electronics works using visual projection method do not differ significantly in their mean achievement score from those taught using project-based method of instruction.
- 3) NTC II students taught practical electronics works using guided discovery method do not differ significantly in their mean achievement score from those taught using project-based method of instruction.

- 4) NTC II students taught practical electronics works using visual projection method do not differ significantly in their mean achievement scores from those taught using guided discovery method and those taught using project-based method of instruction.

## **CHAPTER TWO**

### **REVIEW OF RELATED LITERATURE**

In this chapter, review of literature related to the effects of visual projection, guided discovery and project-based method of instruction on students' achievement in practical electronics works are presented under the following sub-headings:

#### **Conceptual Framework of Technical Practical Science**

Practical Electronics Works

Visual projection Method of Instruction

Guided Discovery Method of Instruction

Project Based Method of Instruction

Students Achievements

#### **Theoretical Framework**

Theories Based on Cognitive Multi-Media Learning

Theories Based on Constructivist Learning

Theories Based on Piagetian Learning

#### **Theoretical Study**

Problems of Teaching and Learning Practical Electronics Works

Visual Projection Method of Instruction and its Effect on Students' Achievement

Guided discovery method of instruction and its effect on students' Achievement

Project based method of instruction and its effect on students' achievement

Instructional Methods and Students Achievement

### **Related Empirical Studies**

Visual projection method of instruction and achievement

Guided discovery method of instruction and achievement

Project-based method of instruction and achievement

### **Summary of Related Literature**

## **Conceptual Framework**

### **Practical Electronics Works**

Practical electronics works provides the world with an infinite amount of information at a much faster speed than the information would have ever been available with participation only. Practical electronics works as a course of study, is the skill and knowledge needed by all citizens to thrive and survive in a society that is dependent on technology for handling information and solving complex problems (Johassen, 2008).

Students and instructors would be at a striking disadvantage without the knowledge of practical electronics works in their educational life/information style. Leeham (2009) imagined the rate of difficulty an instructor will be subjected to without the use of electronics facilities and equipment (computers, slides, projectors, Television sets, signal tracer, signal generator, avometer, among others) for teaching practical electronics works. Leeham further emphasized that it is difficult to think of such as it would make life bored for teachers, students and the world generally.

The time when initial training was a guarantee for long life employability has passed, since we now face the challenge of developing and implementing

approaches to long life learning. In the context, practical electronics works strikes a balance between mass-scale impact, including a direct contribution to world technology and responding to as well as anticipating the labour needs of current and future markets of products and services (Hodson, 2009). Hodson, further argues that in many schools, practical electronics works is ill-conceived, confused and unproductive. For many children, what goes on in the workshop does not contribute to their learning of science or to their learning about science and its methods, nor does it engage them in learning science in any meaningful sense. The root of the problem is the unavailability of workshop materials/equipment in the college. These concerns have led to calls for more authentic and effective practical experience in practical electronics works or to re-think, re-evaluate and perhaps reduce the amount of practical work, to leave more room for other kind of learning activity.

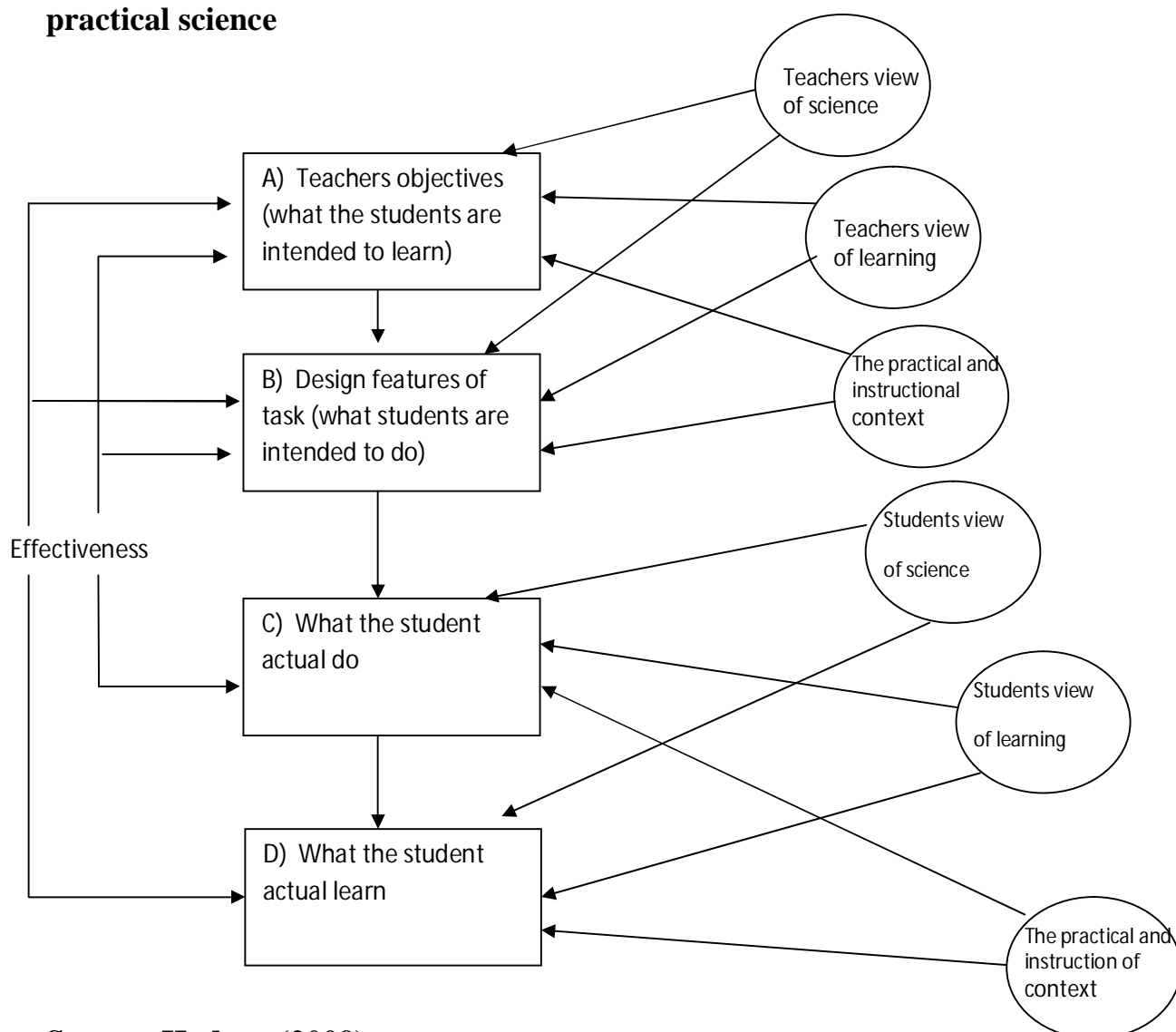
Some teachers who are aware of these Hodson discussions ask: is practical work effective? Is it a good way to teach science? In my view said Hodson, practical work is an essential, indeed inevitable aspect of teaching science because of the subject matter of science.



The diagram below shows a possible model of teaching science as designed by Hodson.

**Figure 1:**

**A model of the development of teaching and learning activities in practical science**



**Source: Hodson (2009)**

In view of this change, every society is in search of the best way to ensure quality and functional education for its citizen to be able to participate in the call for the global economic competition and change.

One reason why practical electronics works is vital to students is that it helps students function effectively in this technologically advancing world. With the above emphasis on practical electronics works, lots of efforts have to be channeled to meet up with the high demand on a functional education.

### **Visual Projection Method of Instruction**

Visual projection method of instruction may be referred to instructions with both sound and visual component of audio visual presentation which some of the examples are slide tape instruction, film and television programmes etc. In a typical presentation, the presenter provides the audio by speaking, and supplements it with a series of images projected onto a screen, either from a slide projector or from a computer connected to a projector using a presentation programme (Poe, 2011)

Audio visual materials designed for both seeing and hearing have many benefits that attract the attention and interest of the learner. They often provide the most direct way of conveying information for school children learning about faulty circuit using such audio visual materials as a circuit globe to find the faulty points, function procedures from readings, picture movements and still pictures. Howstuff (2008) opined that with some audio visual aids, such as chalk board and projectors, the instructor can show large group materials that could otherwise be shown to only few persons at a time. Video presentations, computer systems, and telecommunications equipment are the primary multisensory aids.

Visual projection method of instruction has been used in teaching students to enhance achievement for some time and is generally thought to have positive effect on learning. For example, some researchers concluded that through the use of visual learning method of instruction, students understand the teaching by reflecting on assignment and their alignment of standard with artifacts engage in the process of self assessment, design professional growth plans, and participate in final evaluation of their learning outcome (Campbell, Cignitti, Melenyzer, Nettles & Wyman, 2001).

When we see visual images, whether we are conscious of them or not, they instantaneously shape our perceptions of reality, our internal sense of what is true and real. Images also simultaneously create unconscious memories that reside in the prefrontal lobes of the brain. The memories represent our essential truths against which other information is weighed in the cognitive processes that facilitate complex creative problem solving and advantageous decision making. 75 percent of all information processed by the brain is derived from visual formats. The cognitive modes that support the most complex problem solving, decision-making and determine behaviour are primarily intuitive on our conscious visual memories to make advantageous decisions and guided behaviour (Lavine, 2003).

### **Guided Discovery Method of Instruction**

Guided discovery learning method can be defined as a type of learning where learners construct their own knowledge by experimenting with a domain, and inferring rules from the results of these experiment. The basic idea of this kind of learning is that learners can design their own experiments in the domain and infer the rules of the domain themselves by actually constructing

their own knowledge. Because of these constructive activities, it is assumed they will understand the domain at a higher level than when the necessary information is just presented by a teacher or an expository learning environment. Guided discovery learning also exposes the participants to learn how to recognize problems, characterized what solutions, search for relevant information, develop a solution strategy, and execute the chosen strategy. In collaborative discovery learning, participants immersed a community of practice, solve problems together etc. Guided discovery learning is strongly tilted to problem solving or learning how to solve problems under a more meta-cognitive perspective (Borthick & Jones, 2008, Mayer, 2014).

In research on scientific guided discovery learning, it has been found that in order for discovery of learning to be successful, learners need to possess a number of discovery skills (Jong & Joolingen, 2012). Lack of these skills can result in ineffective discovery behaviour; like designing inconclusive experiment, confirmation bias and drawing incorrect conclusions from data. In other words, ineffective discovery behaviour does not contribute to creating new knowledge in the mind of learner. Therefore, one must try to support discovery learning processes, despite the risk of the disrupting the very nature process that should engage the learner in autonomous knowledge construction. Students discover knowledge without guidance, developing their own understanding whereby the role of instruction is merely to provide a suitable environment, which in software might be a micro-world stimulation. Discovery learning or instruction less learning, involves hypothesis and testing (Goodyear, Njoo, Hijne & Berkum, 2006).

Guided discovery is characterized by convergent thinking in such a way that the instructor devises a series of statements or questions that guide the learner step by logical step, making a series of discoveries that lead to a single predetermined goal. In other words, the instructor initiates a stimulus and learner reacts by engaging in active inquiry where by discovering the appropriate response. The instructor also points out certain drawbacks of this teaching method that precisely controls and manipulates learning behaviour that could therefore be abused and designed for individual rather than group use (Leuthner, 2009).

### **Role of teachers in Constructivist Classroom (Jonassen, 2006)**

- To prompt and facilitate discussion, the teacher's main focus should be on guiding students by asking questions that will lead them to develop their own conclusions on the subject.

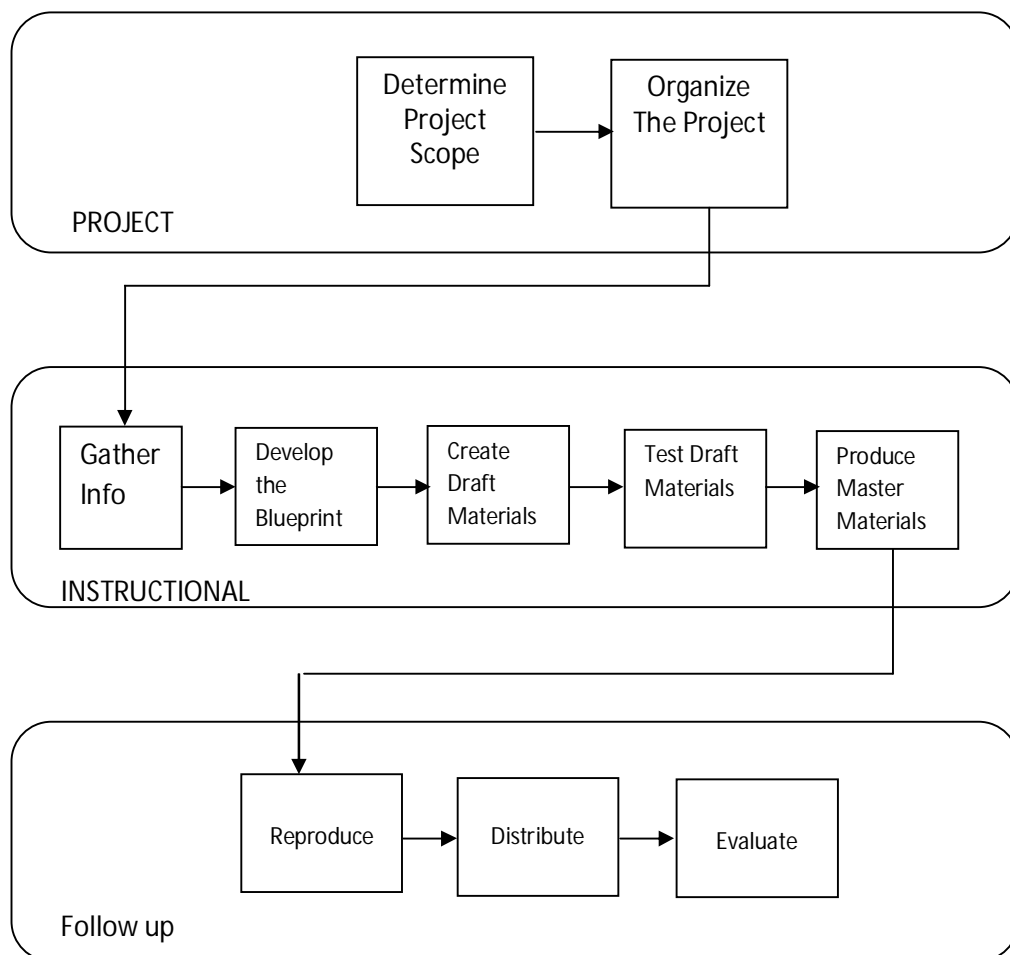
### **Project-Based Method of Instruction**

The project-based method of instruction is an educational enterprise in which students solve a practical problem over a period of several days or weeks. The project-based may involve building, designing or publishing which may be suggested by the teacher, planned and executed as far as possible by the students themselves, either individually or groups. Project work focuses on applying not imparting specific knowledge or skill but on improving students involvement and motivation in order to foster independent thinking, self confidence and social responsibility. Helm & Kaiz (2001) have it that project-based instruction teaches students' 21<sup>st</sup> century skills as well as content. These skills include communication and presentation skills, organization and time management skills, research and inquiry skills, self assessment and reflection

skills, and group participation and leadership skills. Project-based learning allows students to reflect upon their own ideas and opinions, exercise voice and choice also make decisions that affect project outcomes and the learning process in general.

**Figure 2:**

**Greer's Model for project-based instruction**



**Source: Greer (2002)**

The fact that learning to explain ideas in science as well as to evaluate arguments based on scientific evidence were given less emphasis at all levels, suggest that students may be learning science without actually understanding it. It will also mean that science teachers are relying on instructional methods or strategies that are ineffective for promoting understanding of science. Lack of understanding of science is not only a problem for students but also a problem for most people in the large society (National Science Board, 2002). Project-based learning is a dynamic approach to teaching in which students explore real world problems and challenges. With this type of active and engage learning, students are inspired to obtain a deeper knowledge of the subject they are studying.

Project-based learning is an instructional method centered on the learner which does not allow using a rigid lesson plan that directs a learner down a specific path of learning outcomes or objectives but allows in depth investigation of a topic worth learning more about. Through the construction of a personally meaningful artifact, which may be displayed as a multimedia presentation or a poem through which learners represent what they have learnt? In addition, learners typically have more autonomy over what they learn, maintaining interest and motivating learners to take more responsibility for their learning. With more autonomy, learners “shape their project to fit their own interests and abilities”. So, project-based learning and the construction of artifacts enable the expression of diversity in learners, such as interests, abilities and learning styles (Blumenfeld, Marx, Patrick, Krajcik, & Soloway, 2007).

**Benefit of project-based method of instruction** (Vithal, Christiansen & Skovsmose, 2006).

Project-based method of instruction is exploratory in nature because what students learn during their project work cannot always be anticipated in advance.

- i. It provides opportunities for intrinsically motivating students to learn.
- ii. It fosters problem solving.
- iii. It develops independent and cooperative working skills.
- iv. Also allows students to develop critical thinking and decision making skills and engage in in-depth learning of subject matter.

Project-based method of instruction provides opportunities for the students to develop accuracy and fluency through the communicative skills within the framework of the project.

### **Students Achievement**

The students achievement plays an important role in producing the best quality graduates who will become great leaders and manpower for the country thus responsible for the country's economic and social development (Ali, Kamaruzaman, Mokhtar & Salamt, 2009). Students' academic achievement measurement has received considerable attention in previous research, it is challenging aspects of academic literature that science students achievements are affected due to social, psychological, economic, environment, teaching methods and personal factors. These factors strongly



influence on the students achievement but these factors vary from person to person and country to country (Cheesman, Jennifer, Sampson & Wint, 2006).

### **Factors that Impact Students Achievement**

There are many variables that can impact successful students achievement but the most critical are class room instruction and learning disabilities. It is important to remember that all students do not learn the same way or the same rate. Students are like leaves on a tree; there are no two exactly the same. Just as a leaf comes in unique colours, shapes and sizes, each student has there own unique learning style. You must use a variety of teaching methods and understand the background and individual needs of each students (Huitt & Segars, 2010).

According to Tienken and Wilson (2009), classroom instruction is the most important factor that impact students achievement. As a teacher you influence the quality of instruction, set expectations for learning and measure the level of understanding. For example, when a standard is not presented in a way that a students can understand or in a way that is boiling it can be difficult for a student to meet the required level of achievements.

The above researchers further express that a good teacher will use strategies as discussion among students, videos or stories to gain students' attention and support the learning processes. The teacher should constantly be thinking of ways to make learning fun and appropriate. For example, in looking at our "to-do-list" you may prepare for your cleaning to get a discount or join a friend to make the study section more interesting. Likewise, students'

achievement involve well thought out strategies to improve the quality of learning.

A learning disability is a condition that causes a student to learn at a slower pace than students of the same age or grade level. A learning disability can make understanding of some standards more difficult but it does not mean a student with this condition can not achieve academically. It is important to remember that when it comes to students achievements all students can learn (Hijaza & Naqvi, 2006).

### **Theoretical Framework**

Theoretical framework will be discussed under the following sub-headings

Theories Based on Cognitive Multi-Media Learning

Theories Based on Constructivist Learning

Theories Based on Piagetian Learning

### **Theories based on cognitive Multi-Media learning**

According to cognitive neuroscientist, anytime we solve a complex problem, all of the information acquired such as perceptual, intellectual, conscious and non-conscious are synthesized with unconscious memory in the prefrontal lobes of the brain on initiative and non-conscious levels of cognition. Here, bases are formed that drive decision making and generate behaviour in which problems are solved, the decisions made and the behaviour activated 7-10 seconds or longer before the conscious mind even becomes aware of the activity, if it ever done. These findings suggest that

visual communication is the primary support system that drives the most significant cognitive mode for solving complex problems and motivating advantageous behaviour toward human success and sustainability. Because these processes are non-conscious, this finding also suggests that we are the consciously motivated beings that we believe ourselves to be (Damasio, 2012).

Cognitive theory of multimedia learning is known as the multimedia principle states that people learn more deeply from words and pictures than from words alone (Mayer 2001). However, simply adding words to pictures is not an effective way to achieve multimedia learning. The goal of this instructional media is in the light of how human mind works which is the basis for Mayer's cognitive theory of multimedia learning. This theory processes three main assumptions when it comes to learning with multimedia thus:

- 1) There are two separate channels (auditory and visual) for processing information, sometimes referred to as dual-coding theory.
- 2) Each channel has a limited (finite) capacity (similar to Sweller's notion of cognitive load).
- 3) Learning is an active process of filtering, selecting, organizing, and integrating information based upon prior knowledge.

Human can only process a finite amount of information in a channel at a time, and they make sense of incoming information by actively creating mental representations. Mayer (2001) also discusses the role of three memory stores: sensory (which receives stimuli and stores it for a very short time), working (where we actively process information to create mental constructs (or working)), and repository (the repository of all things learned for a long time).

Mayer's cognitive theory of multimedia learning present the idea that the brain does not interpret a multimedia presentation of words, pictures and auditory information in a mutually exclusive fashion; rather these elements are selected and organized dynamically to produce logical mental constructs.

### **Theories based on Constructivist Learning**

Constructivist methods of instruction are based on constructivist learning theory. Alfieri, Brooks and Naomi (2009) along with John Dewey, Jean Piaget research on childhood development on education came out that childhood education must engaged with large experience and exploration of thinking and reflection associated with the role of education. Piaget role in constructivist teaching according to Alfieri, Brooks and Naomi (2009) suggests that we learn by expanding our knowledge from experiences which are generated through play from infancy to adulthood necessary for learning. Their theories are now encompassing in the broader movement of progressive education. Constructivist learning theory says that all knowledge is constructed from a base of prior knowledge. Children are not a blank slate and knowledge can not be imparted without the child making sense of it according to his or her current conceptions. Therefore, children learn best when they are allowed to construct a personal understanding based on experiencing things and reflecting on those experiences (Gray, 2012).

### **Theories based on Piagetian Learning**

Project-based learning has a long history as far back as the early 1900s when John Dewey supported "learning by doing". This sentiment is also reflected in constructivism and constructionism. Constructivism ( Marriott, 2008, Smith, 2002, Shayer, 2005) explain that individuals construct knowledge through

interactions with their environment, and each individual's knowledge construction is different. So, through conducting investigations, conversation or activities, an individual is learning by constructing new knowledge built on their current knowledge. The theoretical framework for this study has four basic aspects including: perceiving, recognizing, conceiving, and reasoning as distinguished from an experience of feeling or of willing and the external work place (Flavell, Miller, & Miller, 2010).

Two key Piagetian principles are that learning is an active process and that learning should be real. In reference to the first principle, it is important for information to be presented as a tool to solve problems. In reference to second principle, it is important for information to be associated with real activities that have meaning for the learner (Chen, 2012).

Another important element to constructionism is that the artifacts must be personally meaningful, where individuals are most likely to become engaged in learning. By focusing on the individual learners, project-based learning strives for considerable individualization of curriculum, instruction and assessment, in other words, the project is learners-centered" (Marriott , 2008).

### **Theoretical Studies**

The theoretical studies are discussed under the following sub-headings:

Problems of Teaching and Learning Practical Electronics Works

Visual projection method of instruction and its effect on students' achievement

Guided discovery method of instruction and its effect on students' achievement

Project-based method of instruction and its effect on students' achievement

### **Problems of Teaching and Learning Practical Electronics Works**

This will be discussed under the following subheadings::

- Problem of global technological change on education.
- Problem of curriculum
- Student related problems
- Instructors related problems
- Related problems on Teaching Technique

### **Problem of Global Technological Change on Education**

In any level of educational system, education must work on a system complying to the changing environment/innovation. The lack of balance in technological change and system of education reflect primarily on teaching and learning, particularly in practical electronics works. Lukatela (2005) stated the problem of new technology and education to be lack of identification and attention to practical electronics and its position in the world. He further stated that in considering the place which science (electronics) should occupy in our educational system, we should remember the basic principle upon which the education of today must work and also the demands which are generally made upon them. Practical electronics teaching in particular must take account not only of technical development and of increasing production but also of the development of society and of the position, role and possibilities for the growth of the individual in the society.

Kuehn (2015) stressed lack of agreement between globalization and education, inability of following new international order with increase

competition due to sense of inevitability and lack of industrial restructuring due to technological change to be major problems. Kuehn further emphasized that lack of agreement between globalization and education reflects and feeds on the sense of powerlessness of a particular government to comply with the global change in education. At any level, government must work on a system of education complying with the changing technology. The powerful sense of inevitability if not adhered to, silences any consideration that should serve the social and cultural needs of a particular people. It also makes incredible and unthinkable the view that groups should be getting together on an international basis to figure out how to bring the global economy under control so that it meets the need of people not the other way round.

Kuehn (2015) also reveals the problem of teaching and learning of practical electronics works to lie on emphasis on education for itself or for good members of a community without a large emphasis on preparation for the future work which are no longer appropriate. In other words, the idea that work is only an instrumental part of one's life is no longer appropriate; such a view on education and work cannot be justified in the world where economic development and change in innovation is emphasized. Lukatela (2005) in his further contribution pointed out that one of the principle tasks of the school is to fit the individual to take part in production and to teach them how to use in their work and in their daily life such change in technology as are becoming available in increasing varieties. Kuehn (2015) concluded thus, a school system should have an integrated frame work on education based on standards and expectations set by a society on which students should acquire a breadth of knowledge, skills and attitudes necessary for adjustments into work environment. To achieve all these, a better match of instructional delivery

system should be formulated and implanted into the course for improved training and motivation in practical electronics works.

### **Problems of Curriculum**

The fundamental problem of curriculum to teaching and learning practical electronics works lies in the clash between the theories of the curriculum developers and those whose responsibilities are to implement. Often, unconsciously in the practice of teachers, developers fail to realize that fundamental changes in classroom practice can be brought about only if teachers become conscious of the current studies and are able to reflect critically on them (Elliott, 2005).

The explosion in development at the point of independence brought about improvement in all sectors. However, that explosion has been overtaken by reasonable manpower development which came with its own problems. The problem being that the expansion of the economy created new job environment where the curriculum presently is not matching. That is why we have so many graduates not fit for the work environment (Nwadinigwe, 2009). Rufia (2010) in his contribution avers that the main problem of teaching and learning practical science is in dishonestly drawing and implementation of curriculum. For instance, the national computer education curriculum for both primary and secondary school were developed by the Nigerian educational research and development council (NERDC) in 2002, until now computer studies particularly at the basic education level has no document of compilation of topics for instruction. Rufia, went further to identify problems of teaching and learning practical science to include lack of involvement of teachers concerned in the establishment of curriculum and so the cognitive operations required of students in the curriculum are often



beyond their cognitive scope. The practical electronics curriculum therefore did not reflect the students' environment and national aspirations. Lack of involvement and availability of current curriculum to teacher and schools contribute to the problem of implementing these principles expected in the curriculum in practice.

Lack of involvement of teachers in the establishment of curriculum makes the problem of implementation clear. For example, students' failure to discuss ideas could be explained in terms of teachers' tendencies to invite consensus, reinforce some views rather than others and promote their own views (Asana & Osho, 2010). Therefore, it is by becoming aware of these patterns and reflecting about the theories implicit in them that teachers will be able to modify their behavior.

Roscoe and Strapp (2009) reveal that lack of satisfaction and unpreparedness on both instructors and students to accept the curriculum create problem on any particular subject area. Therefore, increasing students' motivation satisfactorily, with preparedness through professional issues will create more satisfaction and preparedness in the students who had completed the course. Lukatela (2005) emphasized that curriculum should include subject matter which will form the basis of that information and knowledge which the individuals required in order to undertake the task that are assigned to them.

In another view, Kuehn (2015) postulates that globalization is creating a global economy and inter-related culture, therefore, we should develop common curriculum and educational practice. Kuehn further defines curriculum as preparing students for business, that business should logically

have a central role in determining the content of schooling. The above researcher then condemns the existing curricular for the sake of learning without much emphasis on outcomes.

### **Students Related Problems**

The attitudes of students contribute to the problem of teaching and learning of practical electronics works. The belief by youth that technical and vocational education lack further educational and training opportunities has stifled any interest and motivation young people may have had towards practical electronics works. Technical and vocational education has long been associated with much physical exertion and difficult working environment. It is traditionally viewed as unsuitable for women and girls. This has largely been responsible for the exclusion of nearly half or even more of the population into practical electronics works (Maclean & Kerre, 2009).

Landberger (2005: 45) supports the above researchers saying that people should first work to understand the fact and principles of practical electronics works before trying to memorize them. Students' academic perception plays a prominent role in the teaching and learning of practical electronics works. Students perceive electronics works as a very difficult subject. To many students, the mere mention of electronics invokes fear and demoralization, its link with mathematics has worsened an already bad situation. Landberger in agreement said that students generally find science to be difficult naturally, but they fail to tell themselves that the source of the difficulty lies in the nature of science and acceptance. So they keep themselves away from science and become permanent failure.

Achor (2001) in his observation opined that students' cognitive styles could be a source of difficulty to them in learning practical electronics works, especially with regard to how they process information. Yager (2014) reported that many science teachers have limited understanding of the meaning and the subsequent role of students' cognitive styles. Maclean and Kerre (2009) in Africa, despite the popular call for a more investment in technical and vocational education (electronics works technology) and the creation of a favorable environment for the inclusion of practical electronics works in the general school curriculum, serious challenges emanate from the social and political context. Today, one hears of the second liberation where the majority of students yearn for involvement in their self governance. Furthermore, the current wave of internal conflicts, most of which are deeply rooted in ethnic and economic differences continue to threaten even the most promising young students. In general, the quality of training is low with undue emphasis on theory and certificate rather than on skills acquisition and proficiency testing, inadequate instructor, lack of retraining services to instructors, obsolete training equipment, and lack of instructional materials are some of the factors that combine to bring about poor performance rate into practical electronics works.

**Geographical, Gender and Economic Inequalities:** These are great barriers to participation of youth in practical electronics works. We should not lose sight of these inequalities in designing TVET strategies for participation and performance.

**Poor Public Perception:** For many years, technical and vocational education (electronics works) has been considered as a career path for the less

academically endowed. This perception has been fuelled by low academic requirements for admission into TVET programmes and the limited prospects for further education and professional development. Worse, the impression is sometimes created by governments, who in their attitudes present that the primary objective of the vocational education track is to keep dropouts or lockout (Johanson & Adams, 2004). The socio-economic environment and the contextual framework in which TVET delivery systems currently operate on the continent, is characterized in general by Youth perception, Students cognitive styles, Social and political context, Low quality training, geographical, gender and economic inequalities and Poor public perception. Practical electronics works instructors have vital role to play in creating awareness and the implementation of curriculum for senior technical colleges.

### **Instructor-Related Problems**

Instructors contribute immensely to the problem of teaching and learning practical electronics works through their attitudes, level of education, use of instructional delivery system, use of appropriate instructional materials, class control and management. Aina (2010) in agreement has it that the teacher who enters the class with a far-off strict and withdrawn expression on his face would most probably instill fear and a negative response from his students. It is a well known fact that students tend to link the teachers personality with the subject they teach. If they dislike the teacher as a person, this dislike is often unconsciously transferred to the subject the teacher teaches.

Aina (2010) in an interview revealed that students perform poorly, and are scared of practical electronics works because they are poorly taught both by

inexperience teachers as well as poor environment, which contributed to the quality of result that we are seeing today. I strongly support the above contributor that the inefficiency of students in practical electronics works is a direct reflection of the teacher, environment and technique of instruction. The result of today in practical electronics works is not a surprise at all, however, if we want things to improve, we must reverse all the above lapses. Furthermore, Aina said that the poor performance of students and low involvement in practical electronics works in both internal and external examination in technical colleges were expected, it is not surprising at all because it is garbage in garbage out. Aina again reported that some instructors discourage students by mentioning that practical electronics works course is not an easy subject and that it involves mathematics and invisible components which makes it more complicated. Aina concluded this way, “we have not put in the resources that can give us the expected result in practical science and many of these unqualified teachers lack these relevant skills necessary for practical electronics works”. Most technical colleges in Anambra state and neighboring states have none or do not have enough qualified teachers for teaching practical electronics works (Observation during research inspection in 2009).

According to Landberger (2005), poor performances of students generally proceed from the way they were taught. The researcher noted that many individuals are not mastery of complex cognitive manipulation owing to background and inexperienced, instructors lacking linkage and translation of text and graphics into one to make way for easy understanding of the context. In essence, Landberger concluded thus, this category of teachers are not professionally equipped and may lack the practical skill for practical

electronics works. In an informal interaction with the students by the researcher at federal science and technical college Awka in 2010, most students complained that practical electronics works instructors behave as if they lack memories and factualness, their faces are always frightening without laughter and in an uncondusive environment. This type of attitude can put students off, thereby affecting their performance in the course.

Chadwick (2012) noted that, teaching of practical electronics works concern moral issues that arise because of the specialist knowledge that professionals attain, and how the use of this knowledge should be governed when providing service to the public. The above researcher further stated, that a professional carries additional moral responsibilities to those held by the population in general. This is because professionals are capable of making and acting on an informed decision in situations that the general public cannot, because they have not received the relevant training.

### **Related Problems on Teaching Technique**

Painstaking teachers have long used a variety of teaching aids to motivate their pupils, simplify concept they are presenting and supplement their expressions with chalkboard illustrations. Many of these techniques have proved successful for supporting instruction even outside the classroom but it goes without saying that a particular technique is not necessary but suited for every lesson. The urgent need for greater efficiency in teaching/learning process in practical electronics works has always been a matter of concern to many people who have stake for education.

Forsyth, Joliffe and Stevens (2003) propounded that determining which method of instruction to use in a training program, can sometimes be difficult because there are many different instructional methods which may be used in a training environment. Each method has certain advantages and disadvantages; some are more suited for certain kinds of instruction than others such that the different methods require greater or lesser participation by students. One method or perhaps a combination of methods is usually most appropriate for most subject matters and objectives. The researchers concluded that based on the subject matter and professionalism, an instructor will need to determine which instructional method to use. Another researcher, Landberger (2005) posits that studying science has its foundation which is the scientific method which many do not understand and so find teaching and learning as problem because they cannot pick or choose which instructional method to use.

Larson and Lockee (2009) in their own opinion stated that preparing instructional design that is unsuitable for a particular/different career environment creates inefficient teaching and lack of motivation on the part of students. Furthermore, they opined that instructional design received by students should provide flexibility in their programs in order to allow them to experience the context for the study. Lederman and Gess-Newsome (2012: 199) revealed that

One major problem of teaching method and technique lies on teaching planning, teaching knowledge and belief, which have a profound effect on all aspect of their teaching. Teaching subject is a highly complex activity in which the teacher must apply knowledge from the multi domains. Teachers with differentiated and integrated knowledge will have greater ability than those whose

knowledge is limited and fragmented, to plan and enact lessons that help students develop deep and integrated understandings.

Lederman and Gess-Newsome also have it that effective science teachers know how best to design and guide learning experiences under particular conditions and constraints in order to help diverse group of students develop scientific knowledge and an understanding of the scientific enterprise. In any case, for a teacher, there are questions to be asked in order to achieve the aim and objectives of teaching. These questions include, what shall I do with my students to help them understand their practical electronics works (science concept)? what materials are there to help the students?, what are the students likely to know and what will be difficult for them?, how best shall I evaluate what the students have learnt? These questions are common for every teacher, and central to describing the knowledge that distinguishes a teacher from a subject matter specialist (Magnusson, Krajcik, & Borko, 2012).

Calderan and Summer (2014) in their contribution concentrated on provision of adequate information for students in the light of their prior experiences. Both researchers found students prior experiences to be a determining factor in achievement and also investigated means which could be incorporated into the design of materials to overcome differences in students prior experiences. Another researcher, Bastow (2014) examine the use of knowledge, corrected responses in relation to the use of individualized programmed methods, and found not only did the use of this type of feedback enhanced learning, but that in adult students, performance was also strongly influenced by motivation.



Kernaghan (2007) investigated the potential of feedback, endeavored to determine the effectiveness of delayed feedback as opposed to immediate feedback from the students test achievement in practical electronics area of study. Kernaghan in his research on timing of feedback used two equivalent groups. Three separate tests were given to students, superior achievements being found on the third test from students provided with delayed feedback. Similarly, Crebbin (2004) examined immediate and delayed testing in relation to practical science lesson and he found immediate testing to be of greater value to students than delayed testing. Using adequate teaching materials and format e.g. video or visibility format as the vehicle of instruction and also examined the sequencing of information in relation to a unit of instruction in practical science course, in the context of this task too, short sequences of instruction followed by review techniques were superior to longer sequences (Kaiser, 2014).

Pregent (2013) reminded teachers that as they consider which method or methods of instruction to use and incorporate into their instructional training program, they must carefully develop their objectives and teaching points, must be realistic, logical and achievable not only by them but the students as well. In conclusion, the problem of teaching method and techniques in practical electronics works can be overcome, if only the teachers/instructors research to find out the teaching methods and techniques suitable for a particular segment/course of study. The potential of practical electronics works might be almost infinite, but its success depends to a large extent on the role given it by teachers/instructors. It may therefore be suggested that the future role of practical electronics works in the society lies in the methods

and techniques of instruction designed and adopted by the teachers/instructors of practical electronics works.

Based on the above discussion, adequate/appropriate instructional delivery system is believed to be a source of critical thinking or inspirational disposition on the part of students (Eze & Okoye, 2008). These researchers further agree with the argument that it is when an individual reasons out appropriately, only then could the individual visualize and conceive correctly in technical vocational education and training. The application of visual projection, guided discovery and project-based methods of instruction in practical electronics works offer new opportunities, as teaching and learning the ideas of these methods can make instruction more interesting, lively and relevant to practice. Students can determine themselves when, where, what and how fast they wish to learn, as these methods help lower barriers of non-participation of students.

### **Visual Projection Method of Instructional and Its Effect on Students Achievement**

Planning and teaching any subject is a highly complex cognitive activities in which the teacher must apply knowledge from multiple domain (Resnick 2014; Leinhard & Greeno, 2008; Wilson, Shulman & Richert, 2009). Teachers with differentiated and integrated knowledge will have greater ability than those whose knowledge is limited and fragmented. To plan and enact lesson that help students develop deep and integrated understandings, effective science teachers know how best to design and guide learning experiences under particular conditions and constraints, in order to help diverse groups of students develop scientific knowledge and understanding of the scientific enterprise. These statements about the role of knowledge in

teaching is supported by a body of research, documenting that science teachers' knowledge and beliefs have a profound effect on all aspects of their teaching (Carlsen 2014; Doby & Schafer 2012; Hash-web 2008; Nelson 2012; Smith & Neale 2010). Some of these research were framed by conceptualizations developed by Schulman and his fellow researchers.

Leonard (2013) employed Howard Gardener's multiple intelligence when designing an educational experience for multiple intelligences. They exhort that conscious effort should be made to include activities that incorporate various abilities or ways of knowing. The theory stipulates that; by employing various instructional methods to teaching and learning for example visualization, reflection, discoveries, role playing, performances, etc as well as assessment methods that account for the diversity of intelligences, then the outcome will be that the learning experience can be richer for all students.

To increase participation and retention in teaching and learning, visual projection method of instruction as an educational tool can enhance and compliment such outcome. When visual projection is used to compliment instruction, the emphasis is on providing opportunities which is inextricably linked to the particular context in which the knowledge is used (Kasworm, 2010).

Kupsh and Mason (2012) estimated the amount of learning from seeing to be 83 percent and learning concept in respect to retention through seeing and hearing after three hours to be 85percent and after three days as 65percent against hearing 11percent, touch 1.5percent. These findings emphasize the necessity in making the students adequately comfortable during traditional

class process and during practical instruction classes. The students arrangement in the class must be in such manner that every student should see clearly what is going on in the class. When one hears and sees, the greatest proportion of learning must have taken place among the students (Eze & Okoye, 2008). The above analysis of learning and retention rate has it that audio visual materials can be used to create variety of external conditions that are conducive to learning and retention and also maximize learning outcome in technical college level and beyond. Visual projection is only a tool, therefore instructors at technical college education level must include visual projection technology as part of the total instructional plan, strive to infuse and/or integrate visual technology into instruction and the curriculum. The technology should be used to shift the emphasis from teacher centre to learner centre and instructors/teachers will be prepared to modify the role of the instructor by acting in such a way to show that the teacher is not the only source of information but the student as well with minimal instructional guidance. Visual projection instruction is the use of teaching materials and techniques that do not depend mainly upon the printed words to convey meaning. It is also known as instruction media that works through sight and sound, for example still and motion pictures, video tapes, recordings, museum exhibits and multi-media computer software that are used to supplement teaching. A person's ability to remember what was learnt can increase vastly through a combination of seeing and hearing information (Howstuff, 2008).

A lecture is not visual instruction, but becomes so when the speaker uses slides, exhibits or similar aids. Visual materials designed for both seeing and hearing have many benefits that attract the attention and motivation of the learner. They often provide the most direct way of conveying

information (Howstuff, 2008). Howstuff in his research listed types of visual material practices to include:

- Direct experiences or real things.
- Moving pictures on film, television, and computer screens or still pictures shown on a screen projector.
- Compact discs, multimedia CD ROMs and video tapes.
- Video production system which includes equipment for the production and display of video presentations.

With the advancement in multimedia technology, teachers and instructors have expanded the use of computers in visual instruction and this has improved the ability of teachers to provide retentive information to students. Students can experience realistic situation with the help of visual projector simulations, which are representations that respond to changing condition (Cuyamaca College, 2003).

Educators certainly must be actively involved in determining the appropriate pedagogical approaches for the market of their students. In providing an effective learning environment to more students worldwide certainly is an altruistic objective that can promote educational ideals, that in itself is at least a theoretical benefit to practical electronics works education. Visual learning user benefits particular convenience, it also attracts students to classes and learners develop the required skills. The convenience factor attracts new students who want to study practical electronics works (Moore, 2006). Another benefit to visual learning according to Moore, is the possibility of working with more learners, teachers and subject matter experts outside a student's limited geographical area. Collaborating with diagrams, designs,

photographs from different perspectives and levels of experience is a potential benefit that can enhance the learning environment and provide learners with a wider network of contacts.

Visual learning may offer special benefits to learners who are shy to ask for explanation and have difficulty keeping pace with other students during a face to face instruction only. Learners may feel more confident in a visual learning class because they perceive that visual learning venue creates equal opportunities. The researcher further posits that the use of visual projection method in education may have the following benefits:

- i. Allows the learners to learn together or collaboratively regardless of age, gender or creed.
- ii. Display is much clearer/bigger and therefore can be easily seen by all members of the learning group.
- iii. The audio visual system supports a whole range of multimedia from a wider range of sources.
- iv. Learning via audio visual can benefit students who learn from repetition that is, the need to see material repeated and for students who are absent.
- v. The audio visual solution supports repetitive learning including the strategy adopted before examinations.
- vi. Lesson can continue overtime as it is simple to pick up from where the last class ended.
- vii. The education establishment can improve performance of teaching based on the lessons learned and files saved on the audio visual products.

- viii. Future lessons can be improved upon regarding content for future learners. This saves time and cost for the teachers and the establishment.

Lahatte (2009) added that today education is faced with new challenges, holding an attention of technically inclined students who live in a defined world of high media demand. Visual projection method therefore makes lessons come alive with vibrant colours, superb readability and outstanding quality that lasts. Such instructional method will enable teachers to do what they do best and inspire their students to learn.

### **Guided Discovery Method of Instruction and Its Effect on Students' Achievement**

Labush (2008) stated that guided discovery method of instruction is an approach to instruction and learning which will help students personalize the concepts under study and creating an understanding that cannot be matched using any other method of instruction. The teacher must guide the students towards the discovery, this can be accomplished by providing appropriate materials, a conducive environment, and allotting time for students to make the discovery. Guided discovery greatly impacts instruction as it is the responsibility of the teacher to set the students up to make the desired discovery. Labush, further stated that the teacher must provide all necessary teaching background knowledge to lead the students to the discovery. The students must realize the methods to be used to make the discovery, to assure this, the teacher may demonstrate what the students are expected to do, thus guided discovery becomes the goal of the lesson.

In an example of guided discovery learning in action Allen (2002) displays Daimler Chrysler study as such; Daimler Chrysler uses guided discovery principles for teaching maintenance engineers to troubleshooting automotive electrical systems. Below will summarize its most salient features described in this article: determining the source of faults is a very complex task, maintenance engineers must use diagnostic aids and equipment together with a carefully thought-out strategy to pin point and solve the problems. Since workers cannot remember the configurations in all the vehicles, training cannot anymore be specific to anyone system. Training focus most, to be on strategic thinking as well as specific facts, procedures, and concepts. Training must build flexible skills and adaptive thinking to allow for situation to situation variation in task sequencing. Allen (2002) therefore, listed Daimler Chrysler's finding to include that the learning systems empowers maintenance engineers to:

- Plot their own course of problem solving
- Perform stimulated tests on circuits, with stimulated diagnostic equipment used to report accurate measure
- Access reference information
- Order repairs and test result
- Proceed with the repairs of vehicles returned by customers who have complaint about prior service and get feedback on efficiency (completion time and completion cost of the job)
- Incorrect assumptions and decisions and
- How to approach diagnosis effectively

Guided discovery learning is a learner centered approach that combines didactic instruction with more students centered and task based approaches



(Lavine, 2003). Studies in educational psychology of younger students by Lavine suggest that guided discovery is superior to pure discovery learning with little or no guidance. Generally, agreement by students according to Lavine came out with the theory that guided discovery instructional method helps to focus on real problems and add relevance and motivation to mastery of related basic science information.

According to Schunk (2008), guided discovery method of instruction is when students obtain knowledge by themselves under instructional guidance which provides strategies. It involves constructing and testing hypothesis rather than passively reading or listening to teachers presentation. In another perspective, schunk opined that discovery learning can be of two forms in broadly speaking; these are guided and unguided discovery or just discovery teaching. Guided discovery which is the subject of this research is a guided instructional approach where students are not permitted to do whatever they want, but rather are guided by teachers/instructors. In this case, instructors will typically arrange activities and then allow students to work with the materials provided to figure out concepts also instructors will present questions of problems to encourage learners to make intuitive guesses.

Guided discovery idea of instruction has long dominated teaching method in the scientific and mathematics communities. The belief is that the knowledge students construct on their own is more valuable than that which is presented to them by a teacher (Klahr & Nigam, 2004). Ovute (2011) defined guided discovery learning method as the approach to learning whereby students are guided or assisted in a way in their learning activities so that they could discover scientific knowledge. Personally, discovery method of instruction is

an approach to learning practical electronics works which involves a whole participation or exploration by the students in the learning process. The students, through their intellectual skills such as observing, following procedures, grammar rules, scientific equations, classifying and so on must discover ideas or construct essential information or knowledge on their own with the provision of direct guidance on concepts required by a particular discipline.

Guided discovery teaching method can be deductive or inductive in nature (Prince & Felder, 2006). It is deductive when the general principle is given and the student is required to use the principle in order to discover the solution to a specific problem. For instance, when a circuit is faulty, the student is informed of the fault and asked to remedy the fault. Guided discovery method involves inductive reasoning because students move from a specific topic to formulating rules and principles. For instance, in electricity the use of inductive discovery teaching method may lead a student to discover that electricity is produced by mechanical energy using generators, while in motors, electricity produces mechanical energy.

Kirschner, Sweller, and Clark (2006) provided five advantages of guided discovery method thus:

- i. Guided discovery teaching method challenges the students to solve authentic problems in information rich setting. This idea then encourages the learners to construct their own solutions leading to the most effective learning experience.

- ii. It equips the students with a means of gaining knowledge on their own through active participation, and develop their mind by using it to solve problems.
- iii. It helps to facilitate retention of knowledge which the students have discovered on their own.
- iv. Lastly, it encourages analytical thought and promotes intuitive development among students. Earnestly, in these assumptions, knowledge can best be acquired through experience by contact with materials and appliances.

Proponents of constructivist learning theory Brooks and Brooks (2009) believe that discovery learning has many advantages and disadvantage.

**Advantages of discovery learning include:**

- Encourages active engagement
- Promotes motivation
- Promotes autonomy, responsibility and independence.
- The development of creativity and problem solving skills.
- A tailored learning experiences

**Critics have sometime cited disadvantages including:**

Creation of cognitive overload

Potential misconceptions

Teachers may fail to detect problems and misconceptions.

This belief is explained by the constructivist learning theory which states that learning is an active process of creating meaning from different experiences.

In other words, students will learn best by trying to make sense of something on their own with the teaching as a guide to help them along the way (Brooks & Brooks, 2009).

Despite these advantages of this method of instruction, it is important to note that guided discovery can either mislead or contradict known findings. One deterrent for this teaching method is that due to the emphasis on students centered or on group work, the idea of the most active students may dominate the group's conclusion. In other words, guided discovery learning approach is to consider the large number of varied personal characteristics as well as prevalence of learning problems in children today. For example, if solely guided discovery approach is employed in a class room of children where significant number say with deficit/disorder, might not be able to focus on their perception of learning experiences long enough to build a knowledge base from the event. In any case, guided discovery theory is biased on students who desire to learn more and are capable of focusing attention on the learning process independently. A mixed approach that incorporates components of guided discovery learning along with other approaches which include more guided teaching strategies would better meet the learning needs of the majority of students in a class room by accounting for differences between learning styles and capacities (Kirschner, Sweller, & Clark, 2006).

Reid, Zhang, and Chen (2003) added that guided discovery learning is channeled towards authentic discovery learning, which is characterized by designing scientific experiments. In its current conception and practice, guided discovery learning is thought to increase the ability of student to transfer information they construct to other area as it allows the students to

independently explore broader issue (Klahr & Nigam, 2004). Kirschner, Sweller and Clark (2006) suggested that learners should be provided with direct guidance on concepts required by a discipline and should not have to discover ideas or knowledge on their own. Six basic rules for using guided discovery method of instruction Taft (2008) include:

- i. Never put the learner in an injurious setting. It is the responsibility of the instructor to reduce stress potential.
- ii. Always set your learner up for success. The learner must be placed in a position that can achieve success.
- iii. Give them as little cueing as possible to guide them in the correct direction.
- iv. Ask questions that give you, the instructor, as much input as possible as to how the learners mentally feel during the skill, as well as make them figure out what they want.
- v. Reward the correct performer with strong phrases or words e.g. fantastic, you got it and so on
- vi. Do not reward sluggish or unattended learners, rather give them the feeling that they have to concentrate and deliver a better performance than the one they have just presented.

Taft (2008) further pointed out that the instructor must recognize immediately when the learner is going the wrong way and also give clues that will guide the learner into performing the skill correctly but not actually giving them a step to step approach that may confuse them due to many instructions. Guided discovery is used in such a way that instruction is limited to the point of making sure the learner understands what the skill is and what it should look like, but the learner must use his understanding to perform correctly.

Taft, sees guided discovery as putting the obligation of correct movement on the individual and the responsibility of the instructor is to guide when need be. Taft, also have always felt that too many instructors try to find something to say because they feel it is there job, when in actuality, saying little can get quicker and more resounding results.

Taft (2008) certainly is not advocating that guided discovery is used as the only teaching method, but if used properly, it can create a lasting learning effect. It can establish a framework of understanding by the learner to make self-corrections when needed. The instructors are also encouraged to become fully educated on the skill or knowledge they are teaching, for the foundation of education is knowledge.

Kirchner, Sweller and Clark (2006) is of contrary idea that people learn best in an unguided or minimally guided environment in which the learner must construct essential information for themselves. Magliaro, Lockee, & Burton (2005) posit that unguided discovery learning should not be used for higher level learning or performance, but in situations where motor skills or prerequisite intellectual skills are being instructed. This would include: mathematical procedures, grammar rules, scientific equations, etc. Basic skills must be mastered before moving on to more complex topics, which guided discovery allows the students to do. The guided discovery teaching idea of instruction has long dominated teaching methods in the scientific and mathematical communities. The belief is that the knowledge students construct on their own is more valuable to them than that which is presented to them by a teacher (Klahr & Nigam, 2004). The piagetian notion of discovery learning also contends that when a child is taught something which he could have discovered on his own, the child will not understand it as

completely compared to how he would if he had discovered on his own (Kirschner, Sweller & Clark, 2006).

Discovery or unguided instructional approaches are very popular, however these approaches ignore the structure that constitute human cognitive architecture. A meta-analysis conducted by Kirschner, Sweller and Clark (2006) examined guided discovery instructional approaches and found that based upon knowledge of human cognitive structure that unguided learning is ineffective. The above researchers Kirschner, Sweller and Clark believe that unguided discovery instruction appears to proceed with no reference to the characteristics of working memory, long-term memory, or the intricate relations between them. In any case, one of the goals of instruction is to give learners specific guidance about how to manipulate information in ways that are consistent with a goal, and enable the students to store this knowledge in long term memory. Unguided discovery learning does not serve these purposes.

A great deal of unguided discovery learning ignores the limits of working memory, as a problem based, searching makes heavy demands on it. This form of instruction also does not enable information to get stored in long term memory, because while working memory is being used to search for solutions, it is not available to be used to learn and store.

Unguided discovery learning may even hinder students learning just as Kirschner, Sweller, and Clark (2006) demonstrated that when students learn in pure unguided discovery science classrooms, they often become lost and frustrated. Jong and Joolingen (2012) have stated in agreement that learners may encounter difficulties in four categories when using unguided discovery

learning methodology such as: difficulties in generating and adopting hypothesis, poorly designed experiments, difficulties in data interpretations and problems regarding the regulation of unguided discovery learning.

Reid, Zhang and Chen (2003) stated that presenting students with partial information enhances their ability to construct a representation to a greater extent than when given full information. Jong & Joolingen (2012) contented that students first need to learn and understand the basic skills and facts before taking on more complex roles. Therefore complete information results in a more accurate representation of the knowledge.

Jonassen (2006) identified three major roles for facilitators or instructors to play in supporting students in guided discovery learning environment to be modeling, coaching and scaffolding. Also Jonassen has proposed a mode for developing guided discovery learning environments around a specific learning goal. This goal takes forms from least to most complex thus:

- i. Question or issue
- ii. Case study
- iii. Long term project
- iv. Problem (multiple cases and projects integrated at the curriculum level)

Jonassen (2006) provided some assessment strategies which include:

- **Oral discussions:** The teacher presents students with focus question and allows an open discussion on the topic.
- **KWL(H) chart** (what we know, what we want to know, what we have learned, how we know it). This technique can be used throughout the course of study for a particular topic, but is also a good assessment



technique as it shows the teacher the progress of the student throughout the course of study.

- **Mind mapping:** In this activity, students list and categorized the concepts and ideas relating to a topic.
- **Hands-on activities:** These encourage students to manipulate their environments or a particular learning tool. Teachers can use a checklist and observation to assess students' success with the particular material.
- **Pre-testing:** This allows a teacher to determine what knowledge students bring to a new topic and thus will be helpful in directing the course of study.

Guided discovery is a constructivist method of instruction where learners are makers of meaning and knowledge which is based on believe that learning occurs as learners are actively involved in the process as opposed to passively receiving information. Constructivist teaching fosters critical thinking, and creates motivated and independent learning. This theoretical framework has it that learning will always build upon knowledge that a student already know, this prior knowledge is called a schema. Because all learning is filtered through pre-existing schemata, constructivist suggest that learning is more effective when a student is actively engage in the learning process rather than attempting to receive knowledge passively. A wide variety of methods claim to be based on constructivist learning theory. Most of this methods rely on some form of guided discovery where the teacher avoid most direct instruction and attempt to lead the students through questions and activities to discover, discuss, appreciate and verbalized (Gray, 2012).

## **Constructivist Teaching Strategies**

One of the primary goals of using constructivist teaching is that students learn how to learn by giving them the training to take initiative for their own learning experiences. According to (Gray, 2010) the characteristics of a constructivist classroom are as follows:

- The learners are actively involved
- The environment is democratic
- The activities are interactive and student center
- The teacher facilitates a process of learning in which students are encouraged to be responsible and autonomous.

## **Examples of Constructivist Activities (Gray, 2002)**

- Students work primarily in groups, learning and knowledge are interactive and dynamic.
- There is a great focus and emphasis on social and communication skills, as well as collaboration and exchange of ideas. This is contrary to the traditional classroom in which students work primarily along where learning is achieved through repetition and subjects are strictly adhered to and guided by text books. Constructivism classroom places the teacher as a guide rather than as authority on a subject while the students are the active researchers and discoverers of knowledge.

## **Some Activities Encouraged in Constructivist Classroom (Gray, 2002) are:**

- Experimentation: Students individually perform an experiment and then come together as a class to discuss the result.

- Research Projects: Students research a topic and present their findings to the class.
- Field Trips: This allows students to put the concepts and ideas in real world context. Field trips would often be followed by class discussion, films, these provide visual concept and thus bring another sense into the learning experience.
- Class discussion: This technique is used in all the methods described above. It is one of the most important distinction of the constructivist teaching method of instruction.

Constructivist approaches can also be used in an on line learning, e.g tools such as discussion forums, wikis and block. These can enable learner to actively construct knowledge.

#### **Procedures of Constructivist Classroom (Marlowe & Page, 2005)**

- In a constructivist class room, begin with the whole and expand to parts.
- Pursuit students questions/interest
- Look for primary sources/manipulative materials
- Build interactive learning on what student already know.
- Instructors interact/negotiate with students.
- Assessment via students works, observation, point of view and test.
- Process is as important as product.

Jonassen (2006) recommends making the learning goals engaging and relevant but not overly structured. In guided discovery, learning is driven by problem to be solved; students learn content and theory in order to solve the problem. This is different from traditional learning/teaching where the theory

would be presented first and problems would be used afterwards to practice theory. Depending on students prior experiences, related cases and scaffolding may be necessary for support, instructors also need to provide an authentic context for tasks plus information resources, cognitive tools and collaborative tools. Traditionally, assessment in the classroom is based on testing where it is important for the student to produce the correct answers. However, in guided discovery teaching, the process of gaining knowledge is viewed as being just important as the product and thus assessment is based not only on tests, but also on observation of the student, the student's work and the student's points of view (Jonassen, 2006).

The idea that new learning is based on active engagement with prior knowledge is a philosophy and study of how we tend to learn is not precisely the same as the question of how we learn. Therefore, rational people can support each of these two seemingly paradoxical positions. It simply requires incorporating one in other, as in adding reasonable pre-learning and guidance into discovering call of guided discovery. Acknowledging that the closer we can reasonably come to the way, we most often and naturally learn as reflected in discovering needs to be accommodated in direct instruction, or what might be called guided discovery direct teaching. Similarly, guided discovery methods that are best would likely be the ones that provide the greatest degree of structure and guidance. Learning of science in most countries/classrooms is characterized by the chalk-laboratory method. In a study of science and mathematics education, Weiss, Banilower, McMahon and Smith (2001) found that the most common instructional activities in science classrooms were lecture and discussion. The researchers also noted that despite the reported emphasis on science process and inquiry skills,

classes at all levels are much less likely to stress, having learn to explain ideas in sciences or learn to evaluate arguments based on scientific evidence.

The fact that learning to explain ideas is science as well as to evaluate arguments based on scientific evidence, given less emphasis at all levels suggest that students maybe learning science without actually understanding it. It could also mean that science teachers are relying on teaching methods or strategies that are ineffective for promoting understanding of science. Lack of understanding of science is not only a problem for students but also a problem for most people in the large society (National Science Board, 2002).Colley (2005) pointed out key questions that this section intends to address thus:

- i. What is the most appropriate instructional approach that science teachers can use to teach for understanding?
- ii. How can it be implemented in science classrooms?
- iii. What is the most appropriate instructional approach that science teachers can use to teach science for more understanding?

Discovery learning is an enquiry-based constructivist learning theory that takes place in problem solving situation where the learner draws on his own past experience, existing knowledge to discover facts, relationships and new truths to be learned. Students interact with objects, wrestling with questions and controversies, or performing experiments, as a result, students may be more likely to remember concepts and knowledge discovered on their own (Bruner, 2015).

## **Project-based Method of Instruction and Its Effects on Students' Achievement**

The most appropriate instructional approach that science teachers can use to teach science for understanding is project-based science instruction (PBSI). PBSI is the only instructional method that makes science classrooms function like mini experimental stations, research laboratories and scientific agencies. It is an instructional approach that is driven by well-defined student research questions, facilitated by caring and competent teachers. In a project based science classrooms, students pose research questions and conduct extended studies to find answer to their questions within the context of a unit, curriculum or program of study. In a project-based science classroom, instructors perform more than the role of lesson planners, knowledge providers and classrooms managers; instead they act as facilitators, mentors, resource persons, adviser, scientists, listeners, learners and leaders in the science classroom. They work with students to identify projects that they are interested in and create learning environments that allow them to gather resources, plan, implement, evaluate and report on their projects. PBSI is the only instructional approach that places full responsibility for learning on the students. This means that students decides what to learn, how to learn, the time required to learn, and how to document, report their own learning and hold them accountable. They are more likely to take it seriously and rise up to the challenge than if when they are spoon-fed; they feel marginalized or powerless in their own learning.

In the past two decades, several initiatives have been taken to reform the teaching and learning of science in schools. Some of these reforms include the implementation of inquiry-base science curricula funded by the National Science Foundation (Rush, 2005). Despite all these reforms, the teaching and

methods of effective instruction must also be sensitive to the limits imposed on working memory, and how those limits disappear when working with familiar information.

According to Adderley, Ashwin, Bradbury, Freeman, Goodlad and Greene (1995) in Holt (2005) project based instruction was first conceived by the efficiency expert David Snedden to teach science in United States vocational education classes. It was later developed and popularized for teachers by John Dewey and William Kilpatrick, mainly through their pamphlet “The Project-Based Method”, which was Kilpatrick’s reconstruction of Dewey’s project method of teaching. The project method called for learning from experience by solving real-life problems and it was seen as an alternative to the traditional teacher-centered way of teaching and learning (Bruce, 2007). Project-based method of instruction is therefore defined as a long-term (several weeks) activity that involves a variety of individual or cooperative tasks such as developing a research plan and questions, implementing the plan through empirical or document research that includes collecting, analyzing and reporting data orally or in writing (Osher, 2010). Dewey’s project method was based on action as an expression of a basic empirical process that is organized and guided by activity and the questions it raises. The project method, then involves students creating knowledge in order to solve problems that arise while they are engaged in purposeful real-world activities (Dionne & Horth, 2014). It is an effective way to create opportunities for learner to develop their abilities in the target skills.

As an educational activity, when compared with traditional method, project based science was more effective in promoting critical thinking, observation

and group with skills. In science, individual student thinking was continually affected by the input of others. Students were pushed to consider increasingly broader perspective, instead of narrowing their thinking as the unit progresses (Krajcik, Blumenfeld, Marx & Soloway, 2012). These researchers discovered that in endorsing project-based instruction method, it results in more active involvement, more independence from teachers, and more cooperation among students. The researchers also reported notable improvements in students' learning of new concepts. Students learned new concepts faster, retained them longer and were able to use them in class discussions.

Owens (2008) artifact analyses showed that students liked the project based instruction, especially because it gives them access to the worldwide web and students developed ownership of their learning, gathered around the computers, helped each other, and shared information around and about their projects.

In any case, project-based instruction enables students to find the real-world applications for their disciplines as well as the extensive use of technology. Project-based instruction also is intrinsically motivating and helps develop skills for working in cooperative group settings. Petersen (2008) considered her experience a success because she found that the project-based activity created opportunities for her students to practice listening, handling, operating and oral presentation skills in practical science and enable them to see their project learning needs. Another researcher, Beckett (2009) indicated that project-based instruction is favored because it allows students to take an integrated approach to teaching and learning. It allowed them to foster critical thinking and problem-solving skills and promote independent as well as



cooperative learning skills. Beckett expressed his impression by the creative and in-depth work that the students produced for their projects. Also the above researcher favored project-base instruction because project activities allowed for unexpected learning to take place. For example, by engaging in project work, students were able to find their strength and weakness as learners.

Lakovos (2011) examined students attitudinal and proficiency responses to project-based method of instruction. Lakovos indicated that she was impressed by the oral presentation skills that all her students gained from their experiences of project-based instruction and by the fact that they designed a real-life activity as part of the project. However, she also reported frustrations and tensions, stating that negotiating the curriculum with the students regarding project-based instruction was complex and demanding. She felt that it was difficult to come to consensus about worthwhile topics and assignments, noted that some students complained that they were not learning enough academic skills while conducting project. Coleman (2008) analysis of student's feedback after participating in a project-based instruction showed that they enjoyed a nontraditional learning experience that provided independence. The students also reported that through their project work they learned about teamwork and improved their handling, application and oral presentation skills. However, according to two other systematic research studies, students came about their project successfully and impressively; their evaluations expressed dilemmas, frustrations and tensions (Beckett 2009: 98 & Lakovos, 2011: 62).

For example, the students' participation in the study by Beckett (2009) was 73, of the students, only 18percent said

they liked project-based instruction whereas 25percent had mixed feelings and 57percent said they did not liked it. The students who evaluated project-based instruction positively said that they liked it because doing projects was fun and project creates opportunities for them to learn research, use of tools and communication skills. Those with mixed feelings reported that they liked project work because it made them think, allowing them to gain in-depth knowledge and to learn research and presentation skills. In other words, they disliked it because it is time consuming, that is, it takes too long to carry out a project. The students who did not approve of project-based instruction said that projects evolve too much work and that the oral presentation aspect of project work is too hard for them because it made them nervous about their communication competence. They also said that learning by themselves from other sources through project work distracted them from gaining knowledge from their teachers and textbooks.

Lakovos (2011) reported that although students made their own plans regarding what, how and when to do their projects and seem to have completed all the tasks as required, they felt a great deal of anxiety. The teachers and students said that, allowing so much input and authority was not good in an academic class. In other words, the students did not appreciate the power given to them to plan their own curriculum; many of the students reported a desire for a more traditional way of learning. When the students were asked to rate their favorites activities, the opportunity to talk to their teachers was rated highest.

In conclusion, the above researchers indicated mixed findings in research that examined teachers and students evaluations of project-based instruction. The teachers showed that they enjoy this unconventional way of instruction; however, some are of mixed feelings with reasons. For instance, the teachers

in Lakovos study reported tension in implementing project work instruction due to insecurity organizing a project for the first time (Lakovos, 2011). Whereas others who enjoy this method had several years of experience of project work (Beckett, 2009). Although the essence of the project method is whole hearted, purposeful activity on the part of the learner, little research has been conducted to explore how learners evaluate project-based instruction.

Students evaluated project-based instruction positively; other counterparts did not wholeheartedly endorse project-based instruction despite their apparent success in project work because they want to learn from the teacher directly and the textbooks not by conducting project. The teachers who participated in the study evaluated this activity favorably because it allowed them to teach interactively with content and skills, though students expressed dilemmas and frustrations because this method of instruction disallowed them from learning directly and wholly with interaction and chatting with their teachers. The teachers in this study also were pleased because project-based instruction created opportunities to foster independence among students but their students insisted on learning from their teachers directly not by conducting project. The students in this study also appeared to consider talking to their teachers more important than doing projects. The students also seemed to dislike the power given to them during project work (Beckett, 2009:98).

Beckett's and Lakovos studies summarized thus, it is possible that when the students in their study showed desire for more teacher-centered learning, they could be speaking from their cultural perspectives that expect teachers to be in charge and pass on knowledge from textbooks, not from a philosophical view of traditional education. The dilemmas reported by students in Beckett study was explained from a dilemmatic perspective suggested by Billings

(2008) and Liang (2012) that the students may have had mixed feelings about project-based instruction because project work like everybody's life is complex and full of dilemmas.

Project-based learning involves completing complex tasks that result in a realistic product or presentation to an audience. In a review of research on project-based learning, Thomas (2008) identified five key components of effective project-based learning:

- i. Centrality to the curriculum
- ii. Driving questions that lead students to encounter central concepts.
- iii. Investigations that involve inquiry and knowledge building.
- iv. Processes that are students driven, rather than teacher driven.
- v. Authentic problems that people care about in the real world.

Research on project learning found that students gained in factual learning and are equivalent or superior to those students in traditional forms of classroom instruction. The goals of project-based learning however aim to take learning one step further by enabling students to transfer their learning to new kinds of situations (Thomas, 2008). In the first study, the project-based learning students scored significantly higher on a critical thinking test and demonstration increased confidence in their learning. The second, followed students over three years and found that although students had comparable learning gains on basic science procedures, significantly more project-learning students passed the National Examination in year three than those in traditional school. Although students in the traditional school thought that science success rested on being able to remember and use rules. According to the study, the project-learning students developed more flexible and useful science knowledge. The third study on the impact of multimedia projects on

students learning showed similar gains. The students in the multimedia program earned high scores than a comparison groups on content mastery, sensitivity to audience and coherent design. Though they performed equally well on standardized test scores of basic skills (Darling-Hammond, 2006). Further, Darling-Hammond has it that comparative studies demonstrated benefits from project –based learning, such as increase in the ability to define problems, reason with clear arguments, plan projects, improvements in motivation, attitude towards learning and working habits.

Some science educators and researchers have difficulty distinguishing between project-base science, inquiry-based and problem-based instructions. The reason for this could be a misconception resulting from limited or no formal coursework or professional development on these instructional approaches, poor treatment in science education textbooks and research articles and/or the close similarities between these approaches which make it hard for some science educators to tease them apart.

How can PBSI be implemented in science classroom? Group of researchers gave some concrete steps that could be followed in bid to answer the questions (Bardfield, 2013, Sawyer, 2005, Castleberry, 2010 & Polman, 2012):

- Administer a pre-assessment to determine students' knowledge, process skills and disposition in the specific subject, theme or topic.
- Emphasize that collaboration is a must in PBSI.
- Discuss the advantages as well as the disadvantages of working in groups.

- Note that as they work in group, they will have to compliment each other's weaknesses as well as each other's strengths.
- Divide the class into small manageable groups.
- Explain that each group is required to identify a question that they will investigate within a specific subject, time frame, resources and context.
- Ask each group to present their research questions.
- Ask each group to brainstorm and come up with a research plan.
- Discuss with the students on a collective timetable in which to begin and complete their projects.
- Ask each group to implement its research plan.
- Discuss the basic methods of analyzing quantitative and qualitative data.
- Discuss the protocol of presentation and criteria that will be used for evaluating project reports.

Administering post assessment in planning and implementing PBSI is much more complex than these suggested steps. The key is to have students generate purposeful, doable, relevant and interesting project questions, implement them within the available timeline and reflect on their own learning.

In implementing PBSI, there are some implications for teachers who want to implement this method. These implications are: Some knowledge and experience in the theory and practice of this instructional approach is required. In addition, the teacher must know how to organize and manage students from diverse backgrounds and learning styles, know how to mentor students as they work on their projects and how to assess students' projects.

The teacher must be resourceful, innovative and willing to experiment with new ideas (Tamim, 2010). Furthermore, Tamim, stated that teachers must understand the context from which their students come and plan activities that will motivate and orient them to the requirements and expectations of project-based science learning. Students often come to the science classroom with alternative scientific theories about the universe. Prior to implementing PBSI, teachers should survey their students to determine their prior alternative theories, dispositions towards science, science process skills and interest.

Another implication is scheduling and management of teachers' and students' time (Mistler-Jackson & Butler Songer, 2005). Implementing project based science learning requires time in terms of instructional planning, scheduling, activities, developing collaborative relationship, Implementing activities, supervising students' teamwork, assessing students' project and learning to use technology appropriately.

The type of curriculum in a school system can hinder or promote PBSI. PBSI will not work well where a teacher is required to cover certain amount of material and prepare students so that they can pass state mandated assessments. However, in a school where curriculum is flexible enough to allow teachers to implement or try new ideas, PBSI is more likely to succeed. It is also important to add that PBSI will not work in schools where the political climate is not favorable. Experience has shown that in schools where PBSI was implemented, usually there were competent and supportive principals working to make this happen (Sherwood, 2013).PBSI demands that resources be made available for students to carry out the projects of their choice, professional development may also be required to provide teacher

with the skills they need to implement PBSI. All of these require fund, where funds are not available or limited, it will be very difficult to implement PBSI.

PBSI requires students to conduct extended projects, which means sometimes doing work outside of school. The implication for this is that students need parental or guardian support to pursue project to the end. In conclusion, in a period when there is need at the National, State and Local level to implement standards and integrate technology into science teaching and learning, project can be both a means and an end. This means that Federal and State education Authorities must invest in PBSI in the form of funding for professional development, curriculum development, research tools, technology and materials. Without the appropriate level of funding and interest, PBSI will remain a luxury for the few rich schools and individuals.

In the work place, it is therefore important that information to be learned can be seen by the students as associated with the job and to be a tool that will help him perform better.

In learning environment, learning by doing can be among the most effective ways of acquiring knowledge. This is because in learning by doing, students are given real problem to solve. By immediately learning through practical activities, students are able to learn more quickly how to perform task correctly and efficiently (Blair, 2008; Buell, 2013; Chen, 2012; & Jonassen, 2008)



## **Empirical Studies**

### **Visual Projection Method of Instruction and Performance**

In an experimental study by Herbert, William and Edward (2012) titled “Audio Visual Teaching Method and Apparatus” 32 students were used for the experiment where 18 out of the 32 students stood before the screen where they have clear view of both audio and visual signals while 14 students stood after the screen away from both audio and visual signals. The main purpose of this study was to determine the effects of audio and visual signals in students’ achievement in learning and came out with the following:

- In teaching students to perform an activity in science (electronics), a one-to-one relationship must exist between the instructor, the activities performed and students, in so far as any specific act is concerned.
- An instruction by the instructor must be followed by a corresponding action of the students.
- The primary and basic difficulty in establishing such one-to-one relationship between the instructor and the students arises from the psychological impediment produced by the inability of the pupil to see and relate the performance of the action by the instructor in direct one-to-one relationship to the student’s own performance of the corresponding action.

The above study of Herbert William and Edward was meant to determine the effect of the teaching method of instruction in students’ achievements using audio visual signals as well as the present study. The difference in the two studies was that Herbert William and Edward’s study was not making any comparison of instructional methods while the present study was meant to compare the effects of three methods of instruction on students.

In another study titled “Conceptual Visual Training Methods by Chen (2012) adopting two key piagetian principles, two groups of students numbering 28 were brought together and information on the task given before stratifying them. One group was allowed to perform the task after the information while the other group was allowed to perform the task after they have been connected with the real activities audio visually. As a result, the researcher came out with the following findings:

- Learning is an active process and should be real.
- Referencing his first principle, it is important for information to be presented as a tool to solve problems and so information must be associated with real activities that have meaning for the learner.
- It is important that information to be learned can be seen by learner as associated with the instruction to be a tool that will help him understand the content better.

The similarities between the present study and Chen (2012) study were that they are dealing with two groups as well as given prior information on the expected task before the experiment. The difference between the present study and Chen was that the present study compared the effects of three different methods of instruction while Chen was only using visual instructional method and its effect on students’ achievement.

### **Guided Discovery Method of Instruction and Performance**

In a study by Reid, Zhang and Chen (2013) titled “Discovery Learning” using a computer stimulated learning environment dealing with the floating and sinking of objects in water. The main purpose of the study was to examine three spheres of support (Interpretative, Experimental and Reflective Support). The following findings were made among others (a) the students

were able to generate the hypotheses and construct coherent understanding (b) increases students self awareness of the learning process and prompt reflection and discovery (c) enhance the learners' experimental activities and manifest prominent effects on the discovery of rules and meaningfulness of the discovery process and promote application of discovered rules. The study by Reid, Zhang and Chen and the present study were all practical based and students participatory. The study by Reid, Zhang and Chen concentrated only on one method of instruction with one group contrary to the present study that dwelled on comparison of three methods and two groups (experimental and control groups)

In another study, Anyigbo (2005) titled 'the effect of guided discovery, cognitive styles and cognitive development' using 330 Senior Secondary 2 (SS 2) students in eight sample schools. The main purpose of the study was to examine the effects of guided discovery, cognitive style and cognitive development to lecture method in two physics topics. The subjects were pretested followed with post-test after six weeks. A 2x3x2 analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significant. The researcher avers that after the analysis, the testing of hypothesis revealed that students who were exposed to guided discovery method of instruction had better mean performance scores in physic than those exposed to lecture method. The above finding which Anyigbo revealed was in agreement with that of Ali (2013), Vinell, Mathew and Abyankar (2011) and Ovute (2011) who found that guided discovery method of instruction performed better because students were actively involved in the lesson which is discovery activities. Therefore, the findings from the researchers that students exposed to guided discovery method of instruction perform better are reality not misleading.

### **Project-Based Method of Instruction and Performance**

In a study on contextualizing instruction by Krajcik (2004) reported on a group of 11 experienced United State science teachers (10 middle school and one elementary). The main purpose of the study was to investigate the challenges teachers might face in learning to implement project-based instruction. The duration of the investigation was six to eight weeks and the analysis of the investigation showed that: (a) teachers like teaching science through project approach; (b) project-based method was more effective in promoting critical thinking, observation and group works skill that traditional method. The similarities of the Krajcik study and present study was that project-based method of instruction was adopted but the present study was comparing project-based method with other two methods of instruction (visual projection and guided discovery) also Krajcik made use of teachers while the present study used NTC II students studying practical electronics works in technical colleges.

Beckett (2009) in a study titled project-based instruction in a Canadian secondary school. The purpose was to investigate the implementation of project-based instruction by teacher in an English as a second language (ESL) Canadian Secondary school. The findings from the analysis of data collected through observation and interview from teachers and students indicated that teachers favoured project-base instruction because:

- It allowed them to take an integrated approach to language and science teachings (ie integrated language, content, and skills).
- It allowed the students to foster critical thinking and problem solving skills and promotes independent as well.

Science students on their own part evaluated project based instruction positively while their counterparts in the English department did not whole

heartedly endorse project-based instruction despite their apparent success in project work. The difference between Beckett and present study was in the means of data collection while Beckett uses observation and interview from students. The present study used students' achievement scores

In another study by Lakovos (2011) titled "Teacher Experiences and Students' Responses in Project-based Instruction. The main purpose of the study was to examine the United States Teachers experiences in implementing project-based instruction for the first time and to also examine students' attitudinal and proficiency responses to project-based instruction

The teacher who participated in the study indicated that she was impressed by the oral presentation skills that all her students gained from their experience of project-base instruction and by the fact that they designed a real life activity as part of the project. However, she also reported frustration and tensions that followed project-based instruction. She found that negotiating the curriculum with the students regarding project-based instruction was complex and demanding. Summarizing the dilemmas reported by the students in Beckett and Lakovos studies on project based instruction, from a dilemmatic perspective suggested by Billing, Condor, Edward, Gane, Middleton and Radley (2013) on ideological dilemmas and Liang (2012) on dilemmas of corporative learning said students may have had mixed feelings about project based instruction because project work like everyday life is complex and full of dilemmas.

Jonassen (2006) carried out another research titled "Constructivist Learning". In this study, Jonassen identified three major roles for facilitators to support students in constructivist learning environment such as modeling, coaching and scaffolding. Jonassen gave examples to support his identifications using

Faraday's candle developed from Christmas lectures Faraday gave on the functioning of candles. Using these lectures as basis, students are encouraged to discover for themselves how candle works. The students started the construction by simple observations, from which they later build ideas and hypotheses which they then go on to test. The findings of the study proved that: (a) students can use this lesson to understand the components of combustion (b) learning by doing can be among the most effective way of instructing students and also that the learning goals must be engaging relevant but not overly structured. The study by Jonassen was initiated through pre-instruction before the actual activities by the students just as the present study on project-based method of instruction group. In both studies, the students were given real problems and allow to develop adequate skills to effectively perform work task ahead. The contrast in the Jonassen study and the present study was that Jonassen made use of Faraday candle development while the present study use fault finding procedures. The result proves that students can use this lesson to understand the components of combustion. These ideas suggest that in the learning environments, learning by doing can be among the effective ways of instructing students. This is because in learning by doing, students are given real problems and develop adequate skills to effectively perform work tasks.

### **Summary of Related Literature**

This chapter reviewed the available and relevant studies under the following sub-headings:

- i. Conceptual framework
- ii. Theoretical framework
- iii. Theoretical studies

- iv. Empirical studies on methods of instructional delivery yielded the following information which forms the basis in the summary:

Practical electronics works as a course of study, is the skill, knowledge and attitude (KSA) needed by all citizens to survive especially now that the society is dependent on technology driven economy. Visual projection method of instruction portray that as a new innovative technology in teaching and learning that it can enhance compliment teaching and learning in every curriculum area if well managed. Guided discovery method of instruction greatly impacts individualized learning outcome, it is the responsibility of the teacher to set the students up using question to make the desired discovery. In project-based method of instructional delivery system, it is seen as an alternative to the traditional teacher-centered method of teaching and learning.

In teaching and learning, preparing instructional design unsuitable for a particular career environment creates inefficient teaching and lack of motivation on the part of the students. The lack of balance in technological change and system of education reflect primarily on teaching and learning, particularly in practical electronics works. The fundamental problem of curriculum to teaching and learning practical electronics works lies in the clash between the theories of the curriculum developers and those whose responsibilities is to implement. The attitudes of students contribute to the problem of teaching and learning of practical electronics works.

Instructors contribute immensely to the problem of teaching and learning practical electronics works through their attitudes, use of instructional methods, use of inappropriate instructional materials, lack of good command of subject matter and course, lack of ability to plan effectively, lack of promoting equal opportunities for learners, lack of class control and

management. The disparity between the theories of curriculum developers and those responsible to implement; and lack of balance in technological change and planning educational system impede the teaching and learning of practical electronics works.

Some research works have been carried out on visual projection, guided discovery and project-based method of instruction. However, available relevant literature did not treat the effects of selected instructional methods on students' achievement in practical electronics works in Anambra State technical colleges, hence this work is undertaken to fill this gap in knowledge.



## **CHAPTER THREE**

### **METHOD**

This chapter presents the method employed in carrying out this study. It is organized under the following sub-headings:-research design, area of the study, population for the study, sample and sampling techniques, instrument for the study, validation of instrument, reliability of the instrument, method of data analysis.

#### **Research Design**

The design of this study was non randomized comparison groups (pre and post-test) quasi experimental design. The study was carried out in intact classes where all the NTC II students from the four selected technical colleges in Anambra State were used. It is quasi experimental design because subjects did not have the chance of being randomly assigned to control or experimental groups. According to Trochim (2006) quasi experimental designs are used where true experimental designs are not feasible and where random assignment of subjects create problems resulting in the use of intact classroom setting.

To ensure that the outcome of the observation could only be attributed to experimental treatments, the design was such that all the NTC II students from one of the four selected schools were used as control. All other NTC II students from the other three schools were used as experimental groups considering the availability of facilities in the schools. Pre-test was administered to both control and experimental groups. No treatment was administered to the control group but the experimental groups were exposed to experimental treatment using visual projection, guided discovery and

project-based methods of instruction respectively. Thereafter, a post-test was administered to both the experimental and control groups with the same test item used in the pretesting, in order to determine the effects of the treatment on the independent variable.

**Table 1**

**Non-Randomized pre-post-test control group Design**

Grouping	Pre-testing	Experimental Treatment	Post testing
AVPPG	Q <sub>1</sub> AVPPG	ETA VPPG	Q <sub>2</sub> AVPPG
SDPG	Q <sub>1</sub> SDPG	ETSDPG	Q <sub>2</sub> SDPG
PBPG	Q <sub>1</sub> PBPG	ETPBPG	Q <sub>2</sub> PBPG
CGRP	Q <sub>1</sub> CGRP	—	Q <sub>2</sub> CGRP

**Keys:**

- Q<sub>1</sub> AVPPG: Pretest for visual projection method group.
- Q<sub>1</sub> SDPG: Pretest for guided discovery method group.
- Q<sub>1</sub> PBPG: Pretest for project-based method group.
- Q<sub>1</sub> CGRP: Pretest for control group.
- ETA VPPG: Experimental treatment for visual projection method group
- ETSDPG: Experimental treatment for guided discovery method group
- ETPBPG: Experimental treatment for project-based method group
- CGRP: control group (no experimental treatment)
- Q<sub>2</sub> AVPPG: Post-test for visual projection method group.
- Q<sub>2</sub> SDPG: Post-test for guided discovery method group.
- Q<sub>2</sub> PBPG: Post-test for project-based method group.
- Q<sub>2</sub> CGRP: Post-test for control group.

### **Area of the Study**

This study was carried out in Anambra State of Nigeria. Nigeria is divided into six geo-political zones. Anambra State is located in South East geo-political zone of Nigeria. The population of Anambra state is about 4,182,032 with the state capital and seat of the government situated in Awka. About 98% of Anambra State population are Igbos whose major occupation are agriculture, commerce and establishment of industries. The state places much emphasis on the development of electronics industries/institutions as can be exemplified by the establishments of various electronics development institutions such as National Engineering Design Development Institute (NEDDI) Nnewi, Electronic Development Institute (ELDI) Ukpo, Scientific Equipment Development Institute (SEDI) Enugu with one of its branches located at Awka. With the location of these institutions and establishment of Technical Colleges offering practical electronics works, Anambra State is qualified to be chosen for the study.

### **Population for the Study**

The population for the study was 102 National Technical Certificate II (NTC II) students from three senatorial zones in Anambra State offering practical electronics works as a course (see, appendix C, p. 133). The NTC II students were chosen because they are in the middle class who are not affected either by being in a new level of education like NTC I or NTC III approaching external examination such as National Business and Technical Examination Board (NABTEB). The school managements usually frown at research work that involves their examination classes.

The sizes of three experimental groups used for the study were 36, 26 and 25 subjects respectively while the control group was 15 subjects all these being

the total number or intact classes of NTC II students in the chosen schools offering practical electronics works. These colleges were randomly assigned to experimental groups and control based on the fact that the selected technical colleges have the required facilities for practical electronics works, since they are all approved by NABTEB to present their students for final NTC examination as were confirmed by the Science and Technical Department of Post Primary School Service Commission, Awka, Anambra State. Therefore, there were three experimental groups and one control group with a total population of 102 subjects (see, appendix C, p. 133).

### **Sample and Sampling Techniques**

There were no sample and sampling techniques. Intact classes of all the NTC II students offering practical electronics works were used for the study.

### **Instrument for Data Collection**

The instrument for data collection was “Practical electronics works test” labeled (PEWT). PEWT consist of test items generated by the researcher based on the scheme of work for the period under study. To generate the items, a test blue print was accordingly prepared as shown in Appendix J, page 163. The items were constructed to reflect the specification in the blue print. There were 20 objective items classified into two sections (A and B) with four response options (a, b, c and d) with only one correct answer among the alternatives such that each distracter was made to be as plausible as the correct answer. The items in section A were items numbers 1–15 while section B were items numbers 16–20 which covered knowledge, comprehension, application and interpretation domains. Each behavioral

objective was adequately taken care of and the items were good representatives of the topic on trouble shooting.

The items generated were based on the National Board for Technical Education (2013) scheme of work for NABTEB. The items were used for both pre and post-test assessment.

### **Validation of the Instrument**

The instrument (PEWT) was validated by four practical electronics works instructors in technical colleges and two lecturers in the Department of Vocational Education, Nnamdi Azikiwe University, Awka. The experts were presented with the purpose of study, scheme of work of the students in practical electronics works and the test items generated by the researcher for effective validation. The experts carried out both face and content validation exercises on these twenty items generated by the researcher, the experts carefully examined the test items along side with the other materials tendered and made necessary corrections. The experts confirmed the extent the items covered the content and the purpose of the study. The opinions of experts in practical electronics works were considered and their comments led to the modification of the test items either by rewording certain items on account of seeming difficulty. Care was also taken to ensure that there were no ambiguous items and no inter locking items that remove the effects.

### **Reliability of the Instrument**

Pilot test was carried out in Imo State using four technical colleges that were offering practical electronics works. The colleges selected were assigned to experimental and control groups with intact class sizes of 22, 17, 21 and 20 respectively. The colleges and their subjects did not participate in the main

study. Testing for the reliability of the instrument using pre and posttest scores, the Pearson Product Moment Coefficient was calculated. The calculated value of 0.71 was obtained showing that the instrument was highly reliable.

### **Experimental Procedure**

The units under the topic in troubleshooting selected for this study were procedures and instrument/equipment for fault finding. The researcher confirmed that the units have not been taught to the subjects before the commencement of this study. A pretest was administered to all the subjects in control and experimental groups from the selected technical colleges. The three experimental groups (visual projection, guided discovery and project-based groups) were assigned to the three instructional methods: visual projection, guided discovery and project-based methods of instruction. Each of these experimental groups were treated using either visual projection, guided discovery or project-based method of instruction while the control group was not subjected to any of the experimental treatments. The class instructors were used as research assistants for both the treatment and administration of the tests after briefing and acquainting the research assistants with the instructional objectives for the topic, expected facilities and task achievements of the students in each of the instructional methods used by the researcher for the study. The research assistants were also briefed on the theoretical instructions of the instructional methods and evaluation procedures.

All the subjects in the experimental groups must be administered with pre-test. The three technical colleges for the experimental treatment were selected from each of the three zones of Anambra State for a particular method of instruction, in order to take care of extraneous variables such as intra and interaction variable and so on. The selection was also based on the fact that all the technical colleges in Anambra State have required facilities for practical electronics works.

### **Administration of Pretest**

Pretest of 45 minutes was administered on the subjects. The pre-test was carried out before the experimental treatment in order to determine the initial equivalence of the subjects and also to ascertain their level of achievement after treatment.

### **Experimental Treatment**

The topic was taught to the subjects in the experimental groups step by step, as was in the planned academic scheme of work for the NTC II students in practical electronics works based on the set objectives of the topic, for a period of three weeks of two hours and forty minutes per week (see Appendix E – G, P. 136-158).

The experimental groups, AVPPG, SDPG and PBPG were treated simultaneously using visual projection, guided discovery and project-based methods of instruction for the period of three weeks. Each experimental group was subjected to conducive experimental environment suitable for each method of instruction before administering the treatment.

### **AVPPG Group Treatment**

The subjects for the AVPPG were assembled in the electronics works workshop and the instructor/Assistant provided audio signal, supplementing it with series of images projected on a screen with the aid of a slide-projector. The attention of the subjects were directed onto the screen through audio-music and the topic units in trouble shooting were treated step by step through audio visual signals. The above procedures were repeated throughout the periods of the study. As the subjects focused attention on the screen, step by step procedures of determining faults in a television set (TV) were projected using block diagram of a television receiver. The subjects were allowed to ask questions where necessary and answers provided by the instructor on the process.

### **SDPG Group Treatment**

The concepts in trouble shooting (fault finding) and the environment were introduced to the subjects, using questions, demonstrations, provision of necessary materials and accepting questions from subjects. These inductive techniques provided information that allowed subjects perform the task for expected achievement. The instructor acted as facilitator, guide and adviser to the subjects rather than acting as primary source of knowledge.

The subjects explored, took ownership of conception and solution processes, making use of available resources and depended on the support of the instructor to become effective thinkers and evaluator of fault finding in television sets.



### **PBPG Group Treatment**

The subjects were exposed by the instructor on the concepts of trouble shooting (fault finding) in a television set and what was expected of them to learn from the task. The instructor instructed the subjects to explore into the expected task without any guide but paid careful attention to work processes by the subjects and interacted regularly with them during the learning processes. The subjects applied the knowledge gathered from the method of instruction to execute the project on fault finding in television sets and later presented the processes and procedures involved to arrive at a particular result.

### **CGRP (Control group)**

The subjects in the control group were not subjected to any of the experimental treatments for the period of three weeks before pre and post-test were administered. To determine the effect of the treatment on the experimental groups the scores of the control and experimental groups were compared.

### **Administration of Post-test**

After the administration of the treatment on the experimental groups, which was made to cover 10 units on fault finding in television set, the researcher with the help of the research assistants administered a post-test using the same instrument as in pretest. The post-test was administered on both experimental and control groups. The scores of the subjects in post-test were compared with their scores in the pretest to determine the effect of the treatments (visual

projection, guided discovery and project-based methods of instruction) on students' achievement in practical electronics works.

### **Extraneous Variables**

The results of this experiment may be distorted by some extraneous variables if not controlled by the researcher/experimenter as identified by Gerber and Green (2012). These are variables other than independent variables whose effects are of interest to the researcher that may have an effect on the outcome variables being studied. Such extraneous variables are: Preparatory, experimental, subjects, situational, intra and interaction variables.

**Preparatory Bias:** Preparatory bias is when the instruments for gathering data are unreliable, inaccurate and inappropriate, that the result generated is meant to be biased. To control this factor, the researcher made sure that the instruments are reliable, accurate and appropriate. Furthermore, the researcher and assistants consented on a specific date and time for the experiment, arrangements of gadgets/equipment were made earlier before the commencement of the experiment, all experimental groups started at the same time and date and stopped at the same time and date.

**Experimental Bias:** The characteristics of the experimenter may influence positively or negatively on the behaviour of subjects, which might affect the end result of the study. Therefore, to control such bias, the experimenter displayed equal attention and attitude required by all the subjects.

**Subject Bias:** The characteristics of the learners used in the study might affect the end result of the study. These characteristics include age, health, status, background and so on. To control such bias, the experimenter ensured that these attributes were considered during selection of the subjects by using

subjects that are mainstreamed, where the subjects in the experimental and control groups used for the study were assumed being equivalent before the experiment. Analysis of covariance (ANCOVA) was also used in analyzing the data collected which in itself corrects for non-equivalence of groups for any experimental study.

**Situational bias:** These are feature of the environments in which the study or research was conducted; which have a bearing on the outcome of the experiment in a negative way. Examples electricity, temperature, level of activity, time of the experiment and so on. To control this bias, the experimenter ensured that the environment is conducive for the study.

**Intra and Interaction Bias:** These are actions of the subjects within and outside the environment to influence the outcome of the study. To control this bias, the experimenter ensured strict supervision of the subjects during pre and post-test administration. Also the experimenter stucked to the use of NTC II students of practical electronics works in a particular college for a specific teaching method. This discouraged students going with their friends in the same group and exchanging views.

### **Control of Extraneous Variables**

Trochim (2006) identified some major threats to internal validity of instruments to include instrumentation, pretest sensitization, differential selection of subjects, experimental attrition, therefore, the researcher made effort to ensure that the validity of the design of experiment is not threatened.

**Instrumentation:** The instrument which is unreliable and inconsistent may result in an invalid assessment of achievement (Gerber & Green, 2012). This

may occur due to unequal difficulty level of pre and post-test instrument, non-standardized instrument by the assistant/researcher. Hence, to ensure internal validity of instrument, reliability test was carried on the instrument. In this study, a high coefficient was recorded as stated in the section for reliability of the instrument. The researcher trained research assistant who were used for the study and the test items used in the purposive selected technical colleges were developed by the researcher. All these precautions helped the researcher to ensure that the research assistants were uniformly evaluating behaviors of the subjects.

**Pretest Sensitization:** This influences scores on the post-test and heightening the subjects' sensitivity to the experiment. This will occur where there is a short time gap between the pre and post-test and more so where the testing is based on facts which can be relayed through recall. Based on this research, the time gap during the pre and post-test was three weeks while the pretest sensitization was controlled through the test gaps. The test item took care of all the behavioral levels in formative cognitive testing which is more encompassing than recall of information. It emphasized on three levels, comprehension, application and analysis which cannot be threatened by pretest sensitivity (Ary & Cheser, 2010).

**Differential Selection of Subjects:** The researcher used intact classes for both experimental and control groups, therefore, the selection of the subject was non randomized and can encourage in-equivalency in respect to variables of interest. The perception of subjects in different classes may differ before the study begins which may account for the post-test difference (Trochim, 2006). To avoid this threat of selection bias on the internal validity, the researcher used the entire subjects of NTC II in the selected colleges. A

pretest was administered on both control and experimental groups to determine their initial equivalence before a post-test. Analysis of covariance (ANCOVA) was used in analyzing the data collected because it took care of non-equivalence of groups used for any experimental study (Trochim, 2006).

**Experimental Attrition:** Attrition may likely occur in a study which might result with a dropout of a group or individual whose essence will definitely affect the outcome of the study. Attrition may also occur as a result of prolongation of the experiment, lack of motivation, boredom and so on. To avoid the occurrence of experimental attrition, the researcher ensured immediate follow up instruction and administration of post-test and also provided necessary facilities for a particular instructional method with appropriate appraise of the subjects for excellence participation in the experimental notice.

### **Method of Data Analysis**

In answering the research questions, mean achievement scores were used to determine the differential achievement of those treated with visual projection and guided discovery methods of instruction, visual projection and project-based methods of instruction, guided discovery and project-based methods of instruction also experimental and control groups. To test the hypotheses, analysis of covariance (ANCOVA) was used in analyzing the achievement scores of NTC II students taught practical electronics works using:-

- Visual projection and guided discovery methods of instruction.
- Visual projection and project-based methods of instruction.
- Guided discovery and project-based methods of instruction.

ANCOVA was suitable in testing all these hypotheses at 0.05 level of significant because it has to take care of in-equivalency existing in the subjects and unequal sample sizes of the groups (Trochim, 2006). The extent of differences in achievement scores of the subjects when compared in the three groups respectively determined the most effective methods to teach practical electronics works in technical colleges for better achievement among the subjects.

### **Decision Rule**

In answering the research questions, the most effective method of instruction would indicate the highest mean achievement score. The null hypotheses were accepted when the calculated values of  $F$  were less than the critical  $F$ -value while the null hypotheses were rejected when calculated values of  $F$  were equal to or greater than  $F$ -critical value.

## CHAPTER FOUR

### PRESENTATION AND ANALYSIS OF DATA

This chapter presents the analysis of the data collected in the study in order to answer the research questions and interpret the null hypotheses. The research questions and null hypotheses were orderly analyzed and presented below.

#### Analysis of Data Related to Research Questions

##### Research question 1

What is the mean achievement scores of NTC II students taught practical electronics works before the application of the treatments of visual projection, guided discovery and project-based methods of instruction?

**Table 2: Mean Achievement Score for Pretest**

S/N	Methods	Pre Test $\bar{x}$	Remark
1	Visual Projection Method	7.5	Visual projection group yielded highest achievement score
2	Guided Discovery Method	5.9	
3	Project-Based Method	5.2	
4	Control group	5.4	

Table 2 shows that the pretest mean achievement score of students taught practical electronics works using visual projection, guided discovery and project-based methods of instruction and control groups were 7.5, 5.9, 5.2 and 5.4 respectively. The implication of pretest was to determine the level of achievements of the subject before and after the treatment. The pretest mean achievement scores shows that the subjects in the visual projection group achieved better than those in the other groups.

### Research Question 2

What is the mean achievement scores of NTC II students taught practical electronics works using visual projection, guided discovery and project based methods of instruction respectively?

**Table 3: Mean scores for Visual Projection, Guided Discovery and project-Based methods of instruction**

<b>Method</b>	<b>Mean Scores</b>	<b>Remark</b>
Visual projection	16.5	Project-based group yielded highest achievement score.
Guided Discovery	16.7	
Project-Based Method	17.2	

Table 3 shows that the mean achievement scores for visual projection method, guided discovery method and project-based method of instruction are 16.5, 16.7 and 17.2 respectively. The table shows that the project-based method of instruction yielded highest achievement score.

### Research Question 3

Which of these three methods of instruction, visual projection, guided discovery and project-based methods of instruction, yielded best students achievement in practical electronics works?



**Table 4: Mean Achievement scores of visual projection, guided discovery and project-based methods of instruction**

S/N	Methods	Pre Test $\bar{x}$	Post-test $\bar{x}$	Achievement $\bar{x}$ Gain	Remarks
1	Visual Projection Method	7.5	16.5	9.0	Project-based method yielded best mean achievement score
2	Guided Discovery Method	5.9	16.7	10.8	
3	Project-Based Method	5.2	17.2	12.0	

Table 4 shows that the mean achievement scores of NTC II students taught practical electronics works using visual projection, guided discovery and project-based methods of instruction before the experimental treatments were 7.5, 5.9 and 5.2 respectively while their post-test mean achievement scores recorded were 16.5, 16.7 and 17.2. The mean achievement difference for pre and post-test for visual projection, guided discovery and project-based method of instruction were 9.0, 10.8 and 12.0. The result shows that project-based method of instruction had best effect on students achievement in practical electronics works than guided discovery and visual projection methods of instruction. However, Table 4 also shows that the mean achievement score of the subjects taught using guided discovery method of instruction was slightly higher than the subjects taught using visual projection method of instruction.

#### **Research question 4**

What is the difference in the mean achievement scores of NTC II students taught practical electronics works using visual projection and those taught using guided discovery methods of instruction?

**Table 5: Mean Achievement score difference for Visual projection and Guided Discovery methods of instruction**

<b>Method of instruction</b>	<b>Mean Score</b>	<b>Difference <math>\bar{x}</math></b>
Visual Projection	16.5	0.2
Guided Discovery	16.7	

Table 5 shows that the mean achievement score of students taught practical electronics works using visual projection and guided discovery methods of instruction were 16.5 and 16.7 respectively. The difference between their mean achievement scores was 0.2, indicating that those taught using guided discovery method of instruction achieved slightly higher than those taught using visual projection method of instruction.

### **Research Question 5**

What is the difference in the mean achievement scores of NTC II students taught practical electronics works using visual projection and those taught using project based methods of instruction?

**Table 6: Mean Achievement Score difference for visual projection and project-based methods of instruction**

<b>Methods of instruction</b>	<b>Mean Score</b>	<b>Difference <math>\bar{x}</math></b>
Visual projection	16.5	0.7
Project-based	17.20	

Table 6 shows that the difference in the mean achievement score of students taught practical electronics works using project-based method of instruction and those taught using visual projection method of instruction was 0.7. This

indicates that those taught practical electronics works using project-based method of instruction achieve slightly higher than those taught using visual projection method of instruction.

### **Research Question 6**

What is the difference in the mean achievement scores of NTC II students taught practical electronics works using guided discovery and those taught using project based methods of instruction?

**Table 7: Mean Achievement score difference for guided discovery and project-based methods of instruction**

<b>Method of instruction</b>	<b>Mean Score</b>	<b>Difference <math>\bar{x}</math></b>
Guided discovery	16.7	0.5
Project-based	17.20	

Table 7 shows that the difference in the mean achievement score of students taught practical electronics works using project-based methods of instruction and those taught using guided discovery method of instruction was 0.5. This shows that the achievement scores of the students taught practical electronics works using project-based method of instruction is higher than those taught using guided discovery method of instruction.

### **Research Question 7**

What is the difference in the mean achievement scores of NTC II students in the experimental groups and those in control group?

**Table 8: Mean Achievement Score difference for Experimental and Control Groups**

Group	Mean Score	Difference $\bar{x}$
Experimental	16.71	11.31
Control	5.4	

Table 8 shows that the difference in the mean achievement score of the experimental group and control group was 11.31. Therefore, there was indication that the experimental treatments enable the experimental group to have higher achievement than the control group.

### Analysis of Data Related to Hypotheses

#### Hypothesis 1

NTC II students taught practical electronics works using visual projection method of instruction will not differ significantly in their mean achievement scores from those taught using guided discovery method of instruction.

**Table 9: Analysis of Covariance table for Visual Projection and Guided Discovery Groups**

Source of Variation	DF	SS	MS	$F_{cal}$	$F_{tab} (0.05)$	Significance
Treatment + Error	69	389.93				No significance
Treatment	35	190.36	5.44	$\frac{5.44}{5.87} = 0.92$	1.74	
Error	34	199.57	5.87			

Table 9 shows that the methods have an F value of 0.92 and it has no significance at 0.05 probability level. Since  $F_{cal}$  is less than  $F_{tab}$ , the null hypothesis with respect to the methods was accepted. Therefore, it was

concluded that there was no significant difference between the achievement scores of NTC II students taught practical electronics works using visual projection and those taught using guided discovery methods of instruction.

### Hypothesis 2

NTC II students taught practical electronics works using visual projection method will not differ significantly in their mean achievement scores from those taught using project-based method of instruction.

**Table 10: Analysis of Covariance table for Visual Projection and Project-Based Groups**

Source of Variation	DF	SS	MS	$F_{cal}$	$F_{tab} (0.05)$	Significance
Treatment + Error	69	346.62				
Treatment	35	113.31	3.24	$\frac{3.24}{6.86} = 0.47$	1.74	No significance
Error	34	233.31	6.84			

The analysis of covariance in Table 10 on the mean achievement scores of NTC II students taught practical electronics works using visual projection and project-based methods of instruction show that there was no significant difference at 0.05 probability level. It was therefore concluded that visual projection and project based methods of instruction do not differ in their achievement.

### Hypothesis 3

NTC II students taught practical electronics works using guided discovery method will not differ significantly in their mean achievement scores from those taught using project-based method of instruction.

**Table 11: Analysis of Covariance table for Guided Discovery and Project-Based Groups**

Source of Variation	df	Ss	Ms	F <sub>cal</sub>	F <sub>tab (0.05)</sub>	Significance
Treatment + Error	49	275.45				
Treatment	25	10.36	0.4144	$\frac{0.4144}{11.045} = 0.04$	1.96	No significance
Error	24	265.09	11.045			

Table 11 shows that there was no significant difference in the mean achievement scores of NTC II students taught practical electronics works using guided discovering and project-based methods of instruction with a calculated F of 0.04 which is much lower than the critical F of 1.96. This indicates that there was no significant difference in the mean achievement scores of NTC II students taught practical electronics works using guided discovery and those taught using project-based methods of instruction.

#### Hypothesis 4

NTC II students taught practical electronics works using visual projection method will not differ significantly in their mean achievement scores from those taught using guided discovery method and those taught using project-based method of instruction.

**Table 12: Analysis of Covariance table for Visual Projection, Guided Discovery and Project-Based Groups**

Source of Variation	DF	SS	MS	F <sub>cal</sub>	F <sub>tab (0.05)</sub>	Significance
Treatment + Error	104	563.81				
Treatment	69	345.87	5.02	$\frac{5.02}{6.23} = 0.81$	1.65	No significance
Error	35	217.94	6.23			

The analysis of covariance (ANCOVA) in Table 12 on visual projection, guided discovery and project-based methods of instruction show that the mean achievement scores yielded no significant difference at 0.05 level of significant. Since  $F_{cal}$  was less than  $F_{tab}$ , we accepted the null hypothesis that there was no significant difference between visual projection, Guided discovery and project-based methods of instruction in the achievement of NTC II students taught practical electronics works.

### **Summary of the Findings**

From the analysis of data above, the major findings were summarized as follows:

1. Project-based method of instruction had highest effect on students' achievement in practical electronics works than guided discovery and visual projection methods of instruction (Table 4)
2. There was a margin of 0.05 in the mean achievement score of NTC II students taught practical electronics works using visual projection and guided discovery methods of instruction (Table 5)
3. There was difference of 0.73 (Table 6) in the mean achievement scores of NTC II students taught practical electronics works using visual projection method and those taught using project-based method of instruction.
4. There was difference of 0.55 in the mean achievement scores of NTC II students taught practical electronics works using guided discovery and project-based methods of instruction (Table 7).
5. Analysis of covariance was used to test the hypotheses at 0.05 level of significance, the analysis show that there was no significance

difference in the achievement of NTC II students taught practical electronics works using visual projection and guided discovery methods of instruction (Table 9).

6. Students taught practical electronics works using visual projection and those taught using project-based methods of instruction did not differ in their achievement scores (Table 10).
7. Students taught practical electronics works using guided discovery and those taught using project-based methods of instruction did not differ significantly in their mean achievement scores (Table 11).



## **CHAPTER FIVE**

### **DISCUSSION OF FINDINGS, CONCLUSION AND RECOMMENDATIONS**

This chapter deals with the discussion of the findings, implications of the study, conclusion, recommendations, limitations of the study and suggestion for further studies.

#### **Discussion of the Findings**

The discussion of the results is presented based on the seven research questions that guided the study and four null hypotheses formulated for the study.

#### **Research Question 1**

The pretest mean achievement scores show that the subjects in the visual projection group achieved better than those in the guided discovery and project-based groups before the post-test administration.

#### **Research Question 2**

The project-based method of instruction yielded highest achievement score when compared with visual projection and guided discovery methods of instruction.

#### **Research Question 3**

The mean achievement scores of subjects taught using project-based method of instruction was slightly higher than the subjects taught using visual projection and guided discovery methods of instruction.

**Research Question 4**

Subject taught using guided discovery method of instruction achieved slightly higher than those taught using visual projection method of instruction.

**Research Question 5**

Subjects taught practical electronics works using project-based method of instruction achieved higher than those taught using visual projection method of instruction.

**Research Question 6**

The achievement scores of the subjects taught practical electronics works using project-based method of instruction is higher than those taught using guided discovery method of instruction.

**Research Question 7**

There was indication from the result that the experimental treatments enable the experimental group to have higher achievement than the control group.

**Hypothesis 1**

**Finding:** After the analysis, the testing of the hypothesis shows that the null hypothesis with respect to the methods was accepted.

## **Discussion**

This result agrees with the finding of Lahatte (2009) who found audio visual learning to be lively with vibrant colours and outstanding quality that enable teachers to do what they do best and inspired their learners to achieve more in their learning outcome while Kirschner, Sweller and Clark (2006) had the same confirmation on guided discovery learning as Lahatte in audio visual learning that guided discovery learning equips the learners and develop their mind by using it solve problems through experiences by contact with materials and appliances creating a lasting learning effects. Leonard and Delacey (2002) consented with the result of Howard Gardener's research on multiple intelligence that by employing instruction methods such as visualization and discovery learning, experiences are richer for all students. Therefore, the finding that both visual projection and guided discovery methods of instruction do not differ in students achievement is accepted.

## **Hypothesis 2**

**Finding:** The finding of the study shows that the hypothesis was accepted and not rejected.

## **Discussion**

This result aligned itself with the finding of Thomas (2008) who found project-based learning as learning that enable students to transfer their learning to new kinds of situation, making students gain in factual learning which are equivalent or superior to those students in traditional and other methods of instruction. Thomas also proffer that, when students are put into situation where they learn by doing, they most likely be more successful than if they were just told how something need to be done. This findings may be

attributed to several factors, such as flexibility of curriculum, inadequacy of instruction materials and man power (Nwadinigwe, 2009). Therefore, the findings that both the mean achievement scores of visual projection and project-based methods of instruction do not differ are not misleading.

### **Hypothesis 3**

**Finding:** After the analysis, the testing of hypothesis shows that the null hypothesis was upheld, that it is not rejected.

### **Discussion**

The findings does not support the finding of Ali (2013), Vinell, Matthew and Abyankae (2011) and Ovute (2011) who find that guided discovery method of instruction is more effective than other methods contrary to the finding of the researchers, this study shows that the NTC II students exposed to guided discovery and project-based methods of instruction in practical electronics works performed equally.

### **Hypothesis 4**

**Finding:** The finding of the study shows that the hypothesis was not rejected but accept at 0.05 level of significant.

### **Discussion**

The study shows that the three methods of instruction impacted equally on the achievement of NTC II students in practical electronics works.

The result of the study agreed with the findings of the following researchers on the capability of the three methods of instruction for better achievement of NTC II students in practical electronics works. For guided discovery method

of instruction, Mayer (2014) avered that the basic idea of guided discovery method of instruction is to provide learners the ability to design their own experience in the domain and infer the rules of the domain while Vithal, Christiansen and Skovsmose (2006) inferred that project-based method of instruction is exploratory in nature because what students learn during their project work cannot always be anticipated in advance rather, it provides opportunities for intrinsically motivating students to learn and foster problem solving skills. Damasio (2012) in visual projection method of instruction came out with the findings that 75 percent of all information processed by the brain is derived from visual formats. Also that the cognitive modes that support the most complex problem solving and decision making that determines behaviour are primarily initiative and also visual draw on our conscious memories help to make advantageous decision and guide behaviour. However, the above findings agree with the results of the analysis that three methods of instruction impacted equally on the achievement score of NTC II students in practical electronics works.

### **Implication of the findings**

Numerous implications arose from the findings of this study which include:

#### **Instructional Techniques**

In planning a training program, one must adopt techniques/methods that will create efficient teaching and motivation on the part of students. Hence, this will bring to focus the use of visual projection, guided discovery and project-based method of instruction. Instructors can now have a re-orientation that those with differentiated and integrated knowledge have greater ability than those whose knowledge are limited

and fragmented (Lederman & Gess-Newsome, 2012) and also know that one method of instruction cannot serve for all subjects or teaching units/objectives. Combination of methods or perhaps a method is usually appropriate for most subject matters and objectives. The major problem of teaching method and technique lies on teaching planning, teaching knowledge and belief which have a profound effect on all aspect of teaching.

#### **Visual Projection Method of Instruction**

Instructors can achieve the possibility of working with more learners and outside students limited geographical area. Learners who are shy to ask questions and have difficulty keeping peace with other students during face to face instruction may feel more confident in a visual learning class because they visualized whatever learning one after the other by repeating the slide on their own, which create equal opportunities amongst students/learners. Visual projection method in learning may allow learners to learn together regardless of age, gender or creed.

#### **Guided Discovery method of Instruction**

Guided discovery method of instruction can challenge students to solve authentic problems in information rich setting then encourages the students to construct their own solution leading to the most effective learning experience by facilitating retention of knowledge. One deterrent that can arise from this teaching method is that due to the emphasis on students centered or group work, ideas of the more active students might dominate the groups conclusion and if not well guided, may deviate from the end expectation.

### **Project-based method of Instruction**

For project-based method of instruction to survive, the students need parental or guardian support to pursue their project to the end. Project-based instruction can be both a means and an end when there is need at the national, state and local level to implement standards and integrate technology into science teaching and learning. This means that federal, state and local education authority must invest in project-based learning in the form of funding for professional development, curriculum development, research tools, technology changes and materials. Without appropriate level of funding and interest into project-based instruction learning, this method will be a shambles as it will remain a luxury for the few rich schools and individuals.

### **Technological Change and Education**

In any level of educational system, Kuehn (2015) stressed that there must be agreement between globalization and education as inability of following new international order with increase competition due to technological change become major problem of any nation. Therefore the implication of this study is that at any level, government of a particular nation must work on a system of education complying with the changing technology in order to bring the global economy under control so that it meets the need of people.

### **Curriculum development and implementation**

The problem of curriculum to teaching and learning practical electronics works can be reduced only if, the curriculum developers realize that the fundamental changes in classroom/workshop practice can be brought

about only if teachers/instructors become conscious of the current decision and are able to reflect critically on them (Elliott 2005).

Honestly drawing and implementing of the curriculum will be an end to this problem of curriculum, that is when teacher are involved in drawing of curriculum and current curriculum made available to teachers and schools at the right time, the problem of implementation will be cleared . The instructor as well as the students will be willing to accept the course, which will form the basis of that information and knowledge as required.

### **Conclusion**

In the light of this study, the following conclusions were drawn:

1. Following the instructional procedures, using appropriate and adequate facilities required for the three instructional methods respectively, the students from the three sample schools administered with experimental treatments achieved higher in their post-test in contrast to the students in the school used as control group whose achievements in the post-test were equivalent to the former (pretest).
2. NTC II students in the three sample schools who have been treated using the three different instructional methods (visual projection, guided discovery and project-based methods of instruction) after the analysis, the study found that although these students had an improved achievement, the students in the project-based method group achieved more due to the effectiveness of the method.
3. In answering the research question, the mean achievement scores of students taught practical electronics works using guided discovery method of instruction is slightly higher than those taught using visual projection method of instruction but in testing the hypothesis using



analysis of covariance, the result showed that there is no significance difference in the mean achievement scores. The belief is that the three methods of instruction were participating and the knowledge students construct on their own is more valuable to them than that which is presented to them by somebody else.

4. NTC II students taught practical electronics works using visual projection methods and those taught using project-based method of instruction did not differ in their achievement which is proved in the testing of hypothesis.
5. The achievement of NTC II students taught practical electronics works using guided discovery method and those taught using project based method of instruction shows that there is a slight difference while the testing of hypothesis confirmed that the difference is not significant. The result confirmed that the NTC II students taught practical electronics works using guided discovery method and those taught using project based method of instruction did not differ in their achievement scores.
6. Though students in the visual projection method of instruction group made an improved achievement, those in both guided discovery and project-based methods achieve more impressively but the students in the project-based method group made the highest achievements as this method provided them the knowledge to solve problems that were raised in real-world activities.

When instructional media is used for instruction, it increases vastly the ability of a person to remember what was learnt through a combination of seeing and hearing information. The effect of guided discovery method of instruction on students' achievements emphasizes that the teacher must guide the students

properly towards the discovery this can be accomplished by providing appropriate materials and an environment conducive for the students. Project-based instruction is an instruction approach which results in more active involvement, more independent from teachers and cooperation among students.

Finally, using motivational and participatory instructional methods will encourage and engage learners, challenge learners with innovative ideas and expecting the most excellent achievements from learners also teaching students to perform an activity in science and technology and a one-to-one relationship must exist between the instructor, the activity performed and students in so far as any specific act is concerned.

### **Recommendations**

Based on the findings of the study, the following recommendations are made:

1. In adopting visual projection, guided discovery and project-based methods of instruction in teaching and learning, students from diverse groups should be considered. The instructors should design and guide learning experiences in a manner that these diverse groups should be made to develop in-dept knowledge and understanding of practical electronics works.
2. The use of visual projection, guided discovery and project-based methods of instruction should provide adequate knowledge and skills to improve the academic achievement of students in practical electronics works in the technical colleges.
3. When planning to teach practical electronics works the objectives and teaching points must be carefully developed. Visual projection, guided discovery and project-based methods of instruction are to be used and

incorporate into instructional training program which must be realistic, logical and achievable not only by the teacher/instructors but the students as well.

4. In teaching and learning practical electronics works, visual projection, guided discovery and project-based methods of instruction must be included as part of the total instructional plan or integrated into the curriculum, to shift the emphasis from teacher centered to students centered (hands-on-activity) and modify the role of the instructor acting as the only source of information to the students but the students as well with minimal instructional guidance to perform the task.
5. In the use of guided discovery method of instruction, the teacher must guide the students towards discovery by providing all necessary teaching background knowledge to lead the students to the discovery, provide appropriate materials, conducive environment and targeted time for the students to complete the discovery.
6. Guided discovery method of instruction, if used, should consider the large number of varied personal characteristics as well as prevalence of learning problem in children today. Kirschner, Sweller and Clark (2006) observed that a mixed approach that incorporates components of guided discovery learning along with other approaches and more guided teaching would better meet the learning needs of the majority of students in a classroom by accounting for differences between learning styles and capacities.
7. Project-based learning enables the students to transfer their learning to new kinds of situation and collaboration among students which will improve the students academic achievement in practical electronics works.

### **Suggestions for Further Research**

For further studies, the following topics have been suggested as this study did not cover all aspects of instructional methods, and topics in practical electronics works.

1. The effect of visual projection, guided discovery and project-based methods of instruction on students' achievement in other part of this country since this study has been carried out in Anambra State.
2. An experimental study of a similar research work in which the design allows for randomization, so as to strengthen the findings of this study.
3. Similar studies can be carried out in other technical subject options like auto-mechanics, building technology, wood working technology and electrical technology.

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# APPENDICES

## Appendix A

### Achievement/Enrollment of Students in Electronics Works from 2004-2013 in the South East

Year	No. enrolled	No of pass (A1-C6)	No of failure (D7-F9)	% of pass (A1-C6)	% of failure (D7-F9)
2004	179	66	113	37	63
2005	208	61	147	47	53
2006	208	97	111	49	51
2007	167	80	84	49	51
2008	162	109	53	67	33
2009	137	105	32	77	28
2010	228	33	195	14.5	85.5
2011	174	40	134	23	77
2012	123	20	103	16.3	83.7
2013	169	8	161	4.5	95.5
<b>Total</b>	<b>1752</b>	<b>619</b>	<b>1133</b>	<b>384.3</b> or <b>35.3%</b>	<b>615.7</b> or <b>64.7%</b>

**Source: NABTEB Chief Examiner's Annual Report 2013.**

## Appendix B

### Enrollment of Students in Practical Electronics Works and Four other related Options in Vocational and Technical Education courses in South East.

Year	Practical Electronics Work (EW)	Motor Vehicle mechanic Work (MVM)	Electronic Installation and maintenance (EIM)	Mechanical Engineering Craft Practical (MECP)	Metal Work (MW)
2004	179	338	560	298	1064
2005	208	307	688	217	1001
2006	208	257	536	217	867
2007	164	183	530	224	692
2008	162	195	434	214	218
2009	137	182	489	157	197
2010	228	346	608	326	1206
2011	174	366	521	278	1190
2012	123	319	457	227	940
2013	169	323	493	249	1056
<b>Total</b>	<b>1,752</b>	<b>2,816</b>	<b>5,316</b>	<b>2,407</b>	<b>8,431</b>

**Source:** NABTEB Chief Examiner Annual Report 2013.

## Appendix C

### Sample Distribution

	<b>Experimental groups</b>	<b>Control groups</b>	<b>Total</b>
Anambra North	36		36
Anambra South	26	15	41
Anambra Central	25		25
<b>Total</b>	<b>87</b>	<b>15</b>	<b>102</b>

**Appendix D**  
**Reliability Coefficient of Stability for PEWT Using Pearson Product Moment**

S/No	X(Pre-Test)	Y (Post-Test)	x	y	xy	x <sup>2</sup>	y <sup>2</sup>
1	3	16	-1.44	-0.91	1.31	2.07	0.83
2	6	18	1.56	1.09	1.70	2.43	1.19
3	3	16	-1.44	-0.91	1.31	2.07	0.83
4	3	16	-1.44	-0.91	1.31	2.07	0.83
5	6	19	1.56	2.09	3.26	2.43	4.37
6	5	18	0.56	1.09	0.61	0.31	1.19
7	2	16	-2.44	-0.91	2.22	5.95	0.83
8	6	17	1.56	0.09	0.14	2.43	0.01
9	9	17	4.56	0.09	0.41	20.79	0.01
10	3	16	-1.44	-0.91	1.31	2.07	0.83
11	7	18	2.56	1.09	2.79	6.55	1.19
12	5	17	0.56	0.09	0.05	0.31	0.01
13	6	17	1.56	0.09	0.14	2.43	0.01
14	2	16	-2.44	-0.91	2.22	5.95	0.83
15	4	16	-0.44	-0.91	0.40	0.19	0.83
16	5	19	0.56	2.09	1.17	0.31	4.37
17	1	16	-3.44	-0.91	3.13	11.83	0.83
18	5	18	0.56	1.09	0.61	0.31	1.19
19	6	17	1.56	0.09	0.14	2.43	0.01
20	2	16	-2.44	-0.91	2.22	5.95	0.83
21	5	17	0.56	0.09	0.05	0.31	0.01
22	8	17	3.56	0.09	0.32	12.67	0.01
23	8	18	3.56	1.09	3.88	12.67	1.19
24	2	13	-2.44	-3.91	9.54	5.95	15.29
25	2	16	-2.44	-0.91	2.22	5.95	0.83
26	8	17	3.56	0.09	0.32	12.67	0.01
27	1	17	-3.44	0.09	-0.31	11.83	0.01
28	2	16	-2.44	-0.91	2.22	5.95	0.83
29	5	18	0.56	1.09	0.61	0.31	1.19
30	5	18	0.56	1.09	0.61	0.31	1.19
31	5	18	0.56	1.09	0.61	0.31	1.19
32	1	16	-3.44	-0.91	3.13	11.83	0.83
33	2	16	-2.44	-0.91	2.22	5.95	0.83
34	5	19	0.56	2.09	1.17	0.31	4.37
35	2	16	-2.44	-0.91	2.22	5.95	0.83
36	1	16	-3.44	-0.91	3.13	11.83	0.83
37	5	17	0.56	0.09	0.05	0.31	0.01
38	6	17	1.56	0.09	0.14	2.43	0.01
39	2	14	-2.44	-2.91	7.10	5.95	8.47
40	5	17	0.56	0.09	0.05	0.31	0.01
41	5	17	0.56	0.09	0.05	0.31	0.01
42	2	16	-2.44	-0.91	2.22	5.95	0.83
43	8	17	3.56	0.09	0.32	12.67	0.01

## Appendix D (Contn.)

S/No	X(Pre-Test)	Y (Post-Test)	X	y	xy	x <sup>2</sup>	y <sup>2</sup>
44	5	19	0.56	1.09	0.61	0.31	1.19
45	5	17	0.56	0.09	0.05	0.31	0.01
46	5	17	0.56	0.09	0.05	0.31	0.01
47	6	19	1.56	2.09	3.26	2.43	4.37
48	5	19	0.56	2.09	1.17	0.31	4.37
49	5	19	0.56	2.09	1.17	0.31	4.37
50	1	13	-3.44	-3.91	13.45	11.83	15.29
51	6	18	1.56	1.09	1.70	2.43	1.19
52	3	16	-1.44	-0.91	1.31	2.07	0.83
53	7	18	2.56	1.09	2.79	6.55	1.19
54	1	13	-3.44	-3.91	13.45	11.83	15.29
55	3	13	-1.44	-3.91	5.63	2.07	15.29
56	2	16	-2.44	-0.91	2.22	5.95	0.83
57	6	18	1.56	1.09	1.70	2.43	1.19
58	7	18	2.56	1.09	2.79	6.55	1.19
59	3	15	-1.44	-1.91	2.75	2.07	1.19
60	5	18	0.56	1.09	0.61	0.31	1.19
61	6	19	1.56	2.09	3.26	2.43	4.37
62	6	20	1.56	3.09	4.82	2.43	9.55
63	5	18	0.56	1.09	0.61	0.31	1.19
64	3	16	-1.44	-0.91	1.31	2.07	0.83
65	6	19	1.56	2.09	3.26	2.43	4.37
66	6	19	1.56	2.09	3.26	2.45	4.37
67	2	14	-2.44	-2.91	7.10	5.95	8.47
68	5	19	0.56	2.09	1.17	0.31	4.37
69	7	18	2.56	1.09	2.79	6.55	1.19
70	7	18	2.56	1.09	2.79	6.55	1.19
71	3	15	-1.44	-1.91	2.75	2.07	3.65
72	6	17	1.56	0.09	0.14	2.43	0.01
73	4	17	-0.44	0.09	-0.04	0.19	0.01
74	4	18	-0.44	1.09	-0.48	0.19	1.19
75	2	17	-2.44	0.09	-0.22	5.95	0.01
76	5	17	0.56	0.09	0.05	0.31	0.01
77	6	17	1.56	0.09	0.14	2.42	0.01
78	2	12	-2.44	-4.91	11.98	5.95	5.95
79	4	16	-0.44	-0.91	0.40	0.19	0.83
80	8	19	3.56	2.09	7.44	12.67	4.37
	355	1353			175.56	333.54	184.74
	4.44	16.91					

$$r = \frac{\sum xy}{\sqrt{\sum x^2 \sum y^2}} = \frac{175.56}{\sqrt{333.54 \times 184.74}} = \frac{175.56}{248.23} = 0.71$$

X = pretest scores

Y = post-test scores

$X = (X - \bar{X})$

$y = (Y - \bar{Y})$

$X^2 = (X - \bar{X})^2$

$y^2 = (Y - \bar{Y})^2$

## Appendix E

### Week 1

#### Lesson Plan on Practical Electronics Works using Audio Visual Projection method of instruction

<b>Subject:</b>	Practical Electronics Works
<b>Topic:</b>	Block diagram of a television receiver
<b>Class:</b>	NTC II
<b>Duration:</b>	4 x40 mins
<b>Average Age:</b>	16 yrs
<b>Specific Objective:</b>	By the end of the lesson, students should be able to:
	(a)

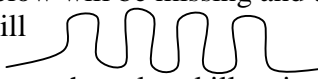
Draw the block diagram of television receiver (b) Explain the functions of each stage and components of the television set in television reception.

**Entry behavior:** Open the back case of a television set. Ask the students if they can identify the stages. Also call their attention on the functions of the components.

#### Instructional Procedures

Step	Time	Content Development	Teacher's Activities	Students' Activities	Instructional Materials	Instructional Strategy/Skill
1	20 mins	The block diagram of a television receiver.	Directs the attention of the students to the screen, using audio music. Asks question such as implication of one stage missing from the diagram of a television receiver. Projects schematic diagram of a television receiver, introduces the lesson topic which is trouble shooting on a television receiver. Explains the stages involved in a television receiver audio visually	Watch and listen very attentively. Participate by answering the question.	Television set, multi meter, signal generator, block diagram of a television set.	Set induction



Step	Time	Content Development	Teacher's Activities	Students' Activities	Instructional Materials	Instructional Strategy/Skill
<b>II</b>	40mins	Functions of each stage of a television receiver	Explain the function of each stage of television receiver to the students audio visually.	Watch and listen attentively.	Television analyzer, multimeter, pattern generator, block diagram of a television set.	Explanatory
<b>III</b>	40mins	Sync stage	Asks the students to point on the block diagram identifying where the output of colour burst is applied. Explains that the colour sync stage receives the colour sync burst and uses it to control the frequency and phase of its own crystal controlled 3.58MHZ oscillator. Emphasis is on the output of the colour sync stage which must be a continuous 3.58 MHZ sine wave. This output will be in frequency and phase with the original signal transmitted from the television station.	Listen very attentively and ask questions where necessary.	Block diagram of a television set, television analyzer.	Explanatory/ Participatory
<b>IV</b>	40 mins	Function of sync stage	The sync signals is used in the colour decoder for synchronous demodulation of phase and amplitude of the 3.58MHZ colour sub carrier. Highlights on monochrome transmission that the colour sync burst shown below will be missing and this will  Cause the colour killer circuit to set up a strong bias on the 3.58MHZ amplifier stage, cutting off any colour subcarrier signal to the colour decoder.	Ask questions at interval as the teacher makes highlights on the function of sync stage.	Block diagram of a television set.	Explanatory

Step	Time	Content Development	Teacher's Activities	Students' Activities	Instructional Materials	Instructional Strategy/Skill
V	10 mins	Evaluation	<p>Evaluates the lesson with the following questions: (a) what will happen to colour sync burst during monochrome transmission? (2) The output of the colour sync stage is always a continuous _____.</p> <p>(3) During the missing of the colour sync burst, what happens to the colour killer circuit?</p> <p>(4) Draw the wave form of colour sync burst</p> <p>(5) Name the first four blocks of a television receiver</p> <p>(6) The R.F signal from the transmission station are received by _____</p> <p>(7) What monitors the presence of the colour burst</p>	<p>Answer the questions orally with the exception of question no 4 which they demonstrate on their jotter.</p>	<p>Generated item from teaching topics</p>	<p>Questioning/ Inquiry.</p>
VI	10 mins	Summary	<p>Summarizes the teaching by answering question under the evaluation. During monochrome transmission, the sync burst will be missing and the colour killer circuit will set up a strong bias on the 3.58 MHZ amplifier stage, cutting off any colour to the colour decoder. The colour sync stage is always a continuous 3.58MH2 sine wave. During the missing of the sync burst, the colour killer circuit will set up a strong bias on the 3.58MHZ amplifier stage. The wave form of sync burst is as shown on the screen. The first four block of a television receiver are: tuner, If amp, dictator and audio amp. The R.F signals are received by A.G.C antenna. The students contribute to the teacher's summary.</p>	<p>Listen attentively as the teacher summarizes the lesson.</p>	<p>Block diagram of a television set, sine wave form of sync burst diagram.</p>	<p>Planned repetition/ Interactive</p>

## Week II

### Lesson Plan on Practical Electronics Works using Audio Visual Projection method of instruction

<b>Subject:</b>	Practical Electronics Works
<b>Topic:</b>	Trouble shooting equipment
<b>Class:</b>	NTC II
<b>Duration:</b>	4 x40 mins
<b>Average Age:</b>	16 yrs
<b>Specific Objective:</b>	By the end of the lesson, the students should be able to: identify trouble shooting equipment and their uses.
<b>Entry behavior:</b>	How many of you have been in a television servicing workshop? What tool and equipment do you see?

#### Instructional Procedures

Step	Time	Content Development	Teacher's Activities	Students Activities	Instructional Materials	Instructional Strategy/Skill
<b>I</b>	20 mins.	Rehearse function of each stage of block diagram of a television set receiver	Project block diagram of a television receiver and rehearses the functions of each stage. Asks students to identify likely damages that might occur on first four stages, then introduces the day's lesson as trouble shooting equipment.	Participate actively in answering the question and take correction on any wrong response.	Block diagram of a television set.	Expository
<b>II</b>	30 mins	Signal generator and its function in trouble shooting	Project the equipment on the screen, informs the students that this is one of the trouble shooting equipment used to send signal to television sets as a reminder of the service time of any station. It is used in making sure that the lines are in correct order.	Watch and listen attentively to see the equipment and ask questions for clarification	Signal generator	Expository/ Explanatory

Step	Time	Content Development	Teacher's Activities	Students Activities	Instructional Materials	Instructional Strategy/Skill
III	30 mins	Identification of a signal tracer and its functions in trouble shooting.	Identifies signal tracer as the equipment used to trace particular points on a television set where transmission or reception can be picked. This is locating different station point on a television set.	Watch and listen very attentively and ask questions where necessary for clarification	Signal tracer	Expository/ Explanatory
IV	30 mins	Identification of a multi meter and uses	Project a multimeter on the screen and identifies it to the students as measuring instrument used for locating current or voltage in a television set and also used in locating a faulty or troubled stage component or short break. Asks students to identify the different between a multimeter and E H T meter.	Watch and listen attentively to the teacher's instruction audio visually. Answer the teachers question orally.	Multimeter	Expository/ Interactive
V	30 mins	Identification of E.H.T Meter	Shows the students the E.H.T meter by projecting it on the screen and points out the uses in trouble shooting in a television set	Watch and listen attentively		Expository/Explanatory
VI	10 mins	Evaluation	Evaluates the lesson with the following questions: (1) What is signal generator? (2) What is signal tracer used for in trouble shooting in a television set? (3) Multi meter is used for _____.	Answer the questions and takes corrections if any	Items generated from the topic	Questioning /Interactive

Step	Time	Content Development	Teacher's Activities	Students Activities	Instructional Materials	Instructional Strategy/Skill
VII	10 mins	Summary	Summaries like this, in trouble shooting in television set, signal generator is one of the equipment used to send signal to the television set to indicate transmission signals. Signal tracer is used to trace point of transmission from the stages of a television set while a multi meter is used to measure current, voltage and amount of resistance existing in a television set. Asks students questions to list out other equipment for trouble shooting in a television set	Listen attentively and interact actively in answering questions	Signal generator, signal tracer, multi meter, EHT meter and other trouble shooting equipment.	Planned repetition and interactive

### Week III

#### Lesson Plan on Practical Electronics Works using Audio Visual Projection method of instruction

**Subject:** Practical Electronics Works

**Topic:** Common Faults in a television receiver and procedures for trouble shooting

**Class:** NTC II

**Duration:** 4 x40 mins

**Average Age:** 16 yrs

**Specific Objective:** By the end of the lesson, the students should be able to familiarize themselves with the tools and instruments identifying common faults in television receiver and identify the procedures to trace these faults. Identify trouble shooting equipment and their uses.

**Entry behavior:** Show two television set to the students, black and white, and colour television sets. Put them on and ask students to identify the two sets. Then tell the students that we are going to study the faults in colour television receiver.

### Instructional Procedures

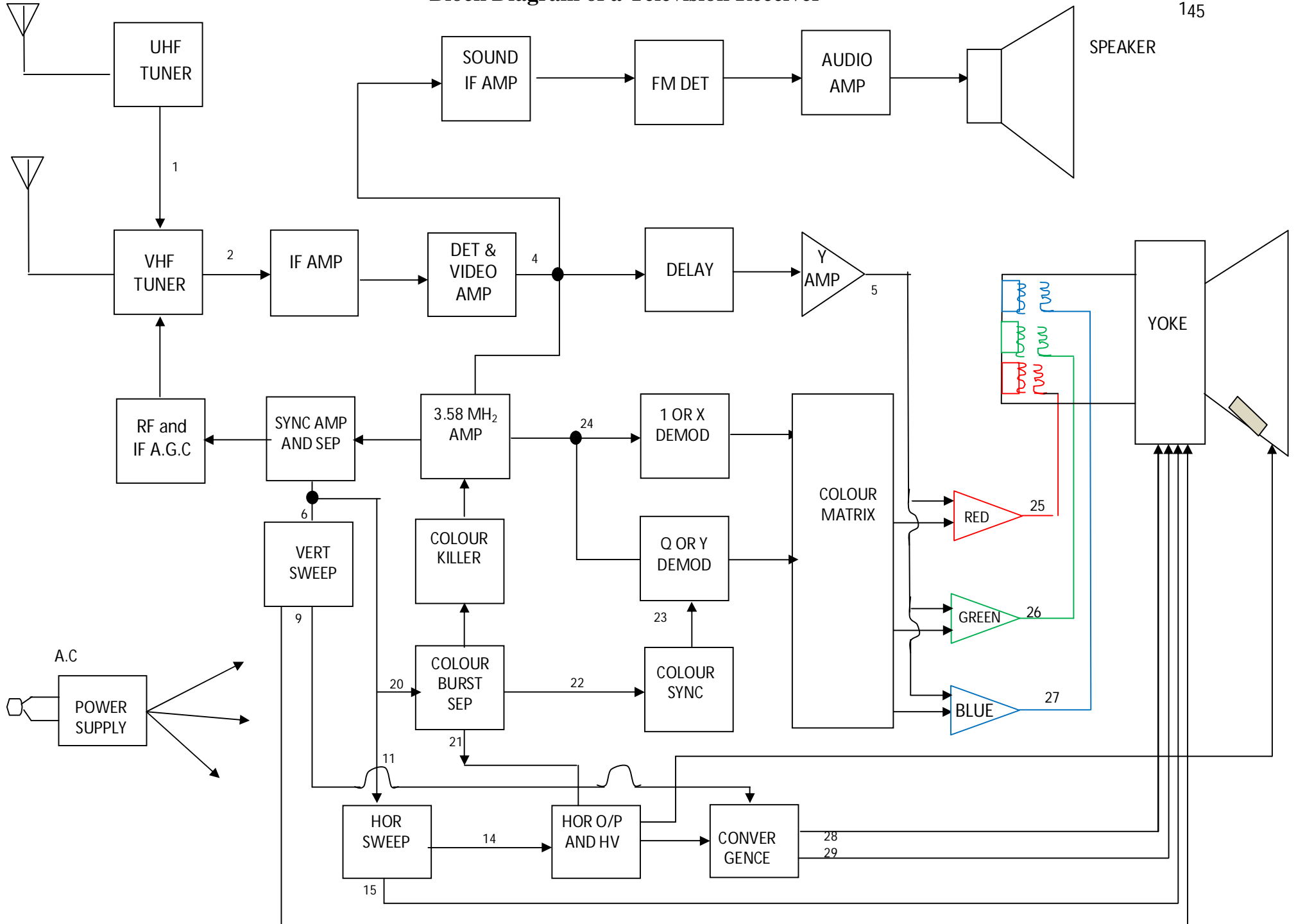
Step	Time	Content Development	Teacher's Activities	Students Activities	Instructional Materials	Instructional Strategy/Skill
<b>I</b>	20 mins.	Identification of other fault findings equipment.	Ask the students to list about eight fault/trouble shooting equipment and identify their uses.	Interact actively as they list the equipment and identify their uses.	Trouble shooting equipment e.g oscilloscope viewing mirror, pattern generator etc.	Introductory
<b>II</b>	35 mins.	Identification of common faults in colour television receiver.	Explains and demonstrates why a colour television sets usually have nine front panel controls and six or more secondary controls. Some of these colour are adjusted for the views preference. Some compensate for component using and some of these control front panel or secondary interact with each other. Here we are going to have a look at how we can diagnose over 75 percent of all television faults or trouble by using only the television screen, the speaker and the front panel and secondary controls.	Watch and listen attentively for the demonstration couple with explanation.		Explanatory /Demonstration

Step	Time	Content Development	Teacher's Activities	Students Activities	Instructional Materials	Instructional Strategy/Skill
III	35 mins.	Demonstration of common faults in colour television receiver	Demonstrates some of the possible faults that might occur in a colour television set. For example, a colour television set showing black and white and No colour on any channel. Asks students to point possible cause for this particular trouble. Weak colour on all channels, weaving strips of red, green and blue. Exaggerated strong colour on all channels, pictures too purple or too green, red, green or blue colour missing in pictures, gray roster contains in colour area colour fringing at either side; colour fringing at top and/or bottom.	Watch and listen very attentively. Participate actively in attempt to answer the question.	Faulty colour television set.	Demonstration/ Participatory
IV	35 mins.	Techniques for trouble shooting in television receiver.	Introduces the techniques for identifying or diagnosis of trouble in a system caused by a failure of some kind. Explains the techniques and processes involved in trouble shooting, stage by stage. Ask students to demonstrate the teachers' explanation using the faulty television set. The first step to take in trouble shooting before any test is carried out is visual inspection of the circuit, check various components in case of burnt out or break in the printed circuit.	Participate actively in the lesson by interacting with the television sets. To identify the faults.	Faulty television set.	Introduction/ Explanatory

Step	Time	Content Development	Teacher's Activities	Students Activities	Instructional Materials	Instructional Strategy/Skill
V		Advanced procedures in trouble shooting	If no success was achieved from the above procedures, informs students to divide the test into two series. Series I known as dynamic test and series II known as static test. The test is then proceeding from the first to the second section until the faulty spot is traced.	Answer questions on the procedures of trouble shooting and actively follow the teachers' instruction.		Interactive/ Informative
VI	20 mins.	Evaluation	The teacher evaluate with the following questions: (1) How many front panels control has a colour television set. (2) These controls are adjusted for _____ (3) In Trouble Shooting, The First Step To Take Is _____ (4) State two series of test in trouble shooting. (5) Differentiate between dynamic test and static test.	Answer the questions and take correction if any.		Questioning
VII	15 mins.	Summary	A colour television sets have nine front panel controls. They are adjusted for the viewers' preference.  In trouble shooting, the first step to take is visual inspection. The two series tests, in trouble shooting are dynamic and static tests. Dynamic tests are tests applied to the complete electronic equipment in order to isolate the faulty stage while static test is test of individual component to pin-point the faulty component within the stage.	Listen very attentively and adjust their memories on any misconception of content.	Faulty television set	Planned repetition and interactive



# Block Diagram of a Television Receiver



## Appendix F

### Week I

#### Lesson Plan on Practical Electronics Works using Guided discovery method of instruction

- Subject:** Practical Electronics Works
- Topic:** block diagram of a television receiver
- Class:** NTC II
- Duration:** 4 x40 mins
- Average Age:** 16 yrs
- Specific Objective:** By the end of the lesson, the students should be able to:
- 1) draw the block diagram of a television receiver
  - 2) explain the functions of each stage and component of the television receiver.
- Entry behavior:** Open the back of a television set, ask the students, if they can identify the stages. Also call their attention on the functions of the components.

#### Instructional Procedures

Step	Time	Content Development	Teacher's Activities	Students Activities	Instructional Materials	Instructional Strategy/Skill
1	20 mins.	Block diagram of a television set.	Design the learning environment by presenting the block diagram of a television set to the students. Asks students to identify the stages in a television receiver.	Share individual perceptions through interaction with each other. Depend on the support of the teacher by interacting regularly with the teacher to bring solution to answer the teachers question.	Television set, Block diagram of television set.	Set induction

Step	Time	Content Development	Teacher's Activities	Students Activities	Instructional Materials	Instructional Strategy/Skill
II	40 mins.	Functions of each stage of a television receiver.	Ask the students question that will lead them to develop their own conclusions as: what happen to the input of a television set, moderator stage, detector stage etc.	Take ownership of the inquiry process and depend on the support of the teacher to clarify the responses notice at each stage.	Block diagram of a television set.	Interactive/ Questioning
III	40 mins.	Sync stage	Asks the students to identify what happen to the sync burst stage of a television set during monochrome transmission informs the students that the colour sync stage also receives the colour sync burst and uses it to control the frequency and phase by showing a sine wave signal.	Take ownership of the task, by constructing knowledge of their previous experience to arrive at the answer to the question through tries and errors.	A television set, power supply equipment, multi meter, etc.	Exploratory
IV	40 mins.	Function of sync stage	Engage the students by asking the following questions: What is the sine wave of the colour sync stage at normal transmission? What signal is used in the colour decoder of a television receiver? What is happening to the transmission when the colour sync burst is missing?	Share individual idea as they collaborate and discuss with their teacher to arrive at a positive understanding of the questions.	Block diagram of a television set, testing and measuring instruments.	Questioning /Interactive
V	20 mins.	Evaluation	Ask the students to rehearse virtually the activities involved in transmission system of a television receiver, stage by stage and give correction if any.	Verbalize the new knowledge acquired and activities engaged in the learning processes. Take any correction if any.	Block diagram of a television receiver and television set.	Inquiry/ Interactive

## Week II

### Lesson Plan on Practical Electronics Works using Guided discovery method of instruction.

<b>Subject:</b>	Practical Electronics Works
<b>Topic:</b>	trouble shooting equipment
<b>Class:</b>	NTC II
<b>Duration:</b>	4 x40 mins
<b>Average Age:</b>	16 yrs
<b>Specific Objective:</b>	By the end of the lesson, the students should be able to identify trouble shooting equipment and their uses.
<b>Entry behavior:</b>	How many of you have been in a television servicing workshop? What are the tools and equipment being used by the service man?

#### Instructional Procedures

Step	Time	Content Development	Teacher's Activities	Students Activities	Instructional Materials	Instructional Strategy/Skill
<b>I</b>	20 mins.	Introduction and identification of trouble shooting equipment.	Remain the students of the topic which is trouble shooting. Asks the students to identify the equipment for trouble shooting one by one and highlighting on the functions of these equipment.	Listen very attentively to the teacher's questions and went into the discovery of trouble shooting equipment and their functions.	Signal generator, signal tracer, multimeter, E.H.T Meter, viewing mirror trimmer screw driver, oscilloscope etc.	Introductory Identification
<b>II</b>	40 mins.	Identification of signal generator and its function in trouble shooting.	Identify the equipment used to send and identify signal in a television receiver. What information if any, the equipment will reveal to the viewers?	Take ownership of the question and depend on the support of the teacher to answer the question. As they rattle with equipment to identify the right equipment and the information it reveals.	Signal generator	Expository/ Questioning

Step	Time	Content Development	Teacher's Activities	Students Activities	Instructional Materials	Instructional Strategy/Skill
III	40 mins.	Identification of a signal tracer	To trace point and location of signals from transmission station. What equipment is used?	Constructing knowledge out of prior experience on transmission and reception system in a television receiver, to answer the teacher's questions.	Signal tracer	Questioning/ Demonstration
IV	40 mins.	Identification of E.H.T Meter	Identify E.H.T meter from the trouble shooting equipment, how is it use in the measurement of electronic signals?	Take ownership of the task and solution processes with the support of the teacher when needed to arrive at a positive understanding of the truth in the question.	E.H.T. meter	Expository /Inquiry
V	20 mins.	Evaluation	Consult on the students' activities. Makes sure the students are not going off the tasks tracks, acts as coach and co-learner as you ask the students questions on their expected learning experiences on the present task.	Response as the teacher ask questions and take correction if any from the teacher. Adhere and make necessary correction to meet the expected learning experience.		Corrective/ Questioning

### Week III

#### Lesson Plan on Practical Electronics Works using Guided discovery method of instruction.

<b>Subject:</b>	Practical Electronics Works
<b>Topic:</b>	Common faults in a television receiver and procedures for trouble shooting
<b>Class:</b>	NTC II
<b>Duration:</b>	4 x40 mins
<b>Average Age:</b>	16 yrs
<b>Specific Objective:</b>	By the end of the lesson, the students should be able to be familiarizing themselves with the common faults in television receivers and demonstrate the procedures in trouble shooting.
<b>Entry behavior:</b>	Show two television sets to the students, black and white and a colour television sets. Switch them on and ask the students to identify the two sets. Then inform the students that the topic for the day is faults or trouble in colour television receiver.

#### Instructional Procedures

Step	Time	Content Development	Teacher's Activities	Students Activities	Instructional Materials	Instructional Strategy/Skill
<b>I</b>	20 mins.	Identification of other fault finding equipment and their functions.	There are other fault finding equipment, identify them. What is the use of oscilloscope and pattern generator in trouble shooting?	Take ownership of the questions and solution. Identifying oscilloscope and pattern generator and find out their functions to trouble shooting.	Oscilloscope, pattern generator, mirror etc.	Introductory
<b>II</b>	30 mins.	Identification of common faults in a television receiver	In what possible ways can about 75 percent of television fault be shooting, using screen, speaker, front panel and secondary control of a television receiver?	Take ownership of the question to determine 75 percent possible ways of shooting troubles in a television receiver using screen, speaker, front panel and secondary control of a television receiver. Depend on the support of the teacher to come out as effective performer.	Faulty television set, multi meter, oscilloscope, pattern generator etc.	Questioning and observation

Step	Time	Content Development	Teacher's Activities	Students Activities	Instructional Materials	Instructional Strategy/Skill
III	30 mins.	Demonstration of common faulty in a television receiver.	When a colour television receiver shows black and white signal and no colour on the channels, what might be the possible cause? Also what is causing colour fringing at either side of a television receiver?	Construct knowledge independently by making use of prior knowledge to test components like colour I.F looking for possible cause of colour demodulator, colour sync. Also making use of prior knowledge will discover that a check on the colour intensity, colour killer and fine tuning will be carried out. For colour fringing, the vertical convergence will be controlled before testing the colour convergence.	Faulty television set, fault finding equipment.	Questioning /Observation
IV	30 mins.	Techniques for trouble shooting in a television receiver.	To identify or diagnosis trouble in a television receiver, what are step by step processes involved? Before any test is carried out, what is the first step to take?	Using the questions asked by the teacher, answers to the questions arrived from previous experiences. Visual inspections of the component starting from the socket to burnt out components and breaker in the printed circuits.	Faulty television set, fault finding equipment.	Questioning and Observation.
V	35 mins.	Advanced procedures in trouble shooting.	If no success is achieved from the previous first step in trouble shooting, what next? Why not divide the faults into two series start from an output going towards the input. Dividing the series into two sections.	Test each stage without following a sequential procedure. Take teachers instruction and depend on the support of the teacher to arrive at the right decision of series I and series II test. Inform the teacher for having divided the circuit into two series. Take the instruction of the teacher step by step.	Skeletal circuit of a television receiver. Trouble shooting equipment e.g multi meter, testers etc.	Questioning and Inquiry

<b>Step</b>	<b>Time</b>	<b>Content Development</b>	<b>Teacher's Activities</b>	<b>Students Activities</b>	<b>Instructional Materials</b>	<b>Instructional Strategy/Skill</b>
<b>VI</b>	10 mins.	Evaluation	What are the steps taken to arrived at the faulty spot?	Verbally demonstrate the steps taken to arrive at the faulty spot.		Questioning /Demonstration



## Appendix G

### Week I

#### Lesson Plan on Practical Electronics Works using Project-Based method of instruction.

<b>Subject:</b>	Practical Electronics Works
<b>Topic:</b>	Block diagram of a television receiver
<b>Class:</b>	NTC II
<b>Duration:</b>	4 x40 mins
<b>Average Age:</b>	16 yrs
<b>Specific Objective:</b>	By the end of the lesson, the students should be able to draw the block diagram of a television receiver and explain the functions of each stage and component of the television receiver.
<b>Entry behavior:</b>	Open the back of a television set. Ask the students, if they can identify the stages and components of the television set also call their attention on the functions of the components.

#### Instructional Procedures

Step	Time	Content Development	Teacher's Activities	Students Activities	Instructional Materials	Instructional Strategy/Skill
1	20 mins.	Block diagram of a television set.	Introduce the topic to the students as block diagram of a television receiver. Instructs the students to show the stages of a television set from input to output stage on their own. Provides television set, and equipments for the task. Encourages the students to take up the challenges to handle the television set for the learning outcome.	Engage and take ownership of the task of showing the block diagram of a television receiver. Taking up the challenges by opening a television set, have a look on the circuit stage by stage. Produces the block diagram on their own.	Television set, schematic diagram of a television receiver. Multimeter, signal generating, etc.	Introductory

Step	Time	Content Development	Teacher's Activities	Students Activities	Instructional Materials	Instructional Strategy/Skill
II	40 mins	Functions of each stage of a television receiver.	Instruct the students to identify the stages involved in television receiver. Examine the functions of each stage in a television set during perform. Observes the students carryout the project of identifying the functions of each stage of a television receiver.	Apply instructional gathered knowledge with hand on activities; identify the functions of each stage of a television receiver, using established tries and error methods. Using measuring instrument indicate responses at every stage.	Television analyzer, multimeters, pattern generator, television set, block diagram of a television set	Observation and Expository.
III	40 mins	Sync stage in a television receiver	Inform the students that the content requires them to locate sync stage of a television receiver.	Developing independence either by working alone or in small groups. Find out sources of locating the sync stage point. Own responsibility for the learning and completion of the task	Television set and identification of equipment.	Expository/ Participatory
IV	40 mins	Functions of sync stage	Instructs the student to discover the functions of sync stage and what they will use it for in future learning.	Apply the prior gathered knowledge to identify the functions of sync stage in a television receiver. Using necessary equipment. Take note of every gathered information.	Television set and block diagram of a television receiver, testing equipment.	Application/Inquiry.
V	20 mins	Evaluation	Asks, rehearse the stages in the block diagram of a television receiver using a television set and explain your experience in the missing of a sync bust wave form during reception of television signal.	Give account of the skills involve and experiences acquired in locating every stage of a television receiver. Pin-pointing the sync stage and the functions of the sync stage.	Block diagram of a television set, testing and measuring equipment.	Questioning/ Evaluative.

## Week II

### Lesson Plan on Practical Electronics Works using Project-Based method of instruction.

<b>Subject:</b>	Practical Electronics Works
<b>Topic:</b>	Identification of trouble shooting equipment
<b>Class:</b>	NTC II
<b>Duration:</b>	4 x40 mins
<b>Average Age:</b>	16 yrs
<b>Specific Objective:</b>	By the end of the lesson, the students should be able to identify trouble shooting equipment and their uses.
<b>Entry behavior:</b>	How many of you have been in a television servicing workshop? What tools and equipment did you see?

#### Instructional Procedures

Step	Time	Content Development	Teacher's Activities	Students Activities	Instructional Materials	Instructional Strategy/Skill
<b>1</b>	60 mins.	Trouble shooting equipment and tools identification.	Remind the students of the stages involved in a television reception and transmission. Informs the students that fault/trouble can develop in any of these stages which can disrupt the television reception system. Brings in the topic for the day, which is equipment and tools for identifying trouble in a television receiver. Gives instruction to the students to examine the equipment and tools used for trouble shooting.	Develop inquiring minds by going on their own into the workshop and environment to identify the tools and equipment for the particular tasks.	Trouble shooting equipment and tools as signal generator, multimeter, pattern generator, trimmer screw driver, E.H.T. meter	Expository and informative.

Step	Time	Content Development	Teacher's Activities	Students Activities	Instructional Materials	Instructional Strategy/Skill
<b>II</b>		Trouble shooting equipment and tools uses.	These trouble shooting equipment and tools are used in various ways in identifying trouble in television receiver. Find out their uses.	Develop more flexible and useful knowledge into the inquiry. Using the instrument one by one on a faulty television receiver. Demonstrate increase confidence in their knowledge of independence to identify the use of each equipment and tools in trouble shooting.	Trouble shooting equipment, faulty television receiver.	Inquiry/ Informative.
<b>III</b>		Evaluation.	Identify each of the equipment and tools in your possession and demonstrate their uses.	Give account of the skills demonstrated to achieve the task of identifying trouble shooting equipment and tools. Give also meaningful highlight on the uses of these equipment and tools.	Trouble shooting equipments and tools, faulty television set, block diagram of a television receiver.	Observation and Inquiry.

### Week III

#### Lesson Plan on Practical Electronics Works using Project-Based method of instruction.

<b>Subject:</b>	Practical Electronics Works
<b>Topic:</b>	Identification of common fault in a colour television set.
<b>Class:</b>	NTC II
<b>Duration:</b>	4 x40 mins
<b>Average Age:</b>	16 yrs
<b>Specific Objective:</b>	By the end of the lesson, the students should be able to be familiar with the common faults in television receivers.
<b>Entry behavior:</b>	Show the students two television sets on operation, one black and white and one colour set. Ask them to identify each of them. Inform them that we are going to study the faults on a colour television receiver.

#### Instructional Procedures

Step	Time	Content Development	Teacher's Activities	Students Activities	Instructional Materials	Instructional Strategy/Skill
<b>1</b>	45 mins	Common fault in a colour television set.	Present a colour faulty television set to the students, instructs them to examine the faults developing in each stage of the television receivers.	Apply prior gathered knowledge to real world performance tasks of search on each stage of the television sets to identify its faults, using fault finding equipment to arrive at the solution.	Colour televisions sets with the following faults: showing black and white but no colour on any channel, weak-colour on all channels, strong colours but fine details missing, fault finding equipments and tools.	Expository  /Inquiry

<b>Step</b>	<b>Time</b>	<b>Content Development</b>	<b>Teacher's Activities</b>	<b>Students Activities</b>	<b>Instructional Materials</b>	<b>Instructional Strategy/Skill</b>
<b>II</b>	45 mins	Technique for trouble shooting in a television receiver.	Inform the students that in trouble shooting, there are techniques. Make use of the techniques to locate faulty components in these television sets having identified the fault developed.	Making use of class room gathered knowledge, demonstrating the right technique of visual inspections before any test is carried out. Inspecting circuits, components, switches, sockets etc.	Faulty television sets, testing and measuring equipment and tools.	Informative and Inquiry.
<b>III</b>	45 mins	Procedures in trouble shooting.	Where visual inspection fails in identifying the faulty spot or component, then go into trouble shooting proper, apply what is called procedure techniques	Demonstrate increase confidence by applying classroom gathered knowledge to divide the trouble shooting into two series of test: dynamic test, which is testing the whole stages of a television receiver and static test, testing to pin-point the faulty component. Dynamic reveals the stage and static identify the particular component.	Fault finding equipment and tools, faulty television sets.	Application and Informative.
<b>IV</b>	25 mins	Evaluation.	Having identify the faulty component, demonstrate the techniques and procedures for doing that. Gives correction if any.	Give account of the skills demonstrated to achieve positive or negative result. Generating meaningful measures to improve in their final presentation through the teachers' correction.	Faulty television set, testing and measuring equipment and tools.	Observation and Corrective.

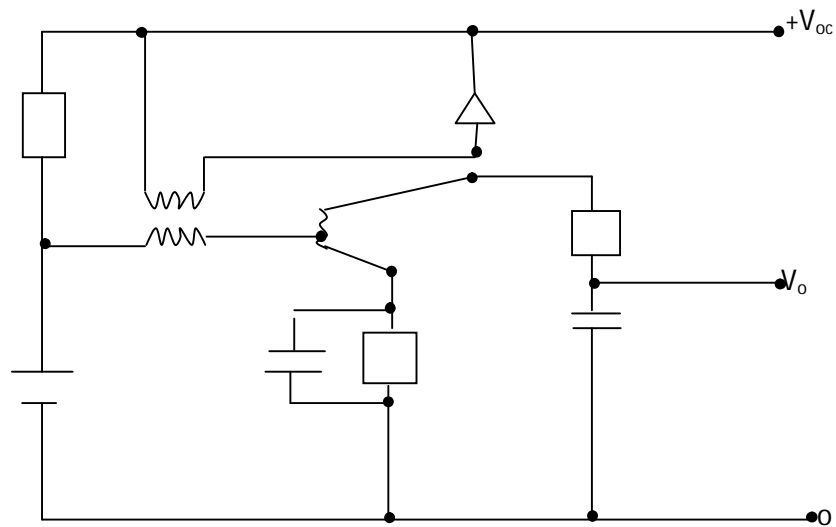
## Appendix H

### Test Items on practical electronics works (Television Services) NTC II

**Instruction: Answer all questions. Each question for 1-15 has options A-D, choose the correct option bearing the letter.**

- (1) A receiving aerial should be matched to a transmission cable in order to \_\_\_\_\_  
(a) increase the impedance of the aerial (b) form standing waves (c) Draw minimum power from the aerial (d) Transfer maximum power to the aerial.
- (2) Forward a.g.c uses transistors whose gain \_\_\_\_\_ (a) increases with current (b) decreases with current (c) stays constant irrespective of the current (d) is very low
- (3) The main functions of video dictator in TV receiver is \_\_\_\_\_ (a) Separation of video, audio and noise signal (b) matching all the video and audio signals (c) integration of forces of reception (d) dropping of signals traces
- (4) Sync and Sweep circuit section perform the following functions except \_\_\_\_\_ (a) To receive and filter the sync pulse from video signal (b) The separation of the vertical pulses from the horizontal sync pulses (c) Development of high voltages which are feeds into the picture tube (d) Rejection of the total output video signal.
- (5) The section that receives the intermediate frequency signal from the mixer is called \_\_\_\_\_ (a) Tuner and RF amp (b) The IF Amplifier (c) Audio Amp (d) Ratio detector
- (6) White vertical lines in visual signal can be corrected by \_\_\_\_\_ (a) Replacing open booster capacities (b) adjusting balancing capacity (c) Replacing tube (d) Replacing defective resistor.
- (7) When pictures are narrow and exhibit poor linearity, the cause could be \_\_\_\_\_ (a) Load resistors (b) By pass capacitors in horizontal output circuit (c) High Video peaking (d) Load resistor open.
- (8) A faulty TV receiver displaying a bright horizontal line across the screen (field collapse) indicates a fault in the \_\_\_\_\_ (a) Power supply (b) Picture board (c) Field time base (d) audio amplifier.
- (9) When sync pulses are available, the vertical hold control is used to make sure that the picture does not \_\_\_\_\_ or roll up or down on the screen (a) Jitter (b) run (c) Stay (d) jump
- (10) VHF and UHF signals are picked up by their respective \_\_\_\_\_ (a) Oscillators (b) Antennas (c) Frequency (d) Bands
- (11) At the detector stage of a monochrome receiver, both the sound and the \_\_\_\_\_ signal pass through it (a) noise (b) video (c) speech (d) voice.
- (12) In a colour pictures tube, the red, green and blue picture elements originate in three electron \_\_\_\_\_ (a) guns (b) Beams (c) Signals (d) Pictures

- (13) The beams are modulated by the red, green and blue \_\_\_\_\_ signals (a) Video (b) Frequency (c) Anode (d) Amplitude
- (14) When the picture tube is normal but there is no sound, we will first try to adjust the \_\_\_\_\_ control (a) Signal (b) Frequency (c) volume (d) Sound
- (15) Refer to fig. 1, the oscillator used is known as \_\_\_\_\_ (a) Hartley (b) Tuned collector (c) Tuned based (d) blocking

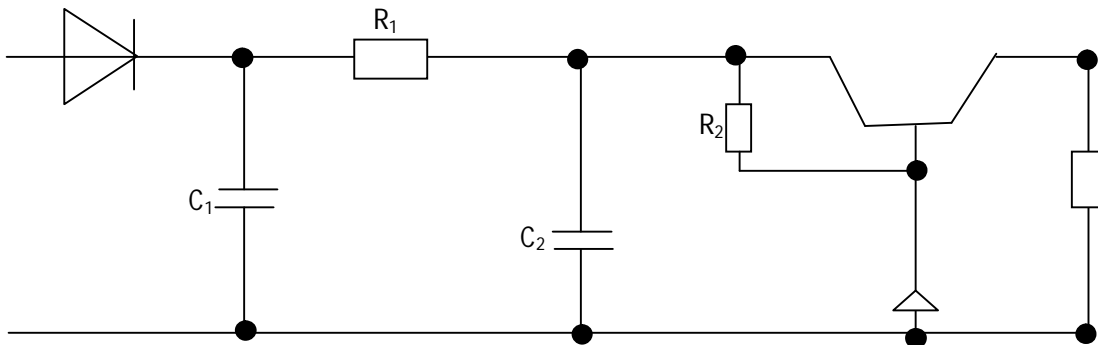


**Fig. 1**



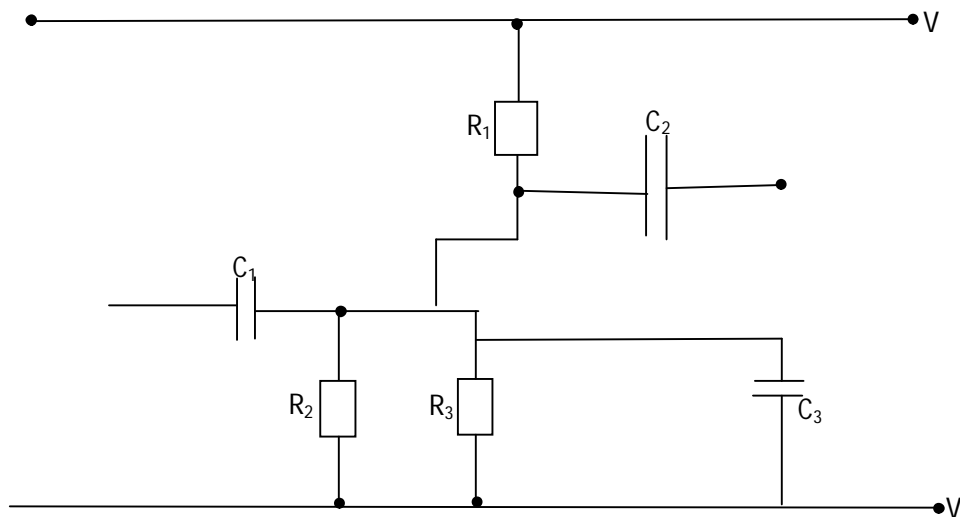
### Section B: Practical Application Questions

Answer the following questions correctly using diagrams attached to them



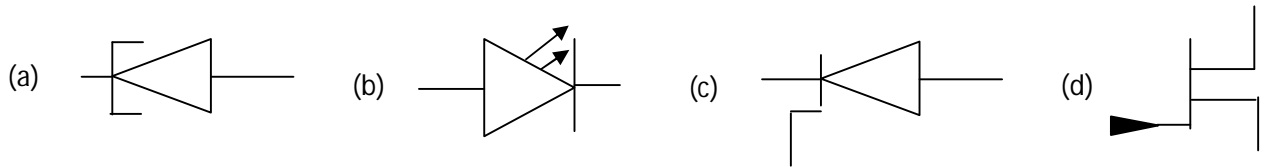
**Fig. 2**

- (16) Refers to fig. 2, what would be the effect on the output if  $c_2$  went open circuit?
- (17) Refer to the fig. 2, in what configuration is the transistor connected?
- (18) Refer to fig. 2, what would the out put be if the sener goes short circuit?
- (19) With no input applied to the a.f amplifier shown in fig. 3, state, giving reasons, the effect on the drain current if
- $R_2$  becomes open circuited
  - $R_1$  becomes open circuited



**Fig. 3**

(20) Name the devices represented by the symbol shown in fig. 4



**Answers to the test items:**

1 c. 2 b. 3 a. 4 d. 5 c. 6 d. 7 c. 8 c. 9 a. 10 d. 11 b. 12 a.  
13 .a 14 c. 15 d.

**SECTION B:**

16 Increase ripple. 17 Emitter Followers. 18  $0V$ . 19 (a) Zero drain 19 (b) Increase current due to the absence of reversed bias. 20 (a) Tunnel diode (b) Light Emissive diode (c) Silicon controlled rectifier (d) n-channel fet.

### Appendix I

**Table of specification for test items**

	<b>Behaviours/Content Areas</b>	<b>Knowledge</b>	<b>Comprehension</b>	<b>Application</b>	<b>Interpretation</b>	<b>Total</b>
1	Block diagram of a televisions set/receiver	1	1	1		3
2	Function of each stage of a television receiver		1			1
3	Sync stage		1			1
4	Function of sync stage	1		1	1	3
5	Identification of signal generator and its function in trouble shooting	1				1
6	Identification of EHT meter and its function in trouble shooting	1		1		2
7	Otherfault finding/trouble shooting equipment and their function	1		1		2
8	Identification of common faults in coloured television set				1	1
9	Techniques for trouble shooting in television receiver		1	1	1	3
10	Procedures in trouble shooting	1	1		1	3
	<b>Total</b>	<b>6</b>	<b>5</b>	<b>5</b>	<b>4</b>	<b>20</b>

## Appendix J

### Blue print item distribution table

Questions/ Domains	Knowledge	Comprehension	Application	Interpretation	Total
	3	2	1	9	
	5	4	6	10	
	7	13	16	12	
	8	14	17	15	
	11	20	18		
	19				
<b>Total</b>	<b>6</b>	<b>5</b>	<b>5</b>	<b>4</b>	<b>20</b>

**Appendix K**  
**Calculation of reliability coefficient of the instrument using Pearson product moment**

<b>X (Pretest)</b>	<b>Y Post-Test</b>	<b>X - <math>\bar{x}</math> = x</b>	<b>Y - <math>\bar{y}</math> = y</b>	<b>xy</b>	<b>x<sup>2</sup></b>	<b>y<sup>2</sup></b>
3	16	-1.44	-0.91	1.31	2.07	0.83
6	18	1.56	1.09	1.70	2.43	1.19
3	16	-1.44	-0.91	1.31	2.07	0.83
3	16	-1.44	-0.91	1.31	2.07	0.83
6	19	1.56	2.09	3.26	2.43	4.37
5	18	0.56	1.09	0.61	0.31	1.19
2	16	-2.44	-0.91	2.22	5.95	0.83
6	17	1.56	0.09	0.14	2.43	0.01
9	17	4.56	0.09	0.14	20.79	0.01
3	16	-1.44	-0.91	1.31	2.07	0.83
7	18	2.56	1.09	2.79	6.55	1.19
5	17	0.56	0.09	0.05	0.31	0.01
6	17	1.56	0.09	0.14	2.43	0.01
2	16	-2.44	-0.91	2.22	5.95	0.83
4	16	-0.44	-0.91	0.40	0.19	0.83
5	19	0.56	2.09	1.17	0.31	4.37
1	16	-3.44	-0.91	3.13	11.83	0.83
5	18	0.56	1.09	0.61	0.31	1.19
6	17	1.56	0.09	0.14	2.43	0.01
2	16	-2.44	-0.91	2.22	5.95	0.83
5	17	0.56	0.09	0.05	0.31	0.01
8	17	3.56	0.09	0.32	12.67	0.01
8	18	3.56	1.09	3.88	12.67	1.19
2	13	-2.44	-3.91	9.54	5.95	15.29
2	16	-2.44	0.91	2.22	5.95	0.83
8	17	3.56	0.09	0.32	12.67	0.01
1	17	-3.44	0.09	-0.31	11.83	0.01
2	16	-2.44	-0.91	2.22	5.95	0.83
5	18	0.56	1.09	0.61	0.31	1.19
5	18	0.56	1.09	0.61	0.31	1.19
5	18	0.56	1.09	0.61	0.31	1.19
1	16	-3.44	-0.91	3.13	11.83	0.83
2	16	-2.44	-0.91	2.22	5.95	0.83
5	19	0.56	2.09	1.17	0.31	4.37
2	16	-2.44	-0.91	2.22	5.95	0.83
1	16	-3.44	-0.91	3.13	11.83	0.83
5	17	0.56	0.09	0.05	0.31	0.01
6	17	1.56	0.09	0.14	2.43	0.01
2	14	-2.44	-2.91	7.10	5.95	8.47
5	17	0.56	0.09	0.05	0.31	0.01
5	17	0.56	0.09	0.05	0.31	0.01

2	16	-2.44	-0.91	2.22	5.95	0.83
8	17	3.56	0.09	0.32	12.67	0.01
5	19	0.56	1.09	0.61	0.31	1.19
5	17	0.56	0.09	0.05	0.31	0.01
5	17	0.56	0.09	0.05	0.31	0.01
6	19	1.56	2.09	3.26	2.43	4.37
5	19	0.56	2.09	1.17	0.31	4.37
5	19	0.56	2.09	1.17	0.31	4.37
1	13	-3.44	-3.91	13.45	11.83	15.29
6	18	1.56	1.09	1.70	2.43	1.19
3	16	-1.44	-0.91	1.31	2.07	0.83
7	18	2.56	1.09	2.79	6.55	1.19
1	13	-3.44	-3.91	13.45	11.83	15.29
3	13	-1.44	-3.91	5.63	2.07	15.29
2	16	-2.44	-0.91	2.22	5.95	0.83
6	18	1.56	1.09	1.70	2.43	1.19
7	18	2.56	1.09	2.79	6.33	1.19
3	15	-1.44	-1.91	2.75	2.07	1.19
5	18	0.56	1.09	0.61	0.31	1.19
6	19	1.56	2.09	3.26	2.43	4.37
6	20	1.56	3.09	4.82	2.43	9.55
5	18	0.56	1.09	0.61	0.31	1.19
3	16	-1.44	-0.91	1.31	2.07	0.83
6	19	1.56	2.09	3.26	2.43	4.37
6	19	1.56	2.09	3.26	2.45	4.37
2	14	-2.44	-2.91	7.10	5.59	8.47
5	19	0.56	2.09	1.17	0.31	4.37
7	18	2.56	1.09	2.79	6.55	1.19
7	18	2.56	1.09	2.79	6.55	1.19
3	15	-1.44	-1.91	2.75	2.07	3.65
6	17	1.56	0.09	0.14	2.43	0.01
4	17	-0.44	0.09	-0.04	0.19	0.01
4	18	-0.44	1.09	-0.48	-0.19	1.19
2	17	-2.44	0.09	-0.22	5.95	0.01
5	17	0.56	0.09	0.05	0.31	0.01
6	17	1.56	0.09	0.14	2.43	0.01
2	12	-2.44	-4.91	11.98	5.95	24.11
4	16	-0.44	-0.91	0.40	0.19	0.83
8	19	3.56	2.09	7.44	12.67	4.37
<b>355</b>	<b>1353</b>			<b>175.56</b>	<b>333.54</b>	<b>184.74</b>

$$\bar{x} = \frac{\Sigma x}{N} = \frac{355}{80} = 4.44$$

$$\bar{y} = \frac{\Sigma x}{N} = \frac{1353}{80} = 16.91$$

$$r = \frac{\Sigma xy}{\sqrt{\Sigma x^2 \Sigma y^2}} = \frac{175.56}{\sqrt{333.54 \times 184.74}}$$
$$= \frac{175.56}{248.23} = 0.71$$

### Appendix L

#### Calculation of mean score for pretest of visual projection, guided discovery and project based and control groups

AVIPT	SDPT	PBPT	CGRP
7	3	5	6
9	5	12	4
8	9	3	5
6	5	7	7
8	4	9	6
5	5	3	4
9	5	6	8
8	2	3	5
9	1	7	5
5	5	3	9
7	2	6	5
5	1	8	3
8	2	5	6
10	2	4	8
7	5	1	7
5	5	3	
10	6	7	
5	1	10	
7	6	3	
9	5	4	
11	5	3	
8	6	5	
9	7	2	
10	6	3	
4	2	7	
8	2		
9			
10			
9			
7			
7			
7			
8			
4			
8			
<b>Total 271</b>	<b>152</b>	<b>129</b>	<b>88</b>
<b>Mean 7.5</b>	<b>5.9</b>	<b>5.2</b>	<b>5.4</b>

$$\text{Mean} = \frac{\text{Total score}}{\text{Number of students}}$$



**Appendix M**  
**Calculation of mean achievement score for post-test**

<b>AVIPT</b>	<b>SDPT</b>	<b>PBPT</b>
16	16	17
19	18	18
2	17	20
17	17	19
19	16	18
17	18	18
19	17	17
19	13	17
20	17	18
14	18	16
17	16	17
14	18	18
15	16	20
19	16	15
14	14	17
16	16	16
18	17	19
14	19	19
13	18	17
16	13	14
19	18	16
18	18	16
17	18	16
16	19	14
18	18	18
20	17	
14	17	
20	12	
19		
19		
19		
13		
12		
16		
17		
16		
<b>Total 591</b>	<b>433</b>	<b>430</b>
<b>Mean 16.5</b>	<b>16.7</b>	<b>17.2</b>

**Appendix N**  
**Mean achievement score for experimental and control groups**

<b>AVIPT</b>	<b>SDPT</b>	<b>PBPT</b>	<b>CGRP</b>
16	16	17	7
19	18	18	10
2	17	20	3
17	17	19	6
19	16	18	4
17	18	18	6
19	17	17	3
19	13	17	5
20	17	18	6
14	18	16	8
17	16	17	2
14	18	18	3
15	16	20	2
19	16	15	8
14	14	17	9
16	16	16	
18	17	19	
14	19	19	
13	18	17	
16	13	14	
19	18	16	
18	18	16	
17	18	16	
16	19	14	
18	18	18	
20	17		
14	17		
20	12		
19			
19			
19			
13			
12			
16			
17			
16			
<b>Total 591</b>	<b>433</b>	<b>430</b>	<b>81</b>

Total achievement score for experimental groups = 591 + 433 + 430 = 1454

Total number of students = 87

$$\text{Mean} = \frac{1454}{87} = 16.71$$

Total achievement score for control group = 81

Number of students = 15

$$\text{Mean} = \frac{81}{15} = 5.4$$

### Appendix O

- 1) **Hypothesis 1:** NTC II students taught practical electronics works using visual projection method will not differ significantly in their mean achievement scores from those taught using guided discovery method of instruction.

X <sub>1</sub> AVPPT	X <sub>2</sub> SDPT	Y <sub>1</sub> AVPPT	Y <sub>2</sub> SDPT	x <sub>1</sub> <sup>2</sup> AVPPT	x <sub>2</sub> <sup>2</sup> SDPT	y <sub>1</sub> <sup>2</sup> AVPPT	y <sub>2</sub> <sup>2</sup> SDPT	x <sub>1</sub> y <sub>1</sub>	x <sub>2</sub> y <sub>2</sub>
16	16	7	3	256	256	49	9	112	48
19	18	9	5	361	324	81	25	171	90
20	17	8	9	400	298	64	81	160	153
17	17	6	5	289	298	36	25	102	85
19	16	8	4	361	256	64	16	152	64
17	18	5	5	289	324	25	25	85	90
19	17	9	5	361	298	81	25	171	85
19	13	8	2	361	169	64	4	152	26
20	17	9	1	400	298	81	1	180	17
14	18	5	5	196	324	25	25	70	90
17	16	7	2	289	256	49	4	119	34
14	16	5	1	196	256	25	1	70	16
15	14	8	2	225	196	64	4	120	28
19	16	10	2	361	256	100	4	190	32
14	17	7	5	196	298	49	25	98	85
16	19	5	5	256	361	25	25	80	108
18	18	10	6	324	324	100	36	180	108
14	13	5	1	196	169	25	1	70	13
13	18	7	6	169	324	49	36	91	108
16	18	5	5	256	324	25	25	80	90
19	18	9	5	361	324	81	25	171	90
18	19	11	6	324	361	121	36	198	114
17	18	8	7	289	324	64	49	136	126
16	17	9	6	256	298	81	36	144	102
18	17	10	2	324	298	100	4	180	34
20	12	4	2	400	144	16	4	80	24
14		8		196		64		112	
20		9		400		81		180	
19		10		361		100		190	
19		9		361		81		171	
19		7		361		49		133	
13		7		169		49		91	
12		7		144		49		84	
16		8		256		64		128	
17		4		289		16		68	
16		8		256		64		128	
<b>593</b>	<b>433</b>	<b>273</b>	<b>107</b>	<b>10489</b>	<b>7295</b>	<b>2193</b>	<b>551</b>	<b>4675</b>	<b>1790</b>

### Keys and formula for testing the hypotheses using ANCOVA

#### keys

$X_1$  = Post test scores for AVPPT

$Y_1$  = Pre-test scores for AVPPT

$X_2$  = Post test score for SDPT

$Y_2$  = Pre-test for SDPT

$C_x$  = Sum of square for total of  $x_1$  and  $x_2$

$SS_x$  = Sum of square for  $x_1$  and  $x_2$

$SST_x$  = Sum of square due to total of  $x_1$  and  $x_2$

$SSE_x$  = Sum of square due to error in  $x_1$  and  $x_2$

$C_y$  = Sum of square for total of  $y_1$  and  $y_2$

$SS_y$  = Sum of square for  $y_1$  and  $y_2$

$SST_y$  = Sum of square due to total of  $y_1$  and  $y_2$

$SSE_y$  = Sum of square due to error in  $y_1$  and  $y_2$

$SSP$  = Sum of square due to product of  $x_1y_1$  and  $x_2y_2$

$SST$  = Sum of square total of product  $x$  and  $y$

$SSE$  = Sum of square due to error of the product of  $x$  and  $y$

$S_1$  = Error within sample

$SS_0$  = Error due to total

#### Formulas

$$C_x = \frac{(\Sigma x_1 + \Sigma x_2)^2}{N}$$

$$C_y = \frac{(\Sigma y_1 + \Sigma y_2)^2}{N}$$

$$SST_x = \frac{(\Sigma x_1)^2}{n_1} + \frac{(\Sigma x_2)^2}{n_2} - C_x$$

$$SS_x = \Sigma x_1^2 + \Sigma x_2^2 - C_x$$

$$SS_{EX} = SS_x - SST_x$$

$$SST_y = \frac{(\Sigma y_1)^2}{n_1} + \frac{(\Sigma y_2)^2}{n_2} - C_y$$

$$SS_y = \Sigma y_1^2 + \Sigma y_2^2 - C_y$$

$$SS_{EY} = SS_y - SST_y$$

$$C_{xy} = \frac{(\Sigma x_1 + \Sigma x_2)(\Sigma y_1 + \Sigma y_2)}{N}$$

$$SSP = \Sigma x_1 y_1 + \Sigma x_2 y_2 - C_{xy}$$

$$SST = \frac{(\Sigma x_1)(\Sigma y_1)}{n_1} + \frac{(\Sigma x_2)(\Sigma y_2)}{n_2} - C_{xy}$$

$$SSE = SSP - SST$$

$$S_0 = \Sigma y^2 - \frac{(\Sigma xy)^2}{\Sigma x^2} \text{ for total}$$

$$S_1 = \Sigma y^2 - \frac{\Sigma xy}{\Sigma x^2} \text{ for sample error}$$

$$C_x = \frac{(1026)^2}{72} = 14620.50$$

$$SS_x = 17784 - 14620.50 = 3163.50$$

$$SST_x = \frac{(593)^2}{36} + \frac{(433)^2}{26} - 14620.50 = 2358.64$$

$$SSE_x = 3163.50 - 2358.64 = 804.86$$

$$C_y = \frac{(380)^2}{72} = 2005.56$$

$$SS_y = 2744 - 2005.56 = 738.44$$

$$SST_y = \frac{(273)^2}{36} + \frac{(107)^2}{26} - 2005.56 = 505.04$$

$$SSE_y = 738.44 - 505.04 = 233.40$$

$$C_{xy} = \frac{(1026)(380)}{72} = 5415$$

$$SSP = 4675 + 1790 - 5415 = 1050$$

$$SST_{xy} = \frac{(593)(273)}{36} + \frac{(433)(107)}{26} - 5415 = 863.88$$

$$SSE_{xy} = 1050 - 863.88 = 186.12$$

List of sum of square and sum of product

Source of variation	$\Sigma x^2$	$\Sigma y^2$	$\Sigma xy$
Total	3163.50	738.44	1050
Among Means	2358.64	505.04	863.89
Within sample (error)	804.88	233.40	186.12

$$S_0 = 738.44 - \frac{(1050)^2}{3163.50} = 389.93$$

$$S_1 = 233.40 - \frac{(186.12)^2}{804.88} = 190.36$$

$$S_0 - S_1 = 389.93 - 190.36 = 199.57$$

$$C_x = \frac{(\Sigma x_1 + \Sigma x_2)^2}{N}$$

$$C_y = \frac{(\Sigma y_1 + \Sigma y_2)^2}{N}$$

Where N = Total number of subjects participated in the experiment.

### Appendix P

**Hypothesis 2:** NTC II students taught practical electronics works using visual projection will not differ significantly in their mean achievement scores from those taught using project based methods of instruction.

X <sub>1</sub> AVPPT	X <sub>2</sub> SDPT	Y <sub>1</sub> AVPPT	Y <sub>2</sub> SDPT	x <sub>1</sub> <sup>2</sup> AVPPT	x <sub>2</sub> <sup>2</sup> SDPT	y <sub>1</sub> <sup>2</sup> AVPPT	y <sub>2</sub> <sup>2</sup> SDPT	x <sub>1</sub> y <sub>1</sub>	x <sub>2</sub> y <sub>2</sub>
16	17	7	5	256	289	49	25	112	85
19	18	9	12	361	324	81	144	171	216
20	20	8	3	400	400	64	9	160	60
17	19	6	7	289	361	36	49	102	133
19	18	8	9	361	324	64	81	152	162
17	18	5	3	289	324	25	9	85	54
19	17	9	6	361	289	81	36	171	102
19	17	8	3	361	289	64	9	152	51
20	18	9	7	400	324	81	49	180	126
14	16	5	3	196	256	25	9	70	48
17	17	7	6	289	289	49	36	119	102
14	18	5	8	196	324	25	64	70	144
15	20	8	5	225	400	64	25	120	100
19	15	10	4	361	225	100	16	190	60
14	17	7	1	196	289	49	1	98	17
16	16	5	3	256	256	25	9	80	48
18	19	10	7	324	361	100	49	180	133
14	19	5	10	196	361	25	100	70	190
13	17	7	3	169	289	49	9	91	51
16	14	5	4	256	196	25	16	80	56
19	14	9	3	361	256	81	9	171	48
18	15	11	5	324	256	121	25	198	80
17	16	8	2	289	256	64	4	136	32
16	14	9	3	256	196	81	9	144	42
17	18	4	7	289	324	16	49	68	126
16		8		256		64		128	
18		10		324		100		180	
20		4		400		16		80	
14		8		196		64		112	
20		9		400		81		180	
19		10		361		100		192	
19		9		361		81		171	
19		7		361		49		133	
13		7		161		49		91	
12		8		144		64		96	
16		9		256		81		144	
<b>593</b>	<b>430</b>	<b>273</b>	<b>129</b>	<b>10489</b>	<b>7458</b>	<b>2193</b>	<b>841</b>	<b>4675</b>	<b>2266</b>

$$C_x = \frac{(1023)^2}{72} = 14535.13$$

$$SS_x = 17947 - 14535.13 = 3411.87$$

$$SST_x = \frac{(593)^2}{36} + \frac{(430)^2}{25} - 14535.13 = 2628.90$$

$$SSE_x = 3411.87 - 2628.90 = 782.97$$

$$C_y = \frac{(402)^2}{72} = 2244.50$$

$$SS_y = 3034 - 2244.5 = 789.50$$

$$SST_y = \frac{(273)^2}{36} + \frac{(129)^2}{25} - 2244.50 = 491.39$$

$$SSE_y = 789.5 - 491.39 = 298.11$$

$$C_{xy} = \frac{(1023)(402)}{72} = 5711.75$$

$$SSP = 6941 - 5711.75 = 1229.25$$

$$SST = \frac{(593)(273)}{36} + \frac{(430)(129)}{25} - 5711.75 = 1003.97$$

$$SSE = 1229.25 - 1003.97 = 225.28$$

List of sum of square and sum of product

Source of variation	$\Sigma x^2$	$\Sigma y^2$	$\Sigma xy$
Total	3411.87	789.50	1229.25
Among Means	2628.90	491.39	1003.97
Within sample (error)	782.97	298.11	225.28

$$S_0 = 789.50 - \frac{(1229.25)^2}{3411.87} = 346.62$$

$$S_1 = 298.11 - \frac{(225.28)^2}{782.97} = 233.31$$

$$S_0 - S_1 = 346.62 - 233.31 = 113.31$$

### Appendix Q

**Hypothesis 3:** NTC II students taught practical electronics works using guided discovery will not differ significantly in their mean achievement scores from those taught using project based method of instruction.

Post-test

Pretest

X <sub>1</sub> SDPT	X <sub>2</sub> PBPT	Y <sub>1</sub> SDPT	Y <sub>2</sub> PBPT	x <sub>1</sub> <sup>2</sup> SDPT	x <sub>2</sub> <sup>2</sup> PBPT	y <sub>1</sub> <sup>2</sup>	y <sub>2</sub> <sup>2</sup>	x <sub>1</sub> y <sub>1</sub>	x <sub>2</sub> y <sub>2</sub>
16	17	3	5	256	289	9	25	48	85
18	18	5	12	324	324	25	144	90	216
17	20	9	3	289	400	81	9	153	60
17	19	5	7	289	361	25	49	85	133
16	18	4	9	256	324	16	81	64	162
18	18	5	3	324	324	25	9	90	54
17	17	5	6	289	289	25	36	85	102
13	17	2	3	169	289	4	9	26	51
17	18	1	7	289	324	1	49	17	126
18	16	5	3	324	256	25	9	90	48
16	17	2	6	256	289	4	36	32	102
16	18	1	8	256	324	1	64	16	144
14	20	2	5	196	400	4	25	28	100
16	15	2	4	256	225	4	16	32	60
17	17	5	1	289	289	25	1	85	17
19	16	5	3	361	256	25	9	95	48
18	19	6	7	324	361	36	49	108	133
13	19	1	10	169	361	1	100	13	190
18	17	6	3	324	289	36	9	108	51
18	14	5	4	324	196	25	16	19	56
18	16	5	3	324	256	25	9	19	48
19	16	6	5	361	256	36	25	114	80
18	16	7	2	324	256	49	4	126	32
17	14	6	3	289	196	36	9	102	42
17	18	2	7	289	324	4	49	34	126
12		2		144		4		24	
<b>433</b>	<b>430</b>	<b>107</b>	<b>129</b>	<b>7295</b>	<b>7458</b>	<b>551</b>	<b>841</b>	<b>1790</b>	<b>2266</b>

x<sub>1</sub> = Post-test for SDPT

x<sub>2</sub> = Post-test for PBPT

y<sub>1</sub> = Pretest for SDPT

y<sub>2</sub> = pretest for PBPT



$$C_x = \frac{(863)^2}{52} = 14322.48$$

$$SS_x = 14753 - 14322.48 = 430.52$$

$$SST_x = \frac{(433)^2}{26} + \frac{(430)^2}{25} - 14322.48 = 284.64$$

$$SSE_x = 430.52 - 284.64 = 145.88$$

$$C_y = \frac{(236)^2}{52} = 1071.08$$

$$SS_y = 1392 - 1071.08 = 320.92$$

$$SST_y = \frac{(107)^2}{26} + \frac{(129)^2}{25} - 1071.08 = 34.91$$

$$SSE_y = 320.92 - 34.91 = 286.01$$

$$C_{xy} = \frac{(863)(236)}{52} = 3916.69$$

$$SSP = 4056 - 3916.69 = 139.31$$

$$SST = \frac{(433)(107)}{26} + \frac{(430)(129)}{25} - 3916.69$$

$$= 1781.96 + 2218.8 - 3916.69 = 84.07$$

$$SSE = 139.31 - 84.07 = 55.24$$

**List of sum of square and sum of product**

Source of variation	$\Sigma x^2$	$\Sigma y^2$	$\Sigma xy$
Total	430.52	320.92	139.31
Among Means	284.64	34.91	84.07
Within sample (Error)	145.88	286.01	55.24

$$S_0 = 320.92 - \frac{(139.31)^2}{430.52} = 320.92 - 45.47 = 275.45$$

$$S_1 = 286.01 - \frac{(55.24)^2}{145.88} = 286.01 - 20.92 = 265.09$$

$$S_0 - S_1 = 275.45 - 265.09 = 10.36$$

### Appendix R

**Hypothesis 4:** NTC II students taught practical electronics works using visual projection will not differ significantly in their mean achievement scores from those taught using guided discovery and those taught using project based methods of instruction.

X <sub>1</sub> AVPPT	X <sub>2</sub> SDPT	X <sub>3</sub> PBPT	Y <sub>1</sub> AVPPT	Y <sub>2</sub> SDPT	Y <sub>3</sub> PBPT	x <sub>1</sub> <sup>2</sup>	x <sub>2</sub> <sup>2</sup>	x <sub>3</sub> <sup>2</sup>	y <sub>1</sub> <sup>2</sup>	y <sub>2</sub> <sup>2</sup>	y <sub>3</sub> <sup>2</sup>	x <sub>1</sub> y <sub>1</sub>	x <sub>2</sub> y <sub>2</sub>	x <sub>3</sub> y <sub>3</sub>
16	16	17	7	3	5	256	256	298	49	9	25	112	48	85
19	18	18	9	5	12	361	324	324	81	25	144	171	90	216
20	17	20	8	9	3	400	298	400	64	81	9	160	153	60
19	17	19	6	5	7	289	298	324	36	25	49	102	85	133
19	15	18	8	4	9	361	256	361	64	16	81	152	64	162
17	18	18	5	5	3	289	324	324	25	25	9	85	90	54
19	17	17	9	5	6	361	298	298	81	25	36	171	85	102
19	13	17	8	2	3	361	169	298	64	12	9	152	26	51
20	17	18	9	1	7	400	298	324	81	1	49	180	17	126
14	18	16	5	5	3	196	324	256	25	25	9	70	90	48
17	16	17	7	2	6	289	256	298	49	4	36	119	32	102
14	15	18	5	1	8	196	256	324	25	1	64	70	16	144
15	14	20	8	2	5	225	196	400	64	4	25	120	28	100
19	17	15	10	2	4	361	256	225	100	4	16	190	32	60
14	17	17	7	5	1	196	298	298	49	25	1	98	85	17
16	19	16	5	5	3	256	361	298	25	25	9	80	95	48
18	18	19	10	6	7	324	324	361	100	36	49	180	108	133
14	13	19	5	1	10	196	169	361	25	1	100	70	13	190
13	18	17	7	6	3	169	324	298	49	36	9	91	108	51
15	18	14	5	5	4	256	324	196	25	25	16	80	90	56
19	18	16	9	5	3	361	342	256	81	25	9	171	90	48
18	19	16	11	6	5	324	361	256	121	36	25	198	114	80
17	18	16	8	7	2	289	324	256	64	49	4	136	126	32
16	17	14	9	6	3	256	298	196	81	36	9	144	102	42
18	17	18	10	2	7	324	298	324	100	4	49	180	34	126
20	12		4	2		400			16	4		80	24	
14			8			196			64			112		
20			9			400			81			180		
19			10			361			100			190		
19			9			361			81			171		
19			7			361			49			133		
13			7			169			49			91		
12			7			144			49			84		
15			8			256			64			128		
17			4			289			16			68		
16			8			256			64			128		
593	433	430	273	107	129	10498	7295	7458	2193	551	841	4675	1790	2266

$$C_x = \frac{(1456)^2}{108} = 19629.04$$

$$SS_x = 25242 - 19629.04 = 5612.96$$

$$SST_x = \frac{(593)^2}{36} + \frac{(433)^2}{26} + \frac{(430)^2}{25} - 19629.04$$

$$= 9768.03 + 7211.12 + 7396 - 19629.04 = 4746.11$$

$$SSE_x = 5612.96 - 4746.11 = 866.85$$

$$C_y = \frac{(509)^2}{108} = 2398.90$$

$$SS_y = 3585 - 2398.90 = 1186.10$$

$$SST_y = \frac{(273)^2}{36} + \frac{(107)^2}{26} + \frac{(129)^2}{25} - 2398.90$$

$$= 2070.25 + 440.35 + 665.64 - 2398.90 = 777.44$$

$$SSE_y = 1186.10 - 777.44 = 408.66$$

$$C_{xy} = \frac{(1456)(509)}{108} = 6862.07$$

$$SSP = 8731 - 6862.07 = 1868.93$$

$$SST_{xy} = \frac{(593)(273)}{36} + \frac{(433)(107)}{26} + \frac{(430)(129)}{25} - 6862.07$$

$$= 4496.92 + 1781.96 + 2218.8 - 6862.07 = 1635.61$$

$$SSE_{xy} = 1868.93 - 1635.61 = 233.32$$

List of sum of square and sum of product

Source of variation	$\Sigma x^2$	$\Sigma y^2$	$\Sigma xy$
Total	5612.96	1186.10	1868.93
Among Means	4746.11	777.44	1635.61
Within sample (Error)	866.85	408.66	233.32

$$S_0 = 1186.10 - \frac{(1868.93)^2}{5612.96} = 563.81$$

$$S_1 = 408.66 - \frac{(233.32)^2}{866.85} = 345.87$$

$$S_0 - S_1 = 563.81 - 345.87 = 217.94$$