# DEVELOPMENT OF CLOSED CIRCUIT TELEVISION AND SOLAR PHOTOVOLTAIC TECHNOLOGY COURSE FOR INTEGRATION INTO NIGERIA CERTIFICATE IN EDUCATION (TECHNICAL) PROGRAMME

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**FEDERAL UNIVERSITY OF TECHNOLOGY**

**MINNA**

**AUGUST, 2023**

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**A THESIS SUBMITTED TO THE POSTGRADUATE SCHOOL FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, NIGERIA IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTERS DEGREE IN INDUSTRIAL AND TECHNOLOGY EDUCATION (ELECTRICAL/ELECTRONICS)**

**AUGUST, 2023**

**ABSTRACT**

Students of Basic Technology Electrical Electronics lack adequate knowledge and skill to secure employment after graduation from Nigeria Certificate in Education Technical Programme. Stakeholders attributed this to insufficient curriculum for the training of the students. The objective of this study is therefore to develop CCTV and Solar Photovoltaic Technology course for integration into Nigeria Certificate in Education Technical Programme. Research and Development model was adapted for the study. The area of the study was Northeast Nigeria. The population of the study was 255 comprised of 54 Basic Technology Electrical and Electronic Lecturers and 81 Industrial Experts. There was no sampling for Lecturers but simple random sampling was used to select 24 industrial experts. Five research questions and five hypotheses guided the study. A structured questionnaire with five points rating scale was used for data collection from the respondents. It is titled: Development of Closed Circuit Television and Solar Photovoltaic Technology for Integration into Nigeria Certificate in Education (Technical) Programme Questionnaire (DCCTVSPTQ). The Instrument was subjected to content and face validation by three course and curriculum development experts. Cronbach Alpha coefficient of 0.88 was established as a reliability of the instrument. the data collected was answered using mean and standard deviation for the five research questions while analysis of variance was used to test the five null hypotheses at 0.05 level of significance. The findings of the study was all twenty two (22) objectives were agreed to be included in the course, all nineteen (19) items of the course content items with mean range between 3.88 to 4.50 were agreed to be included in the course, eleven (11) out of thirteen (13) methods of teaching items with mean range between 3.81 to 4.13 were agreed to be included in the course, twenty three (23) out of twenty five (25) material, tools and equipment items with mean range between 3.80 to 4.01 were selected to be included in the course and all twenty one (21) items of evaluation activities items with mean range between 3.35 to 3.37 were selected to be used in the course. It was therefore recommended that government should do its best to ensure the implementation of the selected objectives, contents, methods of teaching, materials, tools and equipment as well as evaluation activities of this course for the benefit of the entire society. A study for Integration of Closed Circuit Television and Solar Photovoltaic Technology Course into Nigeria Certificate in Education Technical programme was suggested.

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# CHAPTER ONE

## 1.0 INTRODUCTION

### 1.1 Background to the Study

Technology plays a vital role in the well being and progress of humanity. It is the important factor for economic and national development. The live wire of this is Electrical and Electronic Technology without which motor vehicles would not have been moving for transportation, computer would not have been functioning for all e-technologies and educational activities would have been very difficult in this twenty first century. Appliances cannot operate without electricity bringing about the technological development witnessed today (Shetima, 2010). The author added, Electrical/Electronics is the pivot of technological growth and development. That is why Electrical/Electronic Technology programme is offered in Nigerian educational systems such as universities, polytechnics and colleges of education that produces or trains technicians which include Nigeria Certificate in Education (Technical) programme of Colleges of Educations.

Nigeria Certificate in Education (Technical) NCE (T) Programme is a three years programme offered in Colleges of Education (Technical) for training of teachers who will be qualified to teach Technical and Vocational Education and Training courses (TVET) at junior secondary schools level of Nigeria education system. It was established by the recommendation of the Ashby commission in 1959 after modifying Teacher's Grade I College in which the successful completion earned a candidate the Nigerian Certificate in Education (NCE) (Kayode *et al.,* 2015). NCE (T) is a minimum teaching qualification in Nigerian education system (Federal Republic of Nigeria, 2013). Those that successfully completed the course with option in Electrical/Electronic are called NCE (Tech) Electrical/Electronic graduates (Nanyi, 2015).

The programme is intended to prepare competent technical teachers that are capable of impacting basic technology, knowledge and skills to junior secondary school students (National Commission for Colleges of Education (NCCE, 2020). And NCCE is responsible for general supervision of the entire programme. It also provides a Minimum Standard and Implementation Framework documents that outlines the curriculum and the implementation practice guidelines for the programme respectively.

The commission produces the general plan of educational experience in the Minimum Standards document for about seven categorised schools specifying the courses for each option under the respective departments. This is also in accordance with the category of NCE awarding institution. The institutions are categorised into: College of Education (Conventional), College of Education (Technical) and College of Education (Special) each with a little variation in the implementation procedure (NCCE, 2020). This study is concern with the NCE Technical Education programme and Minimum Standards of School of Vocational and Technical Education (Technical) combined in one document.

Technical Education (TE) refers to technical teacher education programme offered in colleges of education, universities and education departments in polytechnics. This means, the programme is both for technical teacher training as well as basic science and engineering preparatory courses of polytechnics and universities that can lead to the production of a professional electrical/electronic technologist and engineer. According to FRN (2013), providing courses of instruction and training in engineering, other technologies, applied sciences, business and management, leading to the production of a trained manpower is one of the goals of technical education.

Electrical/Electronic Technology Education is offered alongside Automobile Technology Education, Building Technology Education, Metalwork Technology

Education, Woodwork Technology Education, General study courses and Educational courses in NCE I first and second semesters and NCE II first semester only. Then specialisation starts from NCE II second semester up to NCE III after the Student Industrial Work Experience Scheme (SIWES) and Teaching Practice (TP) (NCCE, 2020). This curriculum of Technical Education has been considered to be adequate for the preparation of students to handle Electrical and Electronic challenges in the society but there is a gap to be covered due to the higher rate of technological advancement, unemployment, insecurity and Electrical Power problems. This gap can only be covered, if the curriculum is modified by adding a course that will introduce a graduate to Electronic Security systems and Renewable Electrical Energy systems such as Closed Circuit Television (CCTV) and Solar Photovoltaic Systems.

Closed Circuit Television (CCTV) Technology is an electronic surveillance system that uses camera, digital video recorder, network video recorder, transmission link, storage devices, display unit and other accessories to provide round the clock live and documented monitoring system. The United State of American Department of Homeland Security (USADHS, 2013) describe CCTV systems as a system that provides surveillance capabilities for the protection of people, assets, and systems. The agency identifies components of the system to include: cameras, lenses, housings and mounts, monitors, switchers and multiplexers and video recorders. CCTV System is a system consisting of camera equipment, monitoring and associated equipment for transmission and controlling purposes, which might be necessary for the surveillance of a protected area (British Security Industry Association (BSIA), 2016).

Likewise, Infinique (2016) categorises the system into analogue CCTV system and internet protocol (IP) CCTV system. The IP system uses network cameras, Network Video Recorder and can be directly connected internet for remote viewing. The

Analogue CCTV System on the other hand, uses coaxial cable and Digital Video Recorder for its operation. The IP system components are Network Cameras, Network Video Recorder (NVR), UTP Cable, Power Supply while the analogue CCTV System components are analogue camera, Digital Video Recorder (DVR), Coaxial Cable, Coaxial Cable Connectors, Power Supply, UPS and Monitor respectively. Both of these systems need electrical power to operate which can be generated from Solar Photovoltaic system.

A Solar Photovoltaic system converts the sun's radiation into usable electricity using semi-conducting materials that exhibit the photovoltaic effect (Ohanu and Okolo, 2019). This system is one of the energy system derived from solar energy. Solar Energy is a form of renewable energy that primarily originates from sun in form of light, heat and radiation of electromagnetic wave. Solar Energy is radiant light and heat from the sun which are utilised by various technologies (International Energy Agency (IEA) 2011), as cited by Huehn, 2017). Moreover, the cost of energy is rising and therefore solar energy is the inexhaustible source that is abundant, pollution free, distributed throughout the earth and recyclable (Vasanthkumar *et al*., 2017). This is the largest source of energy and the largest source of possible conversions with very large area of application. IEA (2011) stressed that, the solar energy system generates electricity in small and large scale capacity, in-fact, the technology has very large area of application. This indicates that the solar photovoltaic technology is capable of providing employment opportunities for economic self-reliance. According to International Renewable Energy Agency (IRENA) (2019) annual review, the global renewable energy sector employed 11 million people in 2018, this compares with 10.3 million in 2017, based on available information. The review specifically stated that, rising off-grid

solar sales are translating into growing numbers of jobs in the context of expanding energy access and spurring economic activities in previously isolated communities.

While this technology is very important to the function of CCTV system, it also shows its capability to improve self-reliance and provide employment opportunities at the same time solving one of the major power problems ravaging the economic activities of the nation. However, this can only be achieved if these technologies become part of the curriculum of our educational system. To do that, a CCTV and SPVT course needs to be developed for integration into the NCE (Technical) programme.

A Course is a planned and related subject matter or unit of curriculum that is identified with an objective, content, code, credit unit and contact hours to be covered in a particular semester. Ogundu (2013) stated that a Course of study consists of six major components: course description, objectives, content, time allocation, references, and tools/equipment/materials. Due to its basic components that also reflect the components of curriculum so many studies describe a Course of study to mean Curriculum or Content by implication. The focus of this study is to develop a Course that consist of CCTV and Solar Photovoltaic Technology using curriculum development design and model to determine objective, content, method of teaching, materials, tools and equipment and evaluation activities.

Development is the process of designing or creating new product that has not been in existence (Bakare, 2014). This means, development here is creating new CCTV and SPVTC that is not in the NCE (T) programme. To be successful with a programme, objective is mostly the first component required because it gives a direction for driving the content of the programme. Objectives are the intended learning outcomes, with regard to students' performance at the end of a lecture. It is aimed at determining how

much the students have learnt (Chimezie, 2016). Objectives are the behavioural changes expected in the learner as a result of a training programme (Olusegun, 2016).

The Objectives of the CCTV and Solar Photovoltaic Technology are now the behavioural changes expected in the NCE student as a result of training programme with the developed Course of this study. The content is the subject matter delivered during the instructional process. According to Adaobi (2013), Content refers to knowledge, skills, processes and values designed for students to acquire in school. Method of Teaching is a strategy use in presenting or implementing the subject matter to the students. Similarly, Implementation strategies or delivery systems are means of teaching prepared lessons to students (Bakare. 2014). Materials, Tools and Equipment are list of devices needed to teach the practical content of the developed course of study (Chimezie, 2016). Evaluation determines the level of achieving the stated objectives of a course. These components are best identified by the experts in the field for development before integrating into a programme.

Curriculum Integration, according toUnited Nations Educational, Scientific and Cultural Organization UNESCO (2020), is the process of combining/articulating learning content and subjects with a view to promoting holistic and comprehensive learning. When reviewing an existing curriculum, the items selection and curriculum validation are done by the experts obtained from various dimensions of the subject matter to make sure the developed subject is in line with overall objectives before it is integrated into the existing programme. The group of experts in the field of Electrical/Electronic Technology are lectures of the department of Electrical/Electronic Technology Education and CCTV and SPVT industry experts. These have several years of experience in their respective areas of teaching and learning as well as practical activities of designing, installation and maintenance of CCTV and Solar PV system, and

for sure they have a big role to play in the identification and/or validation of the most appropriate items in the development of the course under study.

Going by this, it is very clear that CCTV and Solar Photovoltaic Technology is very relevant to the Electrical/Electronic Technology Education as its ultimate goal is the production of individuals that has knowledge and skill who shall be enterprising or self-reliant (NCCE, 2020). With respect to the above, CCTV and Solar Photovoltaic Technology programme will provide modern employment opportunities that are important to the labour market of twenty-first century and create another energy source for economic development of the country. On this ground, this study seeks to develop the CCTV and SPVT Course for self-reliance with entrepreneurship skill for the students to gain and provide employment opportunities in the labour market upon completion of the programmme.

## 1.2 Statement of the Research Problem

Basic Technology Electrical Electronic programme at NCE (T) level was designed to produce teachers who will teach at junior secondary school level and also to provide the necessary skill, knowledge and attitude for the preparation of student that will impact basic science and technology for the junior secondary school students who will become technical instructor or technology education teacher (NCCE, 2020). According to Nanyi (2015), Electrical/Electronics (E/E) programme provides economic and skills enterprises through which graduates can earn income and employ others. The field of Electrical/Electronic Technology has developed to include CCTV and SPVT.

However, such changes are not reflected in the Basic Technology Electrical/Electronic programme of NCE (T) and result in limiting the knowledge employment potential of the students. A critical analysis of Electrical/Electronic Technology curriculum of

institute of technology in Nigeria revealed lack of relevant skill to prepare students for gainful employment (Ismail and Mohammed, 2015). According to Arfo (2015), the Technical and Vocational Education and Training (TVET) curriculum needs to be reviewed to cater for skills and programmes that would meet the need of the students, community, economy and the nation at large. This implies that there is need to make an adjustment in the curriculum of the programme. Agha (2013), laments over the incompetence of technicians, engineers and tradesmen who are products of Vocational Institutions in Nigeria, which hindered technological advancement and stated that the recent curriculum has not changed with changing situation and therefore needs immediate modification.

Based on the researcher's effort, the review of literature revealed lack of standard course in CCTV and Solar Photovoltaic Technology to be integrated into the curriculum of Electrical/Electronic Technology Education at NCE level. The problem of this study is therefore, graduating students with irrelevant skill for the societal demand and increase in unemployment. Therefore, to fill this gap the researcher sees a need to develop CCTV and Solar Photovoltaic Technology Course to be integrated into Nigeria Certificate in Education (Technical) Programme.

### 1.3 Aim and Objectives of the Study

The aim of this study is to develop a CCTV and Solar Photovoltaic Technology Course for the integration in the NCE (Technical) Programme and specifically to determine:

1. The appropriate objectives for inclusion in CCTV and Solar Photovoltaic Technology Course;
2. The appropriate contents for inclusion in CCTV and Solar Photovoltaic Technology Course;

3. The appropriate methods of teaching of CCTV and Solar Photovoltaic Technology Course;
4. The appropriate materials, tools and equipment for teaching CCTV and Solar Photovoltaic Technology Course;
5. The appropriate evaluation activities for inclusion in CCTV and Solar Photovoltaic Technology Course;

## 1.4 Significance of the Study

The study will be of great significance to the curriculum planners and developers, Electrical/Electronic Technology Education lecturers, Electrical/Electronic students, electronic security production companies, CCTV installation companies, Solar Photovoltaic production companies, Solar Photovoltaic installation companies, consumers of Solar Photovoltaic, residential and commercial structures, researcher and the government at different levels.

The finding of this study can be used by the curriculum planners and developers such as Nigerian Educational Research Development Council NERDC and NCCE to plan and develop a curriculum that can be used in educational institutions. They can have access to the findings through seminars, conferences and workshops which are normally carried out to improve the educational value in line with the current needs of the society.

The finding of this study could be used by the lecturers of Electrical Electronics Technology as a planned curriculum document that will guide the conduct of their instructional activities and training. This is achieved by the use of this study for the preparation lesson note and instructional materials. It will give room for impacting necessary knowledge skill and attitude for the graduate to effectively function in the society as teachers of TVET and technicians.

The result of this research is very important to the students of Electrical/Electronic Technology because it is the framework to be use by the student to acquire relevant skill, knowledge and attitudes for designing, installing and maintenance of CCTV and Solar Power systems in the society. It will serve as means of getting educational resources for training the students. This will also result in employment opportunities for the graduate and solution to security and power challenges after successful completion of the programme.

Electronic security production companies will use the finding of this study to produce most relevant CCTV components. The research and development unit of the company can use this study to identify new security components very relevant to the societal demand. They can also determine the tools and equipment highly required for the installation of CCTV system and therefore increases in the production of such tools and equipment.

CCTV installation companies will also benefit from the findings of this study by gaining the knowledge required to select appropriate CCTV components, tool and equipment to be used in the installation of the system. From the research document also, they can learn procedures and techniques for carrying out their job. Also, the document can be used to prepare material to be used in training the members of staff of the company.

Solar Photovoltaic production companies will utilize the finding of this study to produce most relevant Solar Photovoltaic components. They can also determine the tools and equipment highly required for the installation of Solar Photovoltaic system and therefore increases in the production of such tools and equipment. The finding can serve

as a workshop and seminar resources to be used in research and development for new solar photovoltaic product.

Solar Photovoltaic installation companies will also benefit from the findings of this study by gaining the knowledge required to select appropriate Solar Photovoltaic components, tool and equipment to be used in the installation of the system. From the research document also, they can learn procedures and techniques for carrying out their job accordingly. This is possible when the members of staff of the company are exposed to the finding in workshops and seminars.

The consumers of Solar Photovoltaic will have their systems properly installed and maintained by the product of this Course safely without any damage or breakdown of their activities. After graduation, it is expected that some graduate will establish CCTV and Solar installation companies from which the individual consumers will needs the installation and maintenance of CCTV and solar systems.

The owners of residential and commercial structures will also benefit from the knowledge and skill acquire by the product of this study in getting their structures adequately secured with CCTV system. This in turn will save them from the risk of losing their lives, wealth and properties.

Researchers will use this study as a literature while conducting further investigation. This will be simply done after completing and publishing the study in journals. Thereafter, the researchers will need to review the study as part of their related empirical study or in an effort to back up their ideas.

The government at different levels can also benefit from the finding of this study. The benefits in the above-mentioned area affect government at local, state and even federal level because all the beneficiaries are components and under government. In addition,

the product of this Course will provide a sound and quality services to the government by in teaching and learning from the finding of this study. Designing, installation and maintenance of CCTV and Solar Photovoltaic systems on government facilities and infrastructures such as: streets, markets, offices and schools.

## 1.5 Scope of the Study

The study is intended to develop CCTV and Solar Photovoltaic Technology Course. It is limited to the objective, content, method of teaching, materials, tools and equipment and evaluation activities. These components of the Coursewill be covered because of their relative unique significance in every course of technical education programme. But stand-alone CCTV system, wireless transmission system, solar thermal and practical construction of solar photovoltaic components will not be covered as they are not relevant to the aim of the programme at this level.

## 1.6 Research Questions

These research questions will guide the study:

1. What are the appropriate objectives for inclusion in CCTV and Solar Photovoltaic Technology Course?
2. What are the appropriate contents for inclusion in CCTV and Solar Photovoltaic Technology Course?
3. What are the appropriate methods of teaching CCTV and Solar Photovoltaic Technology Course?
4. What are the appropriate materials, tools and equipment for teaching CCTV and Solar Photovoltaic Technology Course?
5. What are the appropriate evaluation activities for inclusion in CCTV and Solar Photovoltaic Technology Course?

## 1.7 Hypotheses

The following null hypotheses will be tested at 0.05 level of significance:

**$Ho_1$:** There is no significant difference in the mean responses of Electrical/Electronic Technology Lecturerss of NCE (T)and CCTV &SPVT industry experts on the appropriate objectives for inclusion in CCTV and Solar Photovoltaic Technology Course;

**$Ho_2$:** There is no significant difference in the mean responses of Electrical/Electronic Technology Lecturerss of NCE (T) and CCTV and SPVT experts on the appropriate contents for inclusion in CCTV and Solar Photovoltaic Technology Course;

**$Ho_3$:** There is no significant difference in the mean responses of Electrical/Electronic Technology Lecturerss of NCE (T) and CCTV and SPVT industry experts on the appropriate methods of teaching CCTV and Solar Photovoltaic Technology Course;

**$Ho_4$:** There is no significant difference in the mean responses of Electrical/Electronic Technology Lecturerss of NCE (T)and CCTV and SPVT industry experts on the appropriate materials, tools and equipment used in CCTV and Solar Photovoltaic Technology Course;

**$Ho_5$:** There is no significant difference in the mean responses of Electrical/Electronic Technology Lecturers of NCE (T) and CCTV and SPVT industry experts on the appropriate evaluation activities for inclusion in CCTV and Solar Photovoltaic Technology Course.

# CHAPTER TWO

# 2.0 LITERATURE REVIEW

## 2.1 Theoretical Framework

The theoretical framework covers relevant educational theories and models that will guide the development of Closed-Circuit Television and Solar Photovoltaic Technology Course. Teaching and learning theories and models elucidate phenomena. While theories can be the basis for creating a model that shows the possibilities of the observed subjects, models can serve as the structure for the step-by-step formulation of a theory and at the same time, models can be used as a physical tool in the verification of theories (Difference between models and theories, 2021). Therefore, the models that have a role to play in this study are: categorised as linear and cyclic models. The linear model is Tyler (1949) and the cyclic models are Wheeler (1980), Dick and Carey (2015) and lastly Gall *et al.* (2003).

### 2.1.1 Tyler model (linear model)

This model was developed by Tyler in (1949). It is regarded as objective and strategic oriented model because the four steps of the model are tied-down and closely linked to the objective and the strategies of achieving the stated objective of the curriculum. Tyler stated four fundamental questions that resulted to the steps of the models:

1. What educational purposes should the school seek to attain?
2. What educational experiences can be provided that is likely to attain these purposes?
3. How can these educational experiences be effectively organised?
4. How can we determine whether these purposes are being attained?

These questions were transformed to the steps of the curriculum model. The educational purpose to be attained by the school meant selection of objectives and the manner of selecting the learning experience in the second question is answered by the step of

selection of educational experiences. Similarly, the third question implies the organisation of learning experience same way the evaluation indicate how to check the attainment of the stated objectives.

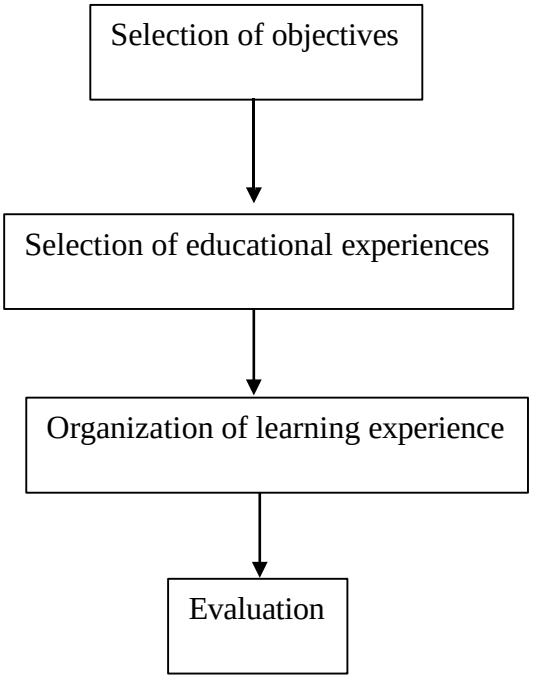


**Figure 2.1:** Tyler Curriculum Development Model
**Source: Tyler (1949)**

This is a linear model starting with the selection of objective and terminated with evaluation for assessing the level of achieving the objective. And as can be seen, the steps are connected with the objectives of the curriculum. The model failed to identify the content of curriculum but only consider the learning experience. This model is relevant to this study since it expresses and emphasizes the selection objective of a curriculum as objective of this course is also going to be selected.

The second category of the models is cyclic models. In contrast to the linear models, this model is a continuous process that has a beginning but do not have an end. The development steps are outlined but the evaluation step is having another link to the beginning of the development so as to effect necessary corrections obtained as a result of previous evaluation.

### 2.1.2 Wheeler Model (Cyclic Model)

This model was developed by Wheeler (1980) to address some of the challenges identified in Tyler model. It is similar to Tyler model that starts with objectives of the curriculum but three major differences are continuity of the process after evaluation, identification of content and separation of content from the learning experience.

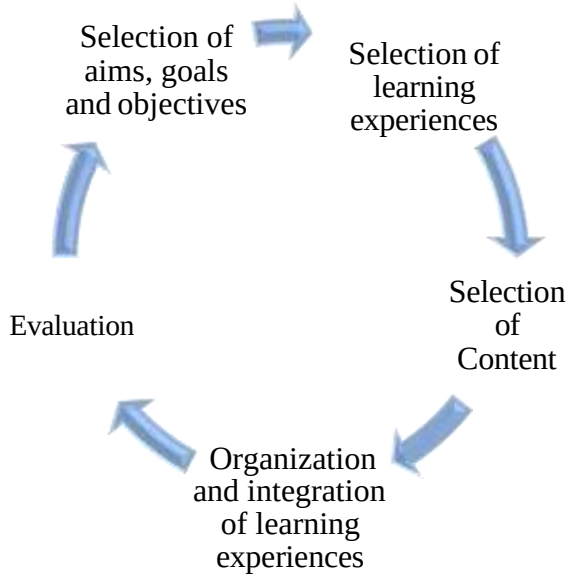


**Figure 2.2:** Wheeler Curriculum Development Model
**Source: Wheeler (1980)**

The role of this model in this study is the idea of dynamic nature of curriculum that will go a long-way in addressing the dynamic need of the society and learners.

### 2.1.3 Dick and Carey Model (Cyclic Model)

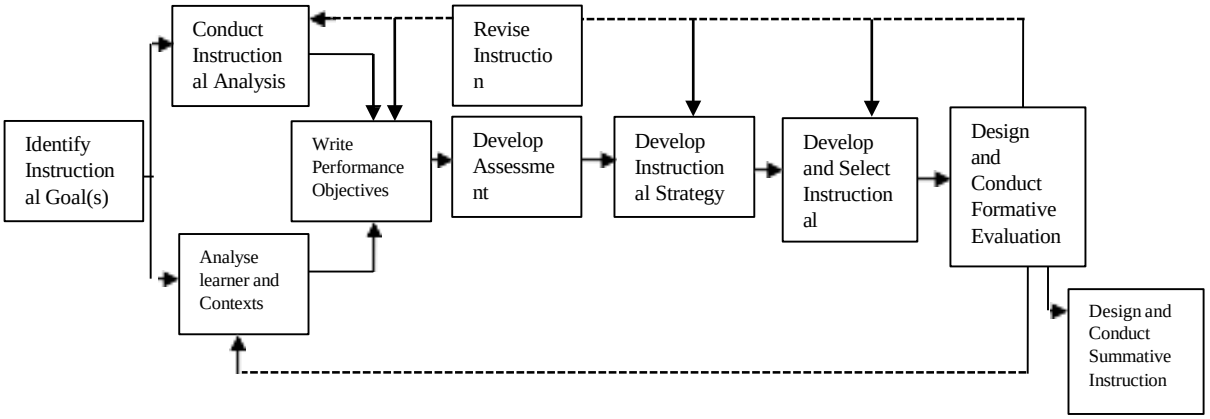


**Figure 2.3:** Dick and Carey System Approach Model for Designing Instruction
**Source: Dick and Carey (2015)**

This model is based on the concept of a system which consist interrelated and interconnected units working together towards a stated goal in which a feedback determines the attainment of the stated goal Dick and Carey (2015). It is also derived from 'system point of view', a perspective of Israelite for addressing e-learning challenges (Dick and Carey, 2015). The authors further express this model to include the common components of models such as Analysis, Design Development, Implementation and Evaluation (ADDIE) that are collectively called Instructional system development or Instructional Design. The components of Dick and Carrey's systems approach Model are:

1. Identify instructional goal(s): has to do with the determining new information and skill needed by the learner to master after completing the instruction. It is expressed as goal and be derived from the analysis of people doing the job or need assessment.
2. Conduct instructional analysis: determine what people are doing after performing the goal and the entry skill of the students.
3. Analyse learners and contexts: at the same time with the second component, analyse and determine the learner's current skill and instructional setting or context for learning the skill.
4. Write performance objectives: write white specific statement of what a learner will do after completing the instruction.
5. Develop assessment instruments: it is developed to measure the learner's ability to perform a description in the objective.
6. Develop instructional strategy: using related theories, the strategies of motivation, presentation, learner's participation and method of instruction.

7. Develop and Select instructional materials: in accordance with the used instructional strategy, the instructional material is developed and selected. The materials include: power point presentation, video, web page, and computer based multimedia.
8. Design and conduct formative evaluation of instruction: after drafting the instruction, this evaluation is designed and conducted to give room for improving the instructional process or product.
9. Revise instruction: this is the last design and development step and the first step in cycling or repeating process. It is represented by dotted lines in the model and indicate need to re-examine the validity of the instructional analysis and the assumption about the learners characteristics and entry skill. It is done at every step of the instruction based on the outcomes of the subsequent step.
10. Design and conduct summative evaluation: this is not part of the instructional design process but is done after formative evaluations and revision to meet the standard of the designer. It is normally done by independent body.

This is very relevant to this study because it enables the design and selection the components of the course under study from the instructional development view point. It is divided into three sections: design, development and evaluation.

### 2.1.4 Gall *et al.* model (cyclic model)

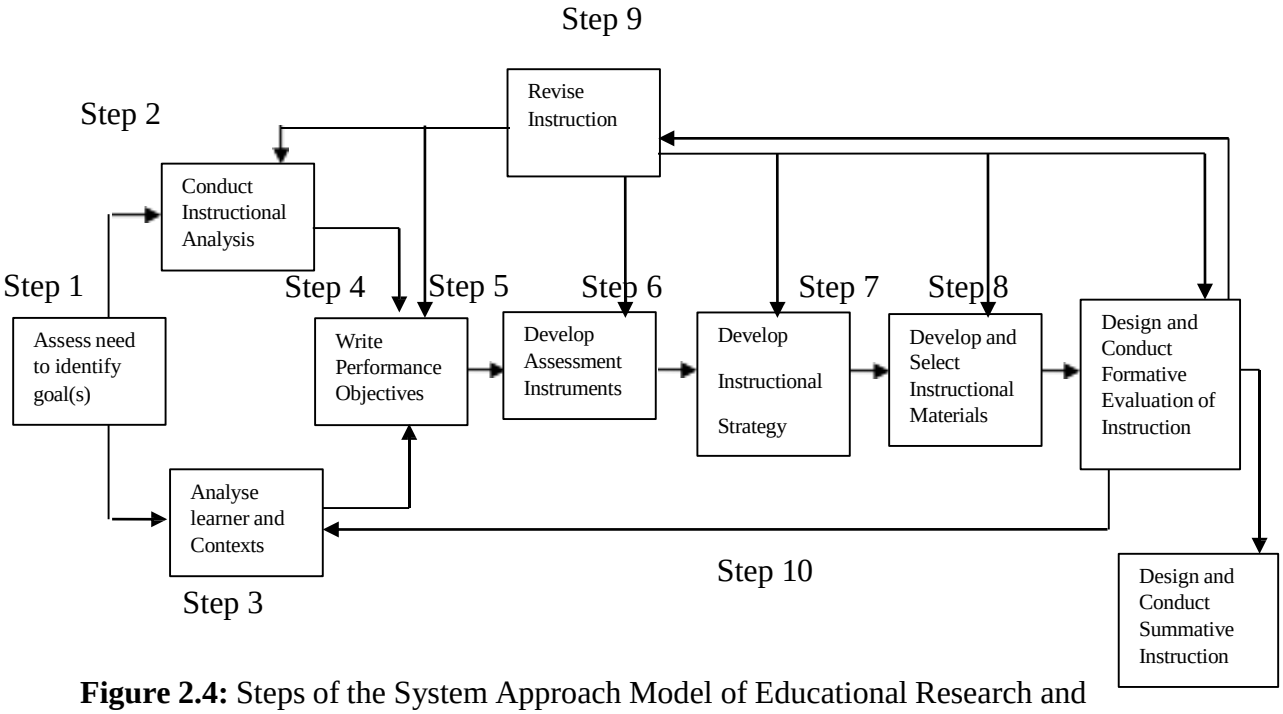


**Figure 2.4:** Steps of the System Approach Model of Educational Research and Development (R&D)
**Source: Gall, *et al* (2003)**

Gall, *et al* modified the model to be used in educational research and came-up with these components:

1- Assess needs to identify goal(s)

2- Conduct instructional analysis,

3- Analyze learners and contexts

4- Write performance objectives

5- Develop assessment instruments

6- Develop instructional strategy

7- Develop and select instructional materials

8- Design and conduct formative evaluation of instruction

9- Revise instruction and

10- Design and conduct summative evaluation.

This is the adaption of Dick and Carey System Approach Model for designing instruction after a modification in the first step. Here it is "Assess needs to identify goal(s)" instead of "Identify instructional goal(s)"and they make additional link between 'revise instruction' and'design and conduct formative evaluation of instruction'. They have same interpretation in all steps and most importantly relate this model to the concept of Research and Development R and D instead of Instructional Design. This is very relevant to this study because it guides the designing and selection the components of this course from the Research and Development point of view.

## 2.2 Conceptual Framework

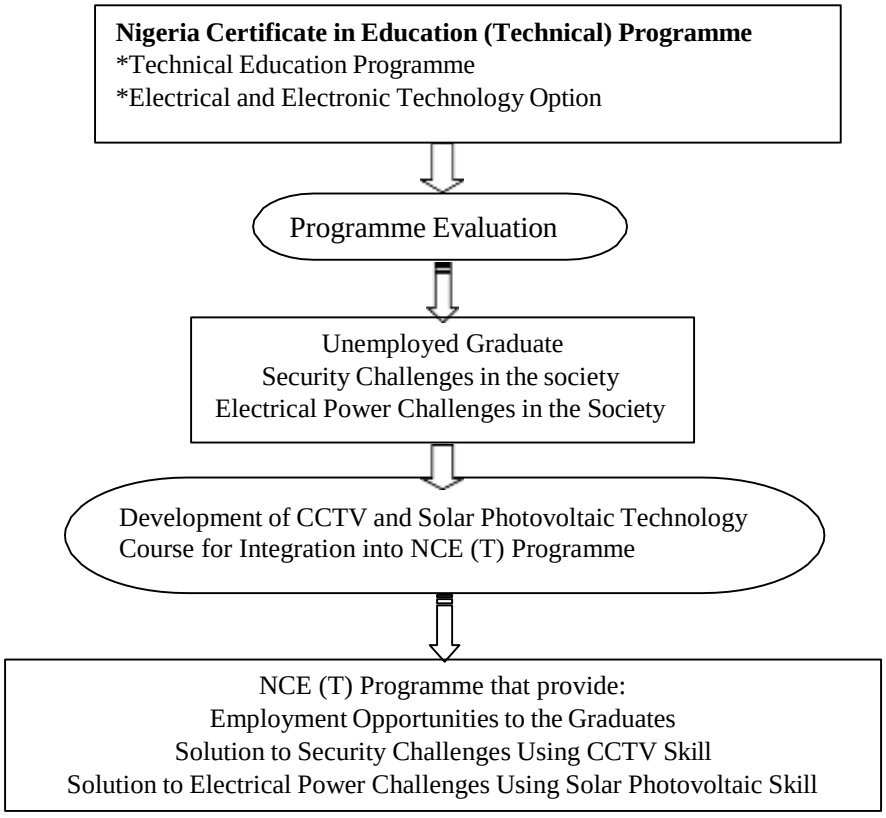


**Figure 2.5:** Schematic Conceptual Framework of Development of Closed Circuit Television and Solar Photovoltaic Technology Course for Integration into Nigeria Certificate in Education (Technical) Programme

**Source: The Researcher**

The schematic conceptual framework of this study is based on the major variables of the study and how they are related to one another. Nigeria Certificate in Education (Technical) Programme is a three years teacher education programme offered in Colleges of Education (Technical). Technical Education Programme is one of the units of NCE (T) programme in which Electrical and Electronic Technology Education option is among the areas of specialization. The results obtained from the evaluation of Electrical and Electronic Technology programme reveals lack of sufficient employment opportunities to the graduates of the programme while there is insecurity and lack of Electrical power in the society. These can be curtailed using CCTV and Solar Photovoltaic Technology skills. That is why this study is going to be conducted to develop CCTV and SPVT course for integration into this option so as to provide employment opportunities to the graduate of the programme as well as tackling security and Electrical Power Challenges of the society making the graduate of the programme self-reliance which is one of the ultimate objectives of the programme.

### 2.2.1 Nigeria certificate in education (technical) programme

The Nigeria Certificate in Education (Technical) Minimum Standard is a document that outlines an operational academic benchmark for the conduct of NCE programme all over the country (Nigeria). This document stipulates the curriculum contents below which no College of Education is allowed to operate (Chijioke and Cherechi, 2020). The Minimum Standards for teacher educators define the minimum the educators should know and be able to do as well as their expected minimum dispositions towards their work, if they are to remain/progress in their career (FRN, 2013). The term “minimum”, signifies that every accredited NCE awarding institution can add more courses to suit the needs of their immediate society.

Minimum Standards refer to pre-determined standards which set the yardstick for each organization; Standard implies the level of quality, skill, ability or acceptable format which something or performance is judged and measured (Alumode, and Onuma, 2016). The authors added it marks only the lower limits below which no organization under review can operate. Presently, there are 194 NCE Certificate awarding institutions in Nigeria that train student in deferent fields of study in any of these institutions before the certificate is awarded (NCCE, 2020). That is why NCCE was established and was given a mandated provide a minimum standard guiding the conduct of the programmes. The document contains the entire curriculum of NCE programme in Nigeria that specifies the minimum requirements of each and every teacher education programme offered by the institutions. Teacher education refers to professional education of teachers towards attainment of attitudes, skills and knowledge considered desirable so as to make them efficient and effective in their work, in accordance with the need of a given society at any point in time (Kayode *et al.*, 2015). Related programmes are grouped under a particular school and a particular department. The Minimum Standard of concern for this study constitutes the curricula of Agricultural Education, Business Education, Fine and Applied Arts, Home Economics and Technical Education which is the area of focus of this study. Department of Vocational and Technical Education are under School of Vocational and Technical Education under which the Technical Education Programme is offered.

### 2.2.2 Technical Education Programme

The philosophy of the programme is to provide technical teachers with the intellectual and professional background adequate for teaching technical subjects and to make them adaptable to any changing situation in technological development not only in the country but also in the world at large (NCCE, 2020). The author added it is offered in

the School of Technical Education with the objectives of producing qualified technical teachers and practitioners of technology capable of teaching basic technology in the junior secondary schools. And further stressed that the programme is to: produce technical NCE teachers who will be able to inculcate scientific and technological attitudes and values into the society; produce qualified technical teachers motivated to start the so much desired revolution of technological development right from the Nigerian schools; prepare technical teachers so as to qualify them for a post – NCE degree programme in Technical Education**.** John and Stephen (2020), opined Technical Education also known Industrial Technology Education, is one of the Vocational Education Courses offered in Nigerian tertiary institutions such as Polytechnics, Colleges of Education and Universities. But the focus of this study is on the one offered in the Federal Colleges of Education (Technical), Colleges of Education and Polytechnics.

Like other programmes under Vocational and Technical Education, it has a standard philosophy, stated objectives and general admission requirements. It also, requires: operational facilities, standard staff offices, standard library, qualified personnel, qualified lecturers//instructors/technologies, relevant modes of Teaching, graduation requirements, conduct of teaching practice, performing project in education, approved subject combinations, conducting Student Industrial Work Experience Scheme (SIWES), stated course outline/description and list of tools and equipment for running the programme in one of the five options or area of specialisation. The options are; Automobile Technology, Building Technology, Metal work Technology, Woodwork Technology and Electrical/Electronic Technology. However, this study is focused on Electrical/Electronic Technology option.

### 2.2.3 Electrical/electronic technology option

The concept of Electrical/Electronics is associated with the flow of electron. Electron is a moving charge that can be positive or negative. That is why any device in the system uses at least two conductors to operate. The major distinction between electrical and electronics is in the type of current they consume to operate. While electrical devices, like refrigerator and water heater use alternating current AC, the electronic devices, such as radio and handset use direct current DC to operate. An adjective, Electrical in some instance, is representing both AC and DC related devices and systems. Electrical and Electronics are mostly used together as qualifiers of another concept or standing on their own. In either of the cases, "and" and forward slash (/) are used to separate the two terms but basically "and" means the first term is different from the second while (/) signifies "or" meaning the first and second terms are same in the context. These are found in the new Minimum Standard which also uses Electrical/Electronic Technology for the year three course outline and tools and equipment but uses Electrical and Electronics for year two course outline and Basic Technology Electrical and Electronic for area of specialisation (NCCE, 2020). Meanwhile, use of Electricals and Electronics as noun or Electrical and Electronic as adjective is another point of concern that attracts misapplications. However, this option is basically concerns with the training of students on technological aspect of Electrical and Electronics for self-reliance, working in industries or training in secondary schools for economic development.

However, our life if fully saturated with modern technological devices, most of them need Electrical or Electronic input to operate. In this regard, if properly manage this Programme is capable of providing job opportunities in the society. Electrical/Electronic (E/E) Programme provides economic and skills enterprises through which graduates can earn income and employ others (Nanyi, 2015). The author added Electrical/Electronic

occupies a vital position in income generations because of its multiple areas of specialization like: house wiring, machine installation, electroplating jobs, rewinding of electrical appliances, drawing and interpretation of electrical wiring plan businesses.

### 2.2.4 Electrical/electronic technology education conventional courses

The conventional courses of this option are the courses offered at specialisation level which start from second semester of NCE II. Specialisation is determined by the course outline or the content so Basic Technology Electrical and Electronics Course are identified with a TEE (Technical Education Electrical) code and followed by three digit numbers (000) representing level, semester and serial number of a course (NCCE, 2020). Basic Technology Automobile and Basic Technology Building Courses have course codes of TEA 326 and TEB 324 respectively. Electronic and Electronic Devices (TEE 221), Digital Electronics (TEE 222) and Building/Electrical Drawing (TEE 223) are the courses offered in NCE II second semester. On the other way, Electrical Machine and Power (TEE 321), Telecommunications (TEE 322), Practical Project (TEE 323), Building Drawing (TEE324), Maintenance and Repair of Electrical Equipment (TEE 325) and School Workshop Management (TEE 326) are offered in NCE III second semester alongside Educational and General Studies Courses. The following are the courses with their brief specific objectives:

Electronic and Electronic Devices Course (TEE 221) introduces students to the basic semiconductor devices for analogue applications, computer system, ICT, global system for mobile communication (GSM) and internet. The specific objectives according to NCCE (2020) are the student should be able to: define and explain the concept of thermionic emission process and vacuum tubes; explain various semiconductor devices and their applications; explain the concept of information and communication technology (ICT) and semi-conductor devices.

Digital Electronics (TEE 222) is advance aspect of electronics that discusses principles and applications of semiconductor devices in a digital mode. This principle is built on binary operation (0s and 1s) which by implication, the operational components receive and transmit signals as 0 or 1, low or high, present or absent. The objectives of this course are: after completion a student is specifically expected to explain basic computer parts, types and other devices; explain computer hardware configuration and techniques of computer aided designs; explain number system, logic gates; identify computer parts and types; explain flip-flop, counters; distinguish between decoders and encoders; explain the functions of microprocessors; carry out designs using computer aided software; configure computer hardware and identify computer and computer devices (NCCE, 2020).

Building/Electrical Drawing (TEB 223) is another NCE II course which is originally from Building option (TEB) but is offered in electrical electronic option to introduce students to the basic of Electrical building installation and their blueprints. The objectives as outline by NCCE (2020) include identification of various electrical and electronic symbols and drawings; interpreting and converting circuit diagram to block diagrams and vice-visa and drawing wiring diagrams for domestic building and school workshop.

Electrical Machine and Power (TEE 321):- Electrical machine are basically motors and generators while electrical power covers generation, transmission and distribution of electricity supply in a safe and efficient system to the consumers. Electric motor converts electrical energy into mechanical energy while electric generator converts mechanical energy into electrical energy. Unlike motor, Electric generator basically is capable of produce only AC that is letter converted to DC when DC power is required or just connected to the supply system when AC is required. Specifically, at the end of

this course, according to NCCE (2020), the student should be able to: Explain types of power generation, transmission and distribution and their components - Explain techniques of protective devices and testing - Explain operation of various electrical machines. – identify Power generation, transmission and distribution, transmission lines, Tariffs, power factor and correction among others.

Telecommunications (TEE 322) introduces the participants to the very large area of human endeavour. The concept of telecommunication is about communication over a distance which includes, audio-visual, audio and visual communication using different electronics devices such as computer, Global system for Mobile communication (GSM), Radio and television. In the context of this study, the course objective is for a student to explain various components of telecommunication system- explain radio and television receivers and transmitters and their components- identify and explain antenna; types, operation and application- identify and explain telephones; types operation and application (NCCE, 2020). The author also expected the student to explain the operation of AM/FM radio transmitters and receivers- explain the principles of modulation (AM/FM) and phase modulation- explain radio waves and propagation- explain the operation television receivers and transmitters and satellite communication.

Practical Project (TEE 323) this course evaluates the psychomotor skill acquired by the student within the period of his academic training. According to NCCE (2020) each student should carry out a major practical project in Electrical Technology backed by a written report in any of the following major areas of Electrical and Electronic Technology. i) Electronic and Communication ii) Electrical power iii) Electrical machine.

Maintenance and Repair of Electrical Equipment (TEE325): This focuses more on the preparation of student to be self-reliant in carrying out maintenance and repair of electrical equipment in their workshop after graduation. Maintenance is the process of preventing and correcting a problem or sustaining a functional capability of an electrical devices or equipment. Repair is mostly corrective act of fixing or putting a device in a functional state. The objectives of this course as enumerated by NCCE (2020) are for the student to be able to: Mention and explain types of Maintenance and Repair Techniques – identify and explain Electrical/Electronic Equipment. – explain safety rules and regulations - explain types of electrical maintenance – carry out Servicing and maintenance of electrical and electronics and Installation – explain the advantages & disadvantages of maintenance – carry out maintenance and repair of computer hard wares.

School Workshop Management (TEA 326):- This is basically from Basic Technology Automobile Option that introduces the students to workshop management. A school Workshop in a technical school is part of the facility operational standard that enables students to carry out practical learning experience and at the same time giving them opportunity to see the real working context to operate and manage after graduation. This course is very relevant to the quality of product and services of the graduate because without proper management there would not be any quality in the production and services of the technical education students. The topics covered in this course in the context of NCCE (2020) are: comprehensive, general and unit workshops - material control - maintenance and records - equipment and supplies - school workshop design (units and integrated) safety and safety equipment workshop/laboratory personnel and their responsibilities.

Building Drawing (TEB 324):-This is similar to Building/Electrical Drawing (TEB 223) offered in NCE II but only concentrate more on plumbing and building aspects of building blueprints which are associated with the electrical fittings on the building structure. After completion, the student is expected to: State basic responsibilities in design process - enumerate standard practices in building design - list and state uses of drafting materials and equipment - list basic principles and design (NCCE, 2020). In addition to these, student is to produce preliminary sketches and design of a simple building - make working drawings (to include standard symbols for plumbing) up to 1 storey building - produce relevant electrical service plan of a building - prepare schedules - produce blue printing - demonstrate basic knowledge of computer aided drafting (CAD).

But with all these courses, the products of the programme are still lagging behind due to the rapid dynamic state of technology. That is why most of the graduate cannot fit into the society in accordance to the objectives of the programme. One of the roles of products of Electrical Electronic Technology is to teach in Technical Colleges and produce well train technician capable of handling technical challenges in the society (Mohammed *et al.*, 2019). The author lamented this has however not been the case in an ideal situation, for effective teaching and learning of electrical and electronic course, the teachers should possess adequate knowledge of the subject matter, the skill needed to impart the knowledge and pedagogical expertise.

### 2.2.5 Career challenges of conventional electrical/electronic technology

The aims of Technical Education and electrical electronics as it is studied presently in colleges of education is to prepare student to teach TVET in training institutions or becomes self-reliant for economic development. Any of these is a form of career opportunity for the graduate of the programme. Unfortunately, unemployment rate of

NCE/OND/Nursing according to the National Bureau of Statistics (2018) in the third quarter of year 2018 is 33.8%. In spite of the various recommendations and reforms that targeted repositioning teacher education in the country for optimal performance, the challenges facing teacher education in Nigeria are still numerous (Kayode *et al.,* 2015). As a stand-alone component of technical education programme that is mostly left alone after forming Construction Technology (Building and Woodwork) and Mechanical Technology (Automobile and Metal work) by some institution, whatever affect it affect technical education programme and vice versa.

The following studies reported inadequate job opportunities for the graduate of this programme due to outdated curriculum content. According to Abdulwahab and Sa'I (2014), the programme is unable to provide its recipients with relevant skills suitable for effective teaching at any level of technical education institutions and also to provide their recipients with concrete vocational skills for self-reliance. Unfortunately many electrical/electronic graduates who are supposed to posses electrical/electronic skills in Nigeria remain unemployed, because they lack the required competencies (Nanyi, 2015).

Not only in Colleges of Education but also the lecturers of this course faces challenges in Universities. In developing countries as Nigeria, Electrical/Electronic Technology Lecturers in the universities are surrounded with various on-the-job irregularities ranging from limited or no electrical and electrical devices and circuits to carry out practical in the workshop, overcrowded class size, multiple job tasks, balancing work-family affairs, political instability, ill-equipped or no workshop facilities, to the gap between what is obtainable in the industry and the educational system (Ogbuanya and Chukwuedo, 2017). The gap between educational system and industrial need proved the presence of career issue.

### 2.2.6 Educational development and integration

Development and Integration or Inclusion are the most common terms in the scope of a discussion whenever educational programme, curriculum, module, course, self-study manual, instrument need to be readjusted of created for better attainment of societal educational objectives. Development is the act or systematic process of using scientific and technical knowledge to build an idea or material (Merriam-Webster, 2017). According to Opeyemi (2014), Development involves a process and this entails putting a prescribed procedure in line with set rules towards improving a test instrument. The term "integrate" means to render something whole or at least to provide some sort of unity or more appropriately here is different ways in which the diverse elements of curriculum can be given unity. Integration refers to the horizontal relationship of curriculum content and learning experiences which also means merging of related content and experiences from different subject areas into one area of knowledge (Offorma, 2016). The author added it deals with using content from one subject area to solve problems in another content area. From the above, it can be understood that development and integration has something to do with curriculum, content and instrument.

Curriculum according to Atsumbe (2010) is a set of courses or content that is planned and taught in or outside the school for the purpose of developing the learner physically, morally, socially and intellectually. Efanimjor and Okolocha (2020) defines Curriculum as the means through which the laid down educational philosophy of a nation is translated into concrete reality. It contains prescribed course of studies which students must learn in order to reach a certain level of education. Its basic component units are objectives, content, learning experience, implementation method and evaluation. This is also implying that, Curriculum can never be dissociated with course and content and

researchers apply Curriculum development theories and models when conducting a study on course of study, educational programmes, instructional package, Curriculum, educational module, self study manual and skill acquisition training document. It is very important at this point to understand that a careful observation shows that studies that develop a content of a programme in skill oriented field of study either generate the objectives and research questions of the study in line with psychomotor (stated like objective) and cognitive (stated like content) domains of Bloom taxonomy of objective or inline with the units (deferent machines or equipment) only. The purpose of this study is to develop and validate Cognitive and Psychomotor skills contents for the operation and maintenance of television cameras for training radio, television and electronics work students in Nigeria (Maxwell and Raymond, 2019). But when developing a curriculum, programme, module or course the scope of the study becomes wider and give for identifying method of implementation, evaluation activities materials, tools and equipment needed for teaching and learning the developed educational product.

Curriculum Development in science education is an aspect of curriculum study that comes at the generation and improvement of curriculum for promoting teaching and learning of basic science and technology as well as enhancing man's lot as a civilized being (Lawrence and Abraham, 2016). Curriculum Integration can generally be defined as curriculum approach that purposely draws together knowledge, skill, attitude, value and components of the curriculum from within or across subject areas to develop a more powerful understanding of key ideas (Atsumbe *et al.,* 2015). The author added Multidisciplinary Integration approach, Interdisciplinary Approach, Interdisciplinary Approach and Transdisciplinary approach can be adopted for the Integration.

An Integrated Curriculum is generally defined as an educational approach that cuts across and draws on multiple subject areas for learning and instruction (Adamu, 2003). He added there are three paradigms that sum up Curriculum Integration and the most traditional paradigm is multidisciplinary in which content is drawn from multiple disciplines in order to increase relevance and applicability (though) primary learning goals remain rooted in the individual discipline. The author further explain that a second paradigm, interdisciplinary, begins to dissolve discipline boundaries by looking for common themes across disciplines that can serve higher order learning objectives but transdisciplinary, dissolves all boundaries between the disciplines and poses higher order learning objectives to address broad questions of shaping curriculum to address issues of productive citizenry and construction of meaning through real-world problems/themes. Atsumbe *et al.* (2015), stressed that supporters of an Integrated Curriculum believe that interdisciplinary education offers heightened for mastery of the content and real-world applications, which inevitably increases the opportunity for deeper level of learning. Offorma (2016) also asserted, the Broad Fields Design is used whereby aspects of related knowledge, skills, and attitudes are brought together and systematically arranged in terms of their gradient of difficulty. The author added, for example, Social Studies, Basic Technology, Basic Science, Business Studies, Language, Cultural and Creative Arts and Civic Education are all Integrated Subjects.

From these points, it can now be concluded that Integration in Education may be regarded as the process of combining ideas, opinions and contents from deferent but related fields of study to form a multidisciplinary field at the same time, the resulted field from the combination of fields is called Integrated Curriculum design or Broad Field Curriculum Design. It is now clear that Curriculum Development and Integration is very tedious job and mostly is conducted with ten steps of R and D model and that is

why Gall *et al.* (2003) recommended that it is best to undertake a small-scale project that involves a limited amount of original instructional design. The author further advised “another way to scale down the project is to limit development to just a few steps of R and D cycle.

### 2.2.7 Closed circuit television and solar photovoltaic technology

CCTV is the technology behind capturing images from a video source at one end of the circuit and transmitting it through some type of transmission media to a receiving unit on the other end, for the purpose of security and monitoring activities (Kruegle, 2011). According to the author it has four major components: video source (Camera), transmission medium, recording unit (DVR) and power source. According to Infinique (2016), The CCTV system is divided into two: Analogue CCTV System and Internet Protocol IP CCTV System. CCTV has been used daily for many purposes such as crime investigation, traffic control, chemical process record, production control, and security surveillance (Ade and Harjoko, 2018). He added that the development of CCTV has transformed from a simple passive surveillance into an integrated intelligent control system of motion detection information, face detection information and face identification information.

A simple analog CCTV system consists of cameras connected to a recording equipment known as DVR (Digital Video Recorder) that converts the signals from analog to digital format for recording and monitoring over the network and the resolution of this camera is measured in television lines which are converted by DVR to digital format called pixel (Jack, 2011). Coaxial cables are used for this type of installation which can be RG-59 for image transmission of between 198-228m and RG-11 for image transmission of between 400m-600m. Bipolar coaxial cable is also used to transmit both image and

power. Small installation normally uses a centralised power supply for the cameras. The cameras are micro, box, bullet, mini dome and dome. The choice of system components should consider capacity of each component for better output, 500 television line camera works well with 500 television line monitor. For digital system also, when 2Megapixel camera is connected to a monitor which shows 1920 pixels horizontally and 1080 pixels vertically, by multiplying the horizontal and vertical pixels of the image 2,073,600 pixels is obtained which is approximately 2 Megapixels of the camera.

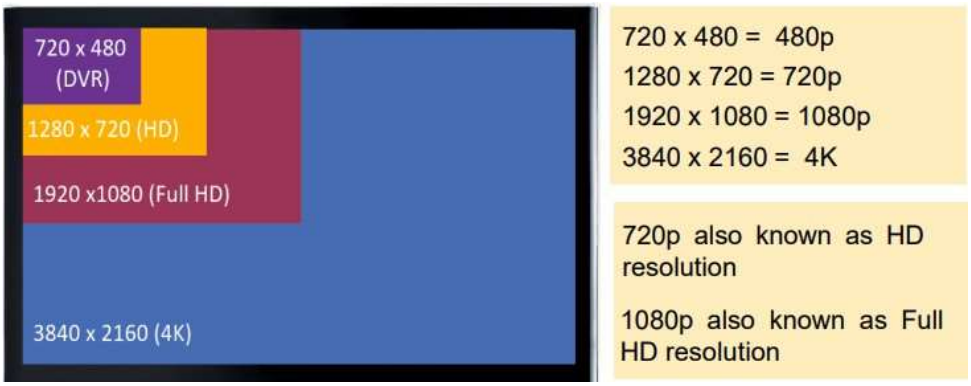


**Figure 2.1:** 2 Megapixels of Camera

**Source:** Jack (2011)

Homeland Security (2013) expressed that CCTV system design involves defining system requirements that is achieved by setting multidisciplinary system design team who will guide the CCTV system design process. According to the author, this is followed by needs assessment to gather and analyze functional, operational, infrastructure and video retention requirements and also the next step is to make a site survey which supports the development of detailed equipment specifications, installation design, and ultimately a thorough system test. This is followed by system layout considerations, collecting of aerial photographs for exterior site and computer aided drawings or blueprints of the facility being surveyed for interior as well as an important factor in the design and layout of a CCTV system such as the location of its

transmission hubs. Other system design considerations includes lighting, fluorescent, incandescent, high-intensity discharge, infrared light emitting diode. Power distribution, video transmission, scalability, cost, infrastructure, reliability and maintainability among others are factors to be considered in CCTV System Design.

The components of CCTV system as outlined by Homeland Security (2013) are cameras, lenses, housings and mounts, Monitors, Switchers and multiplexers and also video recorders. According to the author, the camera are fixed which is mounted on a particular position and direction and Pan Tilt Zoom PTZ camera can be turned and tilted on two axes to provide pan and tilt capabilities and the focal length of the lens can be varied. The author added that they are also classified based on their data transmission as network camera that are connected via IP-based network and internet which exposes the system to cyber attack. This camera provides remote viewing of the CCTV system. The analog camera on the other hand are free from cyber attack and are connected via coaxial cable. Other types of cameras include day/nigh camera, low-light or night vision cameras, thermal imaging cameras and miniature or covert cameras (Home land security, 2013).

Some of the features of camera are auto scan, pre-set, privacy masking, slip ring, motion detection, backlight compensation, digital noise reduction, and mobile compatibility. Lenses provide accurate, focal, clear and undistorted image to the image sensor. The basic types of lenses are fixed focal, variable and zoom. Camera Housing protected the camera from elements such as extreme weather conditions and vandalism while Camera Mounts provide a structural position on which the camera is fixed indoor or outdoor. Monitor is a display unit that provide a channel for image and video viewing. Switches and Multiplexers are used in CCTV systems that have more cameras than monitors and recording devices to route the video signal but Multiplexers has potential of digitizing

video signal as well as motion detection features. Digital Video recorder and Network Video Recorder are used to record video and images and store in hard drive or other storage devices. The signals are transmitted via wired transmission system and wireless transmission system. The wired transmission can be done using coaxial cable, unshielded twisted pair (UTP) wire of abandoned telephone lines, fiber optics, and telephone network and category five cable. While the wireless transmission can be achieved using laser, infrared, radio frequency or microwave. Special transmission system is IP-based transmission system that employs internet and principle of networking by the use of IP address, web browser, power over Ethernet and personal computer. This system is flexible and scalable which provide a means of remote viewing and monitoring.

Solar heating, photovoltaic and solar thermal panels are used to generate electricity or heat, either in large-scale complexes or on the rooftop of private houses, the range of applicable solutions for solar technology is large (Konstantin, 2017). According to Eldin *et al.* (2015) Photovoltaic power were first discovered by a French scientist Edmond Becquerel in 1839. The first working solar cell was successfully made by Charles fritts in 1882 and it was made of thin sheets of selenium and coated with gold. The author added PV cell technologies are usually classified into three generations, depending on the basic material used: Crystalline Silicon (First generation) dominate the market with their low costs and the best commercially available efficiency. They are a relatively mature PV technology, with a wide range of well-established manufacturers; Thin Film (Second-Generation: Thin-Film) low material and manufacturing costs, but this has to be balanced by lower efficiencies than those obtained from first-generation technologies and finally, concentrated photovoltaic (CPV) (Third-Generation PV technology) are yet to be commercialized at any scale. The Organic Material Crystalline silicon cells are

classified into three types as: Mono-crystalline (Mono c-Si), Poly-crystalline (Poly c-Si) or multi-crystalline (mc-Si) and Ribbon silicon.

The Solar Cell is the basic component that is wired together and mounted in a frame which composes a Solar Module and several modules wired together form an Array (Franklin, 2018). The author added a Charge Controller regulates the amount of charge going into the battery from the module to keep from overcharging the battery and when solar energy is to be stored for use when the sun is not shining, a Battery is used. A string Inverter is used to convert DC power from a solar array to AC power and can be connected to an AC distribution power panel (service panel) in a residence or facility.

**Types of Solar Photovoltaic System**

Stand-Alone System: An autonomous or hybrid photovoltaic system not connected to a grid and may or may not have storage, but most stand-alone systems require batteries or some other form of storage (Glossary, N.d). Grid-Connected System: A solar electric or photovoltaic (PV) system in which the PV array acts like a central generating plant, supplying power to the grid. Hybrid System: A solar electric or photovoltaic system that includes other sources of electricity generation, such as wind or diesel generators. According to Kumar (2021), the Photovoltaic Systems are classified based on the functions and the operational requirements, the component configuration and the connection of the equipment to other sources of power and electrical appliances. He added the types of Solar Energy Systems are utility intertie PV systems (Grid Connected) and Stand Alone solar electric systems.

Vasanthkumar *et al.* (2017) stated solar PV installers use a variety of power and hand tools including drills, conduit benders, torque wrenches, and crimping tools. On larger installations, they may operate forklifts or front-end loaders. Tape measures, laser-

assisted measuring devices, digital cameras, and site evaluation tools are standard devices for most jobs. Diagnostic gear including multimeters and amp clamps are also important. Computers are increasingly important with remote monitoring, GPS-assisted site evaluation, and diagnostic procedures

Hand tools are available to assist the solar energy system owner to measure the power output of their system, and to make adjustments in the tilt and orientation of a solar module or array to maximize the energy production of their system, an understanding of the solar PV system and the associated hand-tools used to take measurements, to determine the sunlight intensity, check tilt-angles, and measure solar cell temperature are important to determine if your solar PV system is functioning properly (Franklin 2017). The author mentioned some tools as digital multi-meter, clamp-on ammeter, pyranometer, non-contact thermometer, angle finder and solar pathfinder.

Raymond and Hassan (2016) refer to Measurement as the act of comparing an unknown quantity with a known quantity (standard) to ascertain its value or worth. Multimeter is one of the basic Electronic Measuring Instruments that are popularly used in electronic workshops, laboratories, houses and industries; The Logic Probe is a simple and commercially economical ‘pen like’ device that is used for testing logic circuits; Oscilloscope is an essential instrument that can be used to test electronic systems. It lets us visualize electrical signals for easy analysis; a Signal Generator is an electronic measuring instrument that produces a controlled output in a wave form for use in testing, aligning or measurement of other circuits or electronic systems.

Raymond *et al.* (2020) asserted, generally, maintenance of any electronic system consists of performing some or all of the following functions: detection, location or diagnosis, correction and verification or checking of the cause of failure in electronic

components or equipment; setting up and performing scheduled periodic or preventive inspections and replacements; troubleshooting and repairs activities on failed electronic systems or subsystems and replacement of faulty electronic components or items. There are preventive and corrective maintenances. Preventive Maintenance is carried out to preclude inadvertent failure of the electronic system. Corrective Maintenance therefore is the rectification of electronic equipment or system that has failed so as to ensure restoration of proper operational condition. Electronic troubleshooting is a special category of problem solving process since in addition to fixing a problem; it involves diagnosis of the cause of failure or problem.

Saba *et al.* (2014) defined Hazard as any potential or actual threat to the well being of people, equipment, machinery or environment. The author added electricity is no respecter of persons; it will injure or kill a custodian, manager, rich, poor, president, or office worker just as fast as it will injure or kill an electrician.

According to Tarea (2007), Sizing a system includes the following steps:

1. Estimating the electric load
2. Sizing and specifying batteries
3. Sizing and specifying an array
4. Specifying a controller
5. Sizing and specifying an inverter
6. Sizing system wiring

#### 2.2.7.1 *Objectives*

Objective is a direction pointer and a basis for confirming the success of an activity. It gives direction for the conduct of an activity during the execution and serves as basis for confirming the success during evaluation. Objectives give focus to every activity or process in teaching and learning situation (Kilickaya, 2016). Every curriculum is

planned and developed for a purpose and this purpose of the curriculum is what is referred to as curriculum objective (James, 2017). It is stated using specific terms. Action verbs are used for the statement of objective. Even though, it is specified for a programme and course of study, it is normally used for delivering an instruction for a particular period of time. According to Sofia (n.d), there are general instructional objectives, which include the skills, abilities, or knowledge students are expected to learn from extended instruction, such as an entire course. In addition, there are specific instructional objectives that are reflected in day-to-day instruction of units and lessons. The steps to be taken by a teacher for developing instructional objectives according to Kilickaya (2016), are planning lesson time, choosing appropriate teaching strategies and materials, deciding about learning outcomes and specifying the area/topic in which students might have difficulties. The author further states that, instructional objectives highlight the assessment procedure conducted by the teacher.

#### 2.2.7.2 Content

This concept has to do with the subject matter for presentation to the students leading to acquisition of skill, attitude, knowledge and experience of a particular programme. Content is one of the four main elements of a curriculum along with objectives, methods, and evaluation (Bain and Siddique, 2017). The Content of any curriculum is an embodiment, of the attitudes, knowledge and skills which a society intends to impart to her citizens through the school and other socializing agencies (Cecilia, n.d). Bain and Siddique (2017) has highlighted the importance of appropriate and logically sequenced content and has described it as one of the important aspects of effective and successful learning.

The Content for training includes: analogue CCTV system components, a typical analog CCTV system, cameras, digital video recorder, coaxial cable, BNC connectors, power

supply, backup, power and monitors. While the Content of IP CCTV system is (Infinique, 2016). The IP CCTV system components, a typical IP CCTV system, active components, design considerations, bandwidth and storage calculations, storage options and advanced features. Furthermore, in respect to the System Installation the Content area of coverage is: DVR/NVR network connection setup, cable preparation, connector termination and testing, adjusting camera field of view and adjusting camera parameters through OSD37 alternate cabling solution.

#### 2.2.7.3 *Methods of teaching*

This concept associated with techniques and style applied during presentation of content to the student. It is given several names by the researcher but all have same or very close meaning. Some of the names are: Methods of Teaching, Instructional Strategy, Teaching Strategy and Method of Instruction. There are several of them to be applied in accordance with the course content and instructional setting.

It is very paramount to clarify the meaning of these synonymous terminologies and phrases used to describe the curriculum implementation or teaching and learning process and procedure. Some of the phrases and terms that are very close to Modes of Teaching also includes: Instructional Method, Method of Teaching, Teaching Approach and Teaching Strategy. Approach is broader than method and is a set of ideas or overall view to face teaching and learning problem and realise educational goal which can be Child or Teacher Centered (Gill and Kusum, 2017). The author added, Method refers to the procedure within an approach used for the effective presentation of the specific content of the subject which helps the student to understand better while Strategy is that skill full planning, like use of chalk board in a class, of a working system by which the objectives can be achieved easily. Petrina (n.d) assert that Instructional Systems involve decisions related to what will be taught, how it will be organized for learning and how

learning will be assessed. Rosenshine (2012) outlined the following as Instructional Principles: begin a lesson with a short review of previous learning, present new material in small steps with student practice after each step, ask a large number of questions and check the responses of all students, provide models, guide student practice and check for student understanding among others. NCCE (2020) stated the Mode of Teaching of Technical Education subjects would be by lectures, tutorials, laboratory work/practical, hand-on as deemed appropriate for each course. And further added, learner-centered activity-based Methodologies i.e. demonstration, discussion, brain storming, mind-mapping, questionnaire.

#### 2.2.7.4 *Materials, tools and equipment*

Instructional Materials means print or electronic items that are used, consumed, or worn out in the instructional process to include library books, periodicals, newspapers, audiovisual materials, supplementary books, reference materials, instructional software, and Internet-based resources (Kentucky, 2015). Tools and Equipments influence the academic performance of students and prepare them for useful living (Uwameiye, 2016). Tools are mostly portable and are regarded as Hand Tools while Equipments are larger in size and are mostly associated with machineries. Hand Tools (n.d) defined Hand Tools as a device for doing a particular job that does not use a motor, but is powered solely by the person using it. Examples are almost endless, from general tools like the hammer to specific tools like callipers. Some hand tools are mounted to walls, such as pencil sharpeners. Virtually every type of tool can be a hand tool, although many have also been adopted as power tools, which get their motive power from engines rather than from people.

Osha (2002) stated that Hand Tools are tools that are powered manually but some power tools are hand-held power tools. The author classifies tools into electric tools, portable abrasive wheel tools (grinding and cutting), pneumatic tools, liquid fuel tools, powder-actuated tools, hydraulic power tools (Uwameiye 2016; Egunsola and Abdulmumini, 2012) expressed many factors affect the teaching and learning of practical subjects and one of such factors is the availability and utilization of Tools and Equipment. He added, Garment Making is a skill oriented subject and skills can only be learnt when judicious teachers make use of Equipment and Tools for training the students. Egunsola and Abdulmumini (2012) expressed that a successful and effective utilization of Agricultural Equipment require the teacher to make serious preparation to be able to present the Equipment to the students through proper planning, and ensure that teaching of the course is based on doing, because almost all Agricultural Topics require practical applicability/demonstration which involve manipulation of Equipment and Materials that require consumables such as fuels, oils, brushes. In the opinion of McCubbin *et al.* (2016), adequate Tools and Equipment are required to train a well-prepared and competent workforce that will be prepared for the problems of the future. Equipment refers to all the potable or heavy instrument and mechanical devices for performing special operations in vocational and technical education teaching and learning situation (Uwameiye, 2016).

#### 2.2.7.5 *Evaluation activities*

Evaluation is carried out to determine the level of achieving the stated objectives. Varieties of techniques are used to determine achievement of objective in accordance with the nature of course and the skill required to be tested. Chibuzor (2014) opined that Evaluation is therefore the systematic collection of relevant data, analyzing the data using appropriate statistical tool(s) and using the information obtained from the analysis

of data to make informed decision or judgment. Enang (2015) is of the opinion of Evaluation as the appraisal of the worth or value of a thing or action and the making of appropriate decision on the basis of such appraisal. Added, Evaluation involves collecting quantitative and qualitative data which are processed to arrive at a judgement or value of worth of an instructional programme. Also added Formative Evaluation is concerned with the evaluation of on-going programmes in order to identify and correct mistakes before a programme is completed. Summative Evaluation is carried out at the full completion of a programme. The term used to identify Evaluation Activities in the study are demonstrate ability, identify steps, communicate information, create information, define, discuss, state, interpret and explain (Suphi, 2020).

James (2017) stated that is the means of finding out the achievement of the stated objectives after instructions have taken place and Evaluation Questions are always asked in line with the stated objectives therefore the terms in the view of the author are: observation, questionnaire, continuous assessment, practical work, use of discussion, assignment, interview, essay type test, objective test, formative test and summative test. But these are rarely use and some authors see most of them as Evaluation Strategy since questionnaire is not an activity. But it can be understood from another viewpoint that the Activities in the Evaluation Process mostly use by researchers are Activities of the learner during the Evaluation Process. But in this case some of the activities like interview can be shared by both the evaluator (teacher) and the evaluate (learner).

### 2.2.7 Career prospect of CCTV and solar photovoltaic technology

The level of insecurity in developing countries does not need to be overemphasized. It is very clear that when there is insecurity there is always high demand of security measures to handle the situation. One of these security measures is CCTV and is an electronic system that need steady power supply such as Solar Photovoltaic to operate.

In this regard, a train individual with skill and competency in CCTV and Solar Photovoltaic Technology cannot remain jobless. In addition to this, Solar Photovoltaic System is one of the renewable energy patronised by many countries globally.

Therefore, a 2009 systematic review by researchers from North-Eastern University and University of Cambridge used meta-analytic techniques to pool the average effect of CCTV on crime across 41 different studies (Kille and Maximino, 2014). Other areas of application of CCTV system includes: traffic flow monitoring, crime solving, employee monitoring, schools private homes and industrial uses. According to Market and industry trends United Parcel Service of America (UPS) expanded its investment in Solar Energy as an owner/operator of solar assets at least eight facilities in the United States. By the end of 2017, Deutsche Post DHL had 5,000 Street Scooter electric vehicles operating entirely on renewable electricity for the company's urban postal delivery service (Global Overview, 2018).

Homeland Security (2013) stressed that the CCTV industry is part of an ever-changing IT environment and new capabilities in any one of the digital components, internet, or telecommunications industries will eventually be applicable to CCTV systems. Raymond *et al.* (2013) stressed that if Solar Collectors or Modules were used to convert 1% of Nigeria's land area, it is possible to generate 1850 x10 ^3 GWh of solar electricity per year; this is over one hundred times the current grid electricity consumption level in the country. However, the annual salaries of Solar Photovoltaic Installer ranges from $24,000 to $44,664 and hourly wages range from $11.50 to $21 per hour (Homeland Security, 2013). The author stated that Installers with a supervisory role may expect to earn up to $24 per hour or more and the benefits generally include medical, dental, life, and vision insurance as well as vacation, sick leave, and retirement plans.

## 2.3 Review of Related Empirical Studies

Chimezie **(**2016**)** conducted a study with a purpose of developing Powder Metallurgy Technology Course of study for students in polytechnics. In order to attain the objectives of the study, Research and Development (R and D) design was adopted. The total population for the study was 219 respondents; comprising 43 manufacturing engineering technology lecturers, 79 managers in powder metallurgy industries, and 97 part–time students of manufacturing engineering technology from South-South Nigerian Polytechnics. Six specific purposes, six research questions, and five null hypotheses guided the study. The instrument for data collection was the: Powder Metallurgy Technology Course of Study Questionnaire (PMTCSQ).

The six stated research questions were analyzed using mean, and standard deviation; while ANOVA and t –test were used to test the hypotheses at 0.05 level of significance. The results of the findings from the study are: a Course of Study on Powder Metallurgy Technology for polytechnic students has been developed. The study found five appropriate instructional objectives, 97 items in clusters as content, 109 instructional materials/facilities/equipment/tools was appropriate for implementation of the developed course of study, 20 delivery methods, and 19 evaluation techniques were found appropriate and most suited to be included in the developed program.

Therefore, the study recommends that Powder Metallurgy Technology should be made to stand-alone as a single course in the NBTE HND designed curriculum and module specification in Mechanical Engineering Technology, Manufacturing Option of the Polytechnics.

Chimezie's study is related with the present study by applying Research and Development to develop a Powder Metallurgy Technology Course of study for students in polytechnics the same way the present study developed a course of study but in the

field of CCTV & SPVT for NCE (Technical). Nevertheless, the area of this study is South-South while the present study used North-east Nigeria as the area of study.

Opurum (2016) conducted a study on developing and validating instrument for assessing practical projects in electronics in Technical Colleges. Four research questions guided the study. The study adopted instrumentation design and was carried out in South-South Geo-political Zone of Nigeria which comprised Akwa Ibom, Bayelsa, Cross River, Delta, Edo and Rivers States. The population for the study was 82 subjects made up of 38 teachers and 19 technicians in Electronics Works Department in the 19 Technical Colleges in South-South Zone, Nigeria and 25 industrial-based electronics supervisors from three electronics companies in Rivers State. The entire population was studied because it was of a manageable size. The instrument used for collection of data for this study was a structured questionnaire titled: Technical Colleges Electronics Works Instrument for Practical Projects Assessment (TCEWIFPPA).

A five point rating scale with numerical values of 5, 4, 3, 2 and 1 was included in the assessment instrument. Based on the result of the validation processes, Electronics Works practical skill assessment instrument of 46 tasks and 746 practical skills was developed. The reliability coefficient of the instrument was established using Cronbach alpha reliability method which yielded overall reliability coefficients of 0.90. Mean was used to answer the research questions while factor analysis was used to select items on the instruments. It was recommended that National Business and Technical Examination Board (NABTEB) should include the assessment of practical projects in Electronics Works during National Technical Certificate Examinations. The study among others, recommended that students should be encouraged to acquire practical skills outlined in the NBTE curriculum and make use of such skills for gainful employment, self-reliance and equally employ others.

This study relates with the present study by developing and validating instrument for assessing practical projects in electronics in Technical Colleges. Notwithstanding, the present study developed a course of study for Electrical Electronic in Colleges of Education (Technical). While, the area of this study is South-South Zone, the present study was conducted in North-East Nigeria.

Olusegun (2016) conducted a study titled: Development of a Retraining Programme for Artisans in Blocklaying and Concreting in Lagos State. Six research questions were answered while one null hypothesis was formulated and tested at 0.05 level of significance. The study adopted the Research and Development design and was conducted in Lagos state. The population of the study consisted of 4487, this was made up of: 70 builders, 80 building supervisors, 80 craftsmen, 4200 artisans, 40 teachers from Technical Colleges and 17 Colleges of Education teachers that teach Blocklaying and Concreting. The sample for this study was 540, made up of 30 builders, 40 building supervisors, 48 craftsmen, 365 artisans, 40 Technical College teachers and 17 Colleges of Education teachers that teach Blocklaying and Concreting. Purposive sampling techniques was used to select builders, craftsmen and building supervisors that work directly with the artisans on the building construction sites.

There was no sampling for teachers who teach Blocklaying and Concreting in Technical Colleges and Colleges of Education in view of the manageable size of the population. Two sets of instruments were used for data collection for this study: the questionnaire for retraining programme for artisans in Blocklaying and Concreting and the rating scale for assessing the skills possessed by the artisans after retraining.

The mean statistic was used to answer the research questions while the analysis of covariance was employed for testing the null hypothesis at 0.05 level of significance.

The findings revealed 35 objectives, 76 contents, 15 training strategies, 29 training facilities and 14 evaluation techniques were agreed upon by the respondents for the retraining programme. The result of hypothesis tested revealed that there was a significant mean difference in the skill performance of artisans retrained and not retrained with the developed programme, this implies that the developed programme was effective on the artisans it was retrained with.

This study is related to the present study in the sense that it developed a retraining programme for Artisans in Block-laying and Concreting in Lagos State. The design use for developing the programme was Research and Development which is also going to be used in the present study. The only difference between this study and the present study is while the retraining programme developed is in the area of Blocklaying and Concreting; the present study developed a CCTV and Solar Power Technology Course in the field of Electrical Electronic. The area of this study also is Lagos state but the present study used North-East Nigeria as the area of study.

Bolanle (2016) conducted a study to develop clothing education programme for curbing immodest clothing practice of youths in Colleges of Education in North-East, Nigeria. Specifically, the study determined the objectives; content; identified the instructional: methods, techniques, materials, and determined evaluation activities of the programme. Six research questions guided the study while six null hypotheses were tested at 0.05 level of significance. The study adopted Research and Development (R and D) design. The study was carried out in four phases as follows: phase 1: determination of the objectives, content, instructional: methods, techniques, materials and evaluation activities of the programme. Phase II: development of draft of the clothing education programme based on findings from phase I. Phase III: Validation of the draft; Phase iv:

revision and production of clothing education programme. The study was conducted in North-East, Nigeria.

The population was two sets. First set for phase I and the other for Phase III. Population for phase I was 1,018 made up of 83 lecturers and 935 students of Home Economics Education in the area of study. The second population was 37 made up of 24 lecturers of Home Economics education, 7 lecturers of curriculum development and methodology, and 6 lecturers in measurement and evaluation from 2neighbouring states (Plateau and Nasarawa) to the areas of study. Two sets of samples and sampling techniques were used. The first set of sample was 572 made up of 43 lecturers and 529 students from 5 Colleges of Education free from insurgence out of 10 colleges of education in the area of study for phase I; purposive sampling technique was used for the selection. The second set was 15 lecturers made up of 9 Home Economics education 3lecturers of curriculum development and 3 lecturers from measurement and evaluation from three colleges of education in the neighbouring states for phase III; simple random sampling technique was used for the selection. Two sets of instruments were used for data collection, the first set was109 items questionnaire for data collection in phase I and it was validated by 5 experts. Second instrument was the draft clothing education program validation questionnaire for phase III. Data collection was in two phases: phase I and III. For phase I, 572 copies of the questionnaire were administered on the respondents through five research assistants.

Analysis of phase I provided the followings:17 objectives, content of 24 content topics, 15 instructional methods, 13 instructional techniques, 20 instructional materials and 20 evaluation activities. However, there were significant differences in the mean ratings of the respondents on: 2 content topics, 1 instructional: method, 2 techniques, 2 materials and 3evaluation activities. The implications of the observed differences are that

qualification, experience, and orientation of the respondents significantly affected their responses on these items. The recommendations made included college managements should use the developed programme to form part of the orientation activities for new students annually, direct departments and schools through organized clothing education seminars to improve youth's clothing practices on campuses.

This study is similar to the present study because it developed a Clothing Education Programme for curbing immodest clothing practice of youths in Colleges of Education in North-East, Nigeria and the study adopted Research and Development (R & D). The same way this study developed a course using Research and Development design in the same area of study (North-East Nigeria). The only difference between this study compared with present study is while it developed a clothing education programme, the present study developed a CCTV and Solar Photovoltaic Technology Course in the field of Electrical Electronic.

Augustina (2017) carried out a study on the development of Individualized Instructional Packages in Clothing and Textiles Crafts for teaching Home Economics students in Colleges of Education in North Central States, Nigeria. The study determined the following; objectives, tasks, material resources, step by step procedures, methods and evaluation activities, developed a draft based on feedback from specific purposes 1 – 6, validated the draft, revised the draft based on feedback from the validation and developed Individualised Instructional Packages in Clothing and Textiles Crafts. Eight research questions were answered by the study while eight null hypotheses were tested at 0.05 level of significance. The study adopted Research and Development (R and D) design. The study was carried out in five phases; Phase I determined the objectives, tasks, materials, step by step procedures, methods and evaluation activities to assess the objectives of each Clothing and Textiles Crafts. Phase II involved development of draft

Individualized Instructional Packages in 12 Clothing and Textiles Crafts, Phase III validation of draft Individualized Instructional Packages, Phase IV testing for effectiveness of draft Individualized Instructional Packages and Phase V Revision of draft Individualized Instructional Packages.

The population was 813 and in phases, phase I involved 813, Phase III 10 experts were involved while Phase 1V 630 students were involved. The sample size was 247 and in 3 phases; Phase I, 94 HECL, 75 FAAL, 14 MCM and 63 students. In phase III, 10 Validates comprising of 3 HECL, 5 FAAL, 2 MCM and phase 1V 63 students purposively sampled in the area of study. Six sets of instruments were used for Data collection, Clothing and Textiles Packages Development Questionnaire (CTCPDQ), Developed Individualised Instructional Packages in Clothing and Textiles Crafts (DIIPCTC), Validates Assessment Questionnaire (VAQ), 12 Conventional Lesson Notes (CLN), 12 Developed Individualised Instructional Lesson Notes (DIILN) and Students Performance Test (SPT).

The data collected were analysed in phases; CTCIIPDQ and VAQ were analysed using mean and standard deviation while Hypotheses 1- 7 were analysed using ANOVA and that of SPT was analysed using ANCOVA at 0.05 level of significance. The result showed that students taught with the developed Individualised Instructional Packages in Clothing and Textiles Crafts had higher mean score (16.90>7.26). The major findings among others include: identification of 104 objectives, 89 tasks, 107 items on materials resources, 94 items on procedures, 8 items on methods of teaching and 98 self evaluation activities. Based on the findings of the study, Individualized Instructional Packages in Clothing and Textiles Crafts are suitable and very effective for teaching Clothing and Textiles Crafts to Home Economics students in Colleges of Education in North Central States, Nigeria. It was therefore, recommended among others that Home

Economics lecturers should adopt the use of Individualised Instructional Packages in teaching Clothing and Textiles Crafts.

This study is similar to the present study by the use of Research and Development Design to develop an Individualized Instructional Packages in Clothing and Textiles Crafts for teaching Home Economics students in Colleges of Education in North Central States, Nigeria. But the gap to be covered by the present study is in the area of Electrical Electronic in the North-East Nigeria.

Riyanti (2017) conducted a study with the purpose of developing a learning model based Commercial Graphic Design Drafting project-based learning approach, was chosen as a strategy in the learning product development research. University students as the target audience of this model are the students of the fifth semester Visual Communications Design Studies Program Faculty of Art and Design University of Trisakti. Dick, Carey, and Carey models of Research and Development (R and D) are applied to develop this model. The model consists of the systematic phase used to develop learning products Drafting Commercial Graphics. Results of learning products reviewed by expert instructional design, instructional material expert, and instructional media specialist. The result showed that the learning model Drafting Commercial Graphics implemented a project-based approach has been improving learning outcomes better than the target - the students of the fifth semester Visual Communications Design Studies Program Faculty of Art and Design University of Trisakti.

This study relates with the present study in the use of Research and Development design but differ, as the present design has to do with a course in the field of Electrical Electronic. And also the area of this study was Trisakti while that of the present study was North-East Nigeria.

The study of James (2017) was aimed to develop a Peace Education curriculum for integration into senior secondary school Home Management programme in Rivers State. Specifically, the study sought to: determine objectives of Peace Education curriculum for integration into senior secondary school Home Management programme, determine content for Peace Education selected for Peace Education, find out methods for teaching Peace Education, determine instructional materials for teaching the content of Peace Education, determine the evaluation activities for assessing the achievement of the objectives of Peace Education curriculum for integration into senior secondary school Home Management programme. Seven research questions and three hypotheses guided the study. The study adopted R and D design. It was carried out in five phases.

The population was made up of 650 subjects involving seven members group discussion, Social Studies and Home Economics lecturers, Social Studies and Home Economics students, senior staff of Ministries of Women Affairs, Social Work and Rehabilitation and Youth Education and Development, Secondary School Home Economics and Social Studies teachers and Home Management students. Simple random sampling technique was adopted to select samples from large groups while no sampling was adopted for small groups. Focus Group Discussion Guide (FGDG), Peace Education Questionnaire (FEQ), Peace Education Curriculum (PEC), Peace Education Validation Questionnaire (PEVQ) and Peace Education Test (PET) were the instruments for data collection. Mean and standard deviation were used to analyze the research questions while Analysis of Variance was used to test the null hypotheses at 0.05 level of significance.

The findings included 42 objectives of Peace Education, 37 contents were selected for Peace Education curriculum, 26 methods of teaching Peace Education, 35 instructional materials for teaching of Peace Education and 28 evaluation activities for assessing the

attainment of Peace Education curriculum objective. The findings also showed that the developed Peace Education curriculum was appropriate and effective. The findings of the study from the hypotheses showed that there was no significant difference in the mean responses of the respondents on the objectives of the Peace Education curriculum, contents selected for the Peace Education curriculum and the methods for teaching Peace Education in senior secondary school Home Management programme in Rivers State. Findings from Focus Group Discussion (FGD) revealed killing, kidnapping, armed robbery among others as peace problems in Rivers State and that, the effects of peace problems among others include unsafe life and driving away of foreign investors.

Using Research and Development design for the development of Peace Education curriculum for integration into senior secondary school Home Management programme in Rivers State is very similar to using same design but in this study to develop a Course of study in Electrical Electronic Field in North-East Nigeria.

Moses *et al.* (2017) developed and validated an instrument for assessing practical skills in domestic installation processes at the Technical College Level in Yobe State, Nigeria. The study answered three research questions employing instrumentation research design with a target population of 108 comprising of Electrical Installation and Maintenance Works Trade (EIM) teachers and National Technical Certificate (NTC) III students of 2016/2017 academic session. The study has a total population of 234, comprising 41 EIM teachers and 202 NTC III students. A stratified proportionate-random sampling technique was used to determine eight technical colleges used and a purposive sampling technique was used to select 12 EIM teachers while a simple random sampling was used to select 60 students that were used in the study. Two instruments were used for data collection in two different stages. Findings of the study showed that four clusters and 32 practical skills operations were found appropriate for the DIPQ. Based on these

findings, it was recommended among others that, state ministry of education should impose the use of the assessment instrument in the Technical Colleges of Yobe state, Nigeria.

The relationship between this study and the present study are they are all with the aim of developing educational product but only that this study developed an instrument using instrumentation design while the present study developed a course of study using R & D design. Another point of concern is Yobe state is the area of this study while the present study was carried out in North-East Nigeria.

Maxwell and Raymond (2018) study was for a development of new closed-circuit television content for satellite transmission and reception module for Technical Colleges in Nigeria. The study adopted a four stages Research and Development design. A sample of 228 was obtained using purposive and random sampling techniques from a population 346. Data were collected using a structured questionnaire that had a reliability coefficient of 0.83. The data collected from the respondents were analysed using mean statistics, standard deviation and t-test. The study revealed new cognitive and psychomotor skills for the installation and troubleshooting of closed-circuit television systems for satellite transmission and reception module including applications of closed-circuit television system, operation requirements for installing closed-circuit television, and best practices for setting up and termination procedures for display screens, among others. The study also revealed that there was no significant difference between the mean responses of Electrical/Electronic industrial personnel and teacher on the new cognitive and psychomotor skill contents for the installation and troubleshooting of closed-circuit television. It was recommended that NBTE should consider splitting the current satellite transmission and reception module into four

composite parts, such as closed-circuit television cameras installation and maintenance, which will cater for a more focused acquisition of skills.

This study is related to the present study in the sense that it uses Research and Development design to develop a content of closed circuit television system the same way the present study used R & D to develop CCTV & SPVT course. This study and the present study used the same type of instrument for data collection. The only differences between this study and the present study are: this study developed CCTV Cognitive and Psychomotor Contents while the present study developed CCTV and SPVT Course of Study that is broader than content. The area of study is also another difference between this study and the present study.

Rofii and Rahmatm (2018) conducted a research with title: Development of a Contextual-based Learning Module for Academic Writing Course to Develop the Students' Writing Skill. It adopts Borg & Gall's model modified from Jolly and Bolitho's model of development steps. The development steps include: assessing the teaching materials currently implemented, designing and developing the module, judging module feasibility by experts, and testing module effectiveness. It applies mixed method approach to describe textual data qualitatively and analyze numerical data using t-test. The data were obtained from need analysis through document analysis, interview, observation, survey, and experiment. The analysis found that the lecturers and students need appropriate, practical and effective teaching materials that meet their needs.

Therefore, the module of writing teaching material is developed by integrating the seven components of contextual approach in various learning activities. The practicality test suggests that the module is very practical. The tests of practicality, feasibility, and

effectiveness come into conclusion that the developed module can be implemented in the academic writing class. As suggestion, the lecturers and researchers are recommended to develop comprehensively teaching materials aligning with the students' needs.

This study also relate with the present study in the use of Research and Development design to develop a contextual-based learning module but it is different from the present study as the present study developed a course in Electrical Electronic option.

Hassan *et al.* (2019) designed a study to develop an Intelligent Tutor (IT) for enhancing Think-Pair-Share (TPS) in learning of Light Emitting Diode Television (LED TV) troubleshooting using Research and Development (R & D) method. Three research questions and one hypothesis tested at .05 level of significance guided the study which was carried out in Northwest, Nigeria involving a population of 109 subjects. The instrument for data collection was Intelligent Tutor Assessment Questionnaire (ITAQ). Findings that emerged revealed that the appropriate contents of a four-model IT which are Domain Model involving the principles of operation and how to troubleshoot Power, Picture and Sound Subsystems in LED TV as well as the Student, It was therefore recommended based on this finding that: (1) The National Board for Technical Education should review the curriculum for Radio Television and Electronic Work to include the appropriate contents for LED TV troubleshooting that were developed and validated in the present study among others.

This study is related to the present study in as much it uses Research and Development design to develop an Intelligent Tutor (IT) for enhancing Think-Pair-Share (TPS) in learning of Light Emitting Diode Television (LED TV) troubleshooting. But the area of

distinction in this study developed for Technical colleges while the present study developed a course for NCE (T) at North-East Nigeria as area of study.

Abiodun *et al.* (2019) carried out a research work is on Computer Numerical Control Machining Contents for Inclusion in Metalwork Technology Education Curriculum of Universities. Two research question and two hypotheses guided the study. The design adopted was a survey research design. The population of the study consists of 19 metalwork technology lecturers and 60 industrial personnel that are familiar with CNC machine. The instrument for data collection was a structured questionnairehaving4 point rating scale. The data was analyzed using mean, and standard deviation, while t-test was used in testing the hypotheses. The result showed that metalwork technology students required operational skills in CNC lathe and shaping machine among others. It was recommended that, the National Universities Commission (NUC) should lay more emphasis on curriculum review as when due to update the contents of the curriculum of courses like metal work technology in order to address the technological advancement across all technology education courses in the universities in Nigeria among others.

This study related to the present study by the fact that they make an effort to bring about improvement in the curriculum of educational programme but only that survey research design was used in this study while R & D will be used in the present study which is mostly concluded with a product as an output of the study. This is unlike Content Survey that is narrower in scope compared to Course of Study and at the end, it is not necessary that any educational product can by produced.

Ohanu and Okolo (2019) conducted a study with the aim of determining the solar photovoltaic system installation skill required by electrical technician for self-employment. To achieve this, two research questions and two null hypotheses tested at

0.05 level of significance guided the study. The study adopted a descriptive survey design. The population for this study was 232. This consists of 150 Electrical technicians and 82 Electrical teachers. The sample for the study is 150 respondents. Structured questionnaire was used for data collection. Data collected were analysed using mean to answer the research questions while, t-test for independent sample was used to analyse the data collected for the hypotheses at 0.05 level of significance. The result of the study identified stages and skills involved in solar photovoltaic system installation. It was concluded that electrical technicians should acquire the necessary skills required for installation of solar photovoltaic system.

This study related to the present study by the fact that they make an effort to bring about improvement in the curriculum of educational programme but only that survey research design was used in this study while R & D was used in the present study which is mostly concluded with a product as an output of the study. Though, this study cover solar photovoltaic aspect but the scope of the present study covers both solar photovoltaic technology skill as well as CCTV technology skill.

Yusof *et al.* (2021) conducted a study with the aims of identifying the elements needed to integrate technology and delivery strategies to design and develop an online problem-based learning module for the Islamic Studies course (e-PBM PI-Poli) in a polytechnic. The design of this study is a quantitative study using the Fuzzy Delphi technique. A questionnaire instrument was used to collect research data. Seventeen experts in educational technology, problem-based learning, Islamic studies, and curriculum participated in the study. Data analysis results showed that the experts accepted all these elements through the expert consensus value above 75%, the threshold value (d) $\leq 0.2$, and the fuzzy score (A) $\geq \alpha$ - cut value = 0.5. Therefore, it shows that these elements have gained expert consensus and are needed to design and develop the e-PBM PI-Poli

module in Polytechnic. This research provides tremendous implications to the lecturers and students, and references Malaysia's education system to transform education through technology-based active learning.

This study relates with the present study by coming up with a product using the experts of the field as respondents of the instrument but only that this study used Fuzzy Delphi Method to seek for the input of the experts while the present study used R & D design and questionnaire to gather in input of the expert for the development of the CCTV & SPVT.

## 2.4 Summary of Literature Review

The review of literature covers the Theoretical Framework, Conceptual Framework and Review of Related Empirical Studies. The theories/models that are relevant to this study are discussed for the benefit of guiding the conduct of the study by applying the theories/models. The identified relevant models are in the categories of linear and cyclic models. The linear models are those of Tyler and those of cyclic are Wheeler, Dick and Carey and Gall *et al*. The implementation structural sequence of these models enable the identification of the best objectives, content, modes of teaching, materials, tools and equipment and evaluation activities of CCTV and Solar Photovoltaic Technology Course.

The Conceptual Framework has been a platform for the review of Nigeria Certificate in Education (Technical) Minimum Standards, Technical Education Programme, Electrical/Electronic Technology Option. This section addressed Basic Technology Electrical and Electronic Conventional Courses thus: Electronic/Electronic Device, Digital Electronics, Building/Electrical Drawing for NCE II second semester and Electrical Machine and Power, Telecommunications, Practical Project, Maintenance and

Repairs of Electrical Equipment, School Workshop Management and Building Drawing as well as Career Challenges of conventional Electrical/Electronic Technology Education. Also discussed are the correcting intervening research concepts of Educational Development and Integration, Closed Circuit and Solar Photovoltaic Technology, Objectives, Content, Modes of Teaching, Materials, Tools & Equipment and Evaluation Activities and the Career Prospect of CCTV and Solar Photovoltaic Technology were discussed from the literature view point. This aspect of review enables the researcher to properly identify what is needed in the selection of Objectives, Content, Mode of Teaching, Materials, Tools and Equipment and finally Evaluation Activities of Closed Circuit Television and Solar Photovoltaic Technology Course.

Literature reviewed under empirical related studies guides the researcher in the selection of appropriate method for the conduct of this study, formulating the questionnaire items, selection of proper instrument for data collection, instrument validation and sampling techniques. The section also guided in the data collection procedure, data analysis and discussion of the result obtained from the data. This section of the review has demonstrated a conduct of Development Research works at PhD. level, Masters level and other published studies that cut across development of course of study, educational instruments, educational programmes, instructional content, instructional package, educational model, curriculum, educational module, intelligent tutor using R & D and Fuzzy Delphi method research designs. Survey research design was also applied to source for expert opinions in their respective fields that mostly end up with the need to include or integrate new knowledge and skill in the existing or programme to be established. In conclusion, the studies reviewed so far, has covered a lot but none of the reviewed literature addressed CCTV and Solar Photovoltaic Technology and creating a gap at NCE (Technical) level that is why this study is carried out to close that gap.

# CHAPTER THREE

## 3.0 RESEARCH METHODOLOGY

### 3.1 Design of the Study

The Research and Development (R&D) model was adapted to carry out this study. R & D is an industry-based development model in which the findings of research are used to design new products and procedures, which then are systematically field-tested, evaluated and refined until they meet specified criteria of effectiveness, quality or similar standards (Gall *et al.,* 2003). Research and Development originated from a model designed by Dick *et al. (*2015). The model, Systems Approach Model for Designing Instruction is adapted and modified by Gall *et al.*(2003) to form the Systems Approach Model of Educational Research and Development. Like that of Dick and Carey Model, the R&D has ten steps for the development of educational product, material, programme, curriculum or course. Each step has a component describing the activities required to be executed by the developer in the development process.

However, the authors stated that these steps can be modified to suite the test of researcher in accordance with need of a particular study. Gall *et al.*(2003) recommended that another way to scale down the project is to limit development to just a few steps of R&D cycle. The R&D Model is adapted because it is very relevant to this study and can be used to develop the CCTV and Solar PV Technology Course.

The components as modified by Gall *et al.* (2003) for educational research are:

1- Assess needs to identify goal(s)

2- Conduct instructional analysis,

3- Analyze learners and contexts

4- Write performance objectives

5- Develop assessment instruments

6- Develop instructional strategy

7- Develop and select instructional materials

8- Design and conduct formative evaluation of instruction

9- Revise instruction

10- Design and conduct summative evaluation.

**Source**: Gall *et al.* (2003)

Therefore, six (1, 2, 3, 4 & 6) out of the ten steps are now modified and re-stated into three phases:

**Phase 1:** From the literature reviewed, knowledge and skill needed to master this course are identified in the analysis of experts. The relevant theories reviewed in that chapter guided the selection of entry behavior of the students, best instructional strategies, conducive learning environment and relevant tools and equipment for the course under development. Objectives, content and qualification of the student for CCTV and Solar Photovoltaic Technology Course are generally identified by the researcher while highlighting the prospect of the course.

**Phase 2**: Out of the identified list from phase 1, questionnaire was developed and presented to the respondents: Basic Technology Electrical and Electronic lecturers of federal and state institutions as well as CCTV and Solar photovoltaic Industrial experts that install the CCTV and Solar systems to determine the most appropriate items that were used in developing the course under the following headings: Objective, Content, Methods of Teaching, Materials/Tools & Equipment and Evaluation Activities.

**Phase 3:** The course was drafted for development in this phase based on feedback of the respondents in Phase 2. The selected items of the questionnaire were written as Goal/Objective, Content, Methods of Teaching, Materials/Tools & Equipment and

Evaluation Activities of CCTV and Solar Photovoltaic Technology Course. This was done by the researcher with the help and guidance of the supervisors.

### 3.2 Area of the Study

The area of the study was North-East region of Nigeria. The region has a population of 26 million people, around 12% of the total population of the country FRN (2009). Occupying a total land mass of 272,451 square kilo-meter making it the largest region of the country comprising of six states viz: Adamawa State, Bauchi State, Borno State, Gombe State, Taraba State, and Yobe States. It share boundary in North with Niger republic, in East with Chad Republic, in South with Cameroon Republic, and in West with Jigawa state, Kano state, Plateau state, Benue state and Edo state.

Specifically, the study focuses on the seven Nigeria Certificate in Education (Technical) awarding institutions that are owned by both Federal and State governments in the region. These are: Federal College of Education (Technical) Gombe, Gombe State; Federal College of Education (Technical) Potiskum, Yobe, State; College of Education Hong, Yola, Adamawa State; Aminu Sale College of Education Azare, Bauchi state; Umar Ibn Ibrahim El-Kanemi College of Education, Science and Technology Bama, Borno State; Abubakar Tatari Ali Polytechnics Bauchi, Bauchi State and Ramat Polytechnics, Maiduguri, Borno State. CCTV & Solar PV Industry comprises of different companies that engaged in CCTV and Solar PV Technology in the area. The area is blessed with abundant solar energy with insecurity challenges result into destruction of electric infrastructure and lack of power supply associated with high rate of unemployment. Precisely, the FCE (T'S), COE'S and Polytechnics and CCTV & Solar PV Industry in the area are chosen for the study because of the interest of researcher and up-to-date practical skill and competencies of the CCTV & Solar PV industries experts respectively. The map of the Northeast is shown in Figure 3.1.

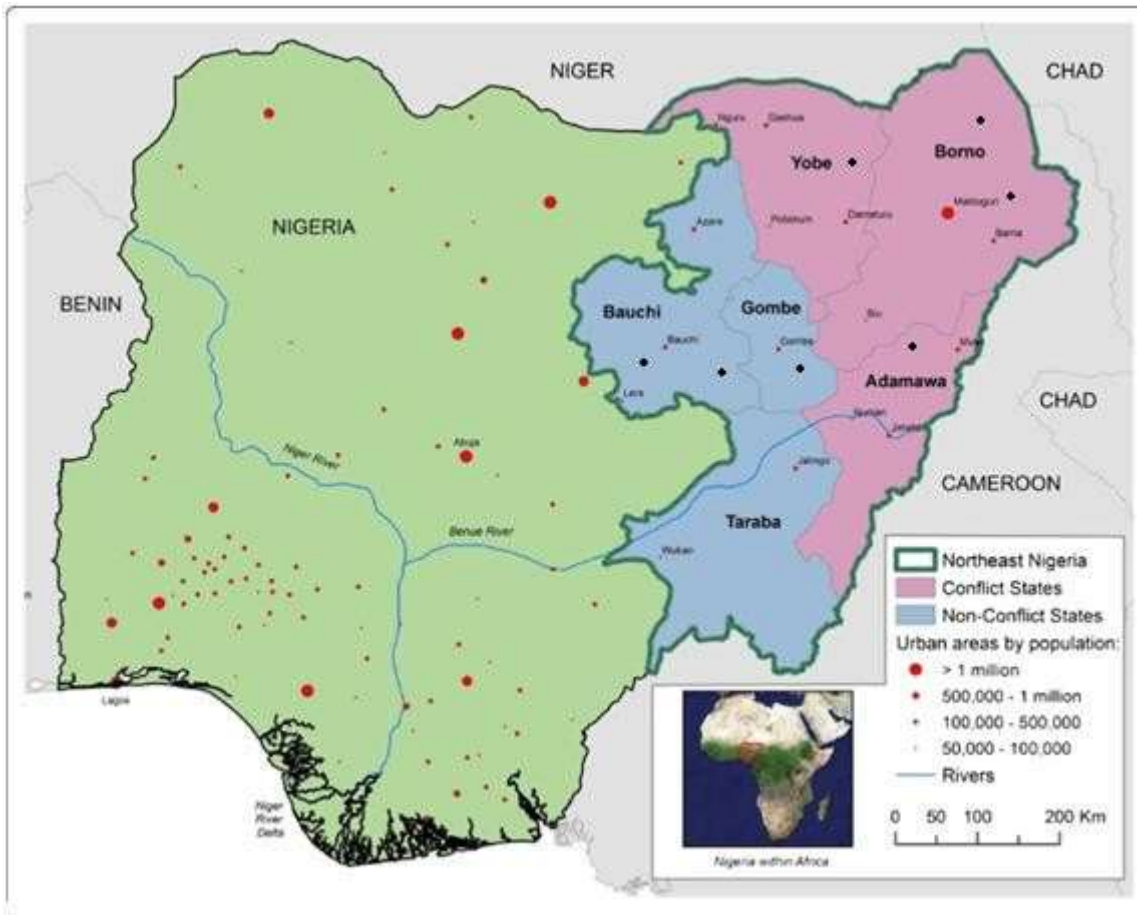


**Figure 3.1:** Map of the Area of Study Showing Distribution of Federal Colleges of Education, Polytechnics and NCE Technical
**Source:** Research Gate

### 3.3 Population of the Study

The population of the study was 135 targeted respondents from three relevant categories. It consists 54 Basic Technology Electrical and Electronics Lectures from federal and state institution within the area of study and 81industrial expert from various CCTV and Solar Photovoltaic installations companies all within the study area as detail in Appendix A. The population of lecturers was obtained from the institutions while that of industrial expert was obtained from Google map contacts. The Lecturers of Basic Technology Electrical Electronic Education from FCE (T), COE and Polytechnics offering NCE Technical programme are selected because of their experience in the field and being the potential implementers of the course after development and integration.

These are also selected for this study because it focus in this area was to determine the curriculum content which the student will be exposed to and which will be considered adequate enough to enable them enter or re-enter the teaching profession with confidence in their ability to perform creditably as anticipated (Chijioke and Cherechi 2020).

While CCTV & Solar Photovoltaic Technology industrial Experts are selected because of their relevant working experience in design, installation, supply, maintenance and associated services of CCTV & SPV Systems all over the area. This combination is expected to provide the best choice of the Objectives, Contents, Method of Teaching, Materials, Tools & Equipment and Evaluation Activities of CCTV and Solar PV Course that will meet the expectations of the society in the study area and Nigeria in general.

### 3.4 Sample and Sampling Techniques

There was no sampling of Basic Technology Electrical and Electronic Education Lecturers since their population size (54) is manageable and can be handled by the researcher. Whereas, simple random sampling was used to select one CCTV and Solar Photovoltaic Installation and maintenance organisation from each state in the region to obtain 24 respondents which is also detailed in Appendix A. The simple random sampling was used for the sampling because it gives equal chance to all respondent without any bias.

### 3.5 Instrument for Data Collection

A structured questionnaire with five points rating scale was used for data collection from the respondents. It is titled: Development of Closed Circuit Television and Solar Photovoltaic Technology for Integration into Nigeria Certificate in Education (Technical) Programme Questionnaire (DCCTVSPTQ). The questionnaire was divided into two parts (A and B). Part: A sought information about the personal data of the

respondent while Part: B was sub-divided into five Sections. Section:1 consisting of 22 items for the Objectives of the Course, Part:2 had 19 items for the Contents of the Course, Part:3 was 13 items for the Method of Teaching the Course and Part:4 had 25 items for the Materials, Tools and Equipment to be used in learning the Course and then Part:5 was 21 items for Evaluation Activities used for determining the achievement of the stated Objectives of the Course. The instrument was based on five point Likert-type scale with Strongly Agree/Highly Required (5), Agree/Required (4), Undecided (3), Disagree/Not Required (2) and Strongly Disagree/Highly Not Required (1). Refer to Appendix B for a copy of the questionnaire. Structured Questionnaire was used to collect data for the study because it is easily understood by the respondents for giving their opinion and data collected is easily analysed to arrive at findings and conclusion. The five point Likert-type scale was also employed using Strongly Agree/Highly Required (5), Agree/Required (4), Undecided (3), Disagree/Not Required (2) and Strongly Disagree/Highly Not Required (1) because it gives room for justice in opinion seeking both for or against the item of the questionnaire by using 3.5 (0.5 away from average of 3.0 points) as a yardstick(decision) for accepting or rejecting the item under review. The tool used to determine the reliability of the instrument was Cronbach alpha. See appendix B for the questionnaire.

### 3.6 Validation of the Instrument

The Instrument was subjected to content and face validation by three course and curriculum development experts, one from Department of Technical Education, Federal College of Education (Technical) Gombe, and another one from Division of Curriculum Development and Innovation NCCE, FCT Abuja and lastly from Industrial Technology Education Department, Federal University of Technology Minna that finalise the validation. They scrutinised each items of the questionnaire for statement clarity,

appropriateness and adequacy of instrument to provide the required responses or answers to the questions. The correction and observations on the Instrument were done and clarified that led to production of the final copy for data collection.

### 3.7 Reliability of the Instrument

The instrument was pilot-tested on ten Basic Technology Electrical and Electronics Lectures of FCE (T) Bichi Kano State, and ten CCTV & SPVT Industrial experts of Chosen one Technologies Kano state Nigeria which are not part of the population and are not within the study area. The instrument was presented to them for the exercise that was properly completed and retrieved to determine its reliability. The reliability of the questionnaire was determined by Cronbach alpha using Statistical Package for Social Science (SPSS) Version 20 for the internal consistency of the sections of the Instrument from the obtained result/data. It was found to be 0.87, 0.89, 0.87, 0.88 and 0.89 with overall reliability coefficient of 0.88. Appendix E is the result of the reliability test.

### 3.8 Administration of the Instrument

The researcher, with the help of seven research assistants, administered seventy-eight (78) copies of the Instrument: Development of Closed Circuit Television and Solar Photovoltaic Technology for Integration into Nigeria Certificate in Education(Technical) Programme Questionnaire (DCCTVSPTQ) to the respondents via a physical contact. The assistants were trained to be familiar with the instrument, administration procedure, collection procedure and how to make any clarification needed by the respondents. See Appendix F for the Training Manual. After a period often days, seventy instruments were retrieved from the respondents, getting 90% returned for data analysis.

### 3.9 Method of Data Analysis

The collected data was analysed using mean and standard deviation for the research questions on Likert five point rating scale. Any item with the mean value of 3.5 and above was considered agreed/required while any item with mean value of 3.49 and below was considered disagreed/not required. Analysis of Variance (ANOVA) was used to test the null hypotheses at the probability value (p-value) of $\leq 0.05$ level of significance. The decision on the hypotheses was taken by accepting no significant difference (null hypothesis) if the P-value is greater than 0.05 level and this means that there is no significant difference among the mean ratings of the responses of the groups of respondents on that item. But If the P-value is less than 0.05 levels, it shows that the hypothesis of no significant difference in the mean responses of the groups of respondents was rejected on that item. The latest version (20) of Statistical Package for Social Science (SPSS) software was used for the statistical computations.

# CHAPTER FOUR

# RESULT AND DISCUSSION

## 4.1.1 Research Question 1

What are the appropriate objectives for inclusion in CCTV and Solar Photovoltaic Technology Course? The data used to answer this research question is shown in Table 4.1

**Table 4.1** Mean and Standard Deviation Responses of Basic Technology Electrical and Electronic Lecturer, CCTV and SPVT Industrial Expert on the Appropriate Objectives for Inclusion in CCTV and Solar Photovoltaic Technology Course

| SN | Objectives for Inclusion in CCTV and Solar Photovoltaic Technology Course | Xt | SDt | Decision |
|---|---|---|---|---|
| | **CCTV** | | | |
| 1 | Explain the concept of Closed Circuit Television Technology | 4.50 | .50 | **Agreed** |
| 2 | List and explain safety precautions in CCTV industry. | 3.92 | .77 | **Agreed** |
| 3 | List and explain Personal Protective Equipment (PPE) used in CCTV system installation | 4.25 | .86 | **Agreed** |
| 4 | Mention and explain relevant Institute of Electrical Electronic Engineering (IEEE) regulations applicable to CCTV practices | 3.51 | .94 | **Agreed** |
| 5 | Explain the basic types of Internet Protocols (IP) addresses used in CCTV Installation | 3.94 | .84 | **Agreed** |
| 6 | Describe basic components of CCTV system with their functions. | 3.95 | .85 | **Agreed** |
| 7 | List and explain materials, tools and equipment used in CCTV installation | 3.88 | .84 | **Agreed** |
| 8 | Design a CCTV system for a school workshop | 4.10 | .81 | **Agreed** |
| 9 | Install an analogue CCTV system in a school workshop | 4.15 | .87 | **Agreed** |
| 10 | Install IP CCTV system | 4.01 | .82 | **Agreed** |
| 11 | Configure a CCTV system for remote viewing | 4.14 | .85 | **Agreed** |
| | **SPVT** | | | |
| 12 | Explain the concept of Solar energy and its conversion process | 4.15 | .87 | **Agreed** |
| 13 | Describe the construction of solar Photovoltaic module | 4.01 | .82 | **Agreed** |
| 14 | Explain the basic types of solar photovoltaic modules stating their advantages and disadvantages | 3.91 | .76 | **Agreed** |
| 15 | Differentiate properly between on-grid and off-grid solar PV systems | 3.98 | .83 | **Agreed** |
| 16 | State and explain Safety precaution in solar photovoltaic industry | 4.14 | .82 | **Agreed** |
| 17 | List and explain five National Electric Code applicable to solar photovoltaic practice | 3.64 | .89 | **Agreed** |
| 18 | Describe at basic components of solar photovoltaic system with their functions | 4.07 | .79 | **Agreed** |
| 19 | Design a solar photovoltaic system for a small house hold. | 4.07 | .87 | **Agreed** |
| 20 | Install a solar photovoltaic system for a small house hold. | 3.94 | .87 | **Agreed** |

**Table 4.1 Continue**

| | | | | |
|---|---|---|---|---|
| 21 | Troubleshoot a solar photovoltaic system for fault detection. | 4.01 | .86 | **Agreed** |
| 22 | Maintain a solar photovoltaic system for a small house hold. | 3.93 | .87 | **Agreed** |

Xt= Average Mean, SDt= Average Standard Deviation

Table 4.1 presents twenty-two items mean responses and standard deviations of the appropriate objectives for inclusion in CCTV and Solar Photovoltaic Technology Course. All twenty-two items have average means that ranges between 3.88 to 4.50 which are above 3.50 cutoff point and indicating that they are agreed to be included in the objectives of the course. The standard deviations of all items range from 0.50 to 0.94. This means that the responses did not deviate from each other and the standard deviation added validity to the mean.

### 4.1.2 Research Question 2

What are the appropriate contents for inclusion in CCTV and Solar Photovoltaic Technology Course? The data used to answer this research question is shown in Table 4.2

**Table 4.2** Mean and Standard Deviation Responses of Basic Technology Electrical and Electronic Lecturer and Industrial Expert on the Appropriate Content for Inclusion in CCTV and Solar Photovoltaic Technology Course

| SN | Contents for Inclusion in CCTV and Solar Photovoltaic Technology Course | Xt | SDt | Decision |
|---|---|---|---|---|
| | **CCTV** | | | |
| 23 | The concept of Closed Circuit Television Technology | 3.93 | .86 | **Agreed** |
| 24 | Safety precaution in CCTV industry and Personal Protective Equipment (PPE) | 4.13 | .78 | **Agreed** |
| 25 | Relevant Institute of Electrical Electronic Engineering (IEEE) Regulation on CCTV installation | 3.55 | .88 | **Agreed** |
| 26 | Components of CCTV system with their functions: cameras, lenses, video monitors, housing and mount, switchers, multiplexers, video recorder, PTZ, Video Balun, multichannel DVR&NVR, power adaptor, cable tester | 3.97 | .93 | **Agreed** |
| 27 | Material, Tools and Equipment used in CCTV practices | 4.04 | .86 | **Agreed** |
| 28 | Design of CCTV system: defining system requirement, design consideration, block and schematic diagrams | 3.86 | .80 | **Agreed** |
| 29 | Installation of an analogue CCTV system | 4.06 | .74 | **Agreed** |
| 30 | CCTV signal transmission: wired (coaxial, Cat5), wireless and IP network transmission | 3.97 | .78 | **Agreed** |
| 31 | IP address and its basic classes | 4.03 | .82 | **Agreed** |
| 32 | Installation of CCTV system with IP cameras and use of CCTV software: Sadptool, V-connect | 3.91 | .81 | **Agreed** |
| 33 | Configuration of CCTV system for video and audio storage, retrieval and remote viewing | 4.06 | .80 | **Agreed** |

**Table 4.2 Continue**

| | | | | |
|---|---|---|---|---|
| | **SPVT** | | | |
| 34 | Concept of Solar energy: meaning, uses, conversion processes tracking system, converging system, use of pyranometer | 3.94 | .78 | **Agreed** |
| 35 | Construction of solar photovoltaic module: types, features, advantages and disadvantages. | 3.94 | .85 | **Agreed** |
| 36 | Solar PV systems: Grid-connected and Off-grid systems | 3.81 | .84 | **Agreed** |
| 37 | Safety precaution in solar photovoltaic industry | 3.96 | .81 | **Agreed** |
| 38 | IEEE and National electric code regulation for solar power practices | 3.64 | .79 | **Agreed** |
| 39 | Components of solar photovoltaic system with their functions: photovoltaic module, battery, controller, inverter, wire, solid state relay etc. | 3.93 | .75 | **Agreed** |
| 40 | Solar photovoltaic system design: site survey, site plan reading | 4.09 | .79 | **Agreed** |
| 41 | Solar photovoltaic wiring, installation, troubleshooting and maintenance | 3.91 | .85 | **Agreed** |

Xt= Average Mean, SDt= Average Standard Deviation

Table 4.2 shows nineteen items mean responses and standard deviations of the appropriate content for inclusion in CCTV and Solar Photovoltaic Technology Course. All nineteen items have average means that ranges between 3.81 to 4.13 which are above 3.50 cut-off point and indicating that they are agreed to be included in the content of the course. The standard deviations of all items range from 0.74 to 0.93. This means that the responses did not deviate from each other and the standard deviation added validity to the mean.

### 4.1.3 Research Question 3

What are the appropriate methods of teaching CCTV and Solar Photovoltaic Technology Course? The data used to answer this research question is shown in Table 4.3.

**Table 4.3:** Mean and Standard Deviation Responses of Basic Technology Electrical and Electronic Lecturer and Industrial Expert on the Appropriate Method of Teaching CCTV and Solar Photovoltaic Technology Course

| SN | Methods of teaching CCTV and Solar Photovoltaic Technology Course | Xt | SDt | Decision |
|---|---|---|---|---|
| 42 | Lecture method | 3.90 | .73 | **Agreed** |
| 43 | Tutorials | 3.80 | .75 | **Agreed** |
| 44 | Laboratory work/practical | 3.87 | .87 | **Agreed** |
| 45 | Panel discussion | 3.39 | .92 | **Disagreed** |
| 46 | Simulation method | 3.96 | .84 | **Agreed** |
| 47 | Activity Approach method | 4.00 | .87 | **Agreed** |
| 48 | Discovery method | 3.37 | .98 | **Disagree** |
| 49 | Demonstration method | 3.81 | .84 | **Agree** |

**Table 4.3 Continue**

| | | | | |
|---|---|---|---|---|
| 50 | Individualized Instruction method | 3.81 | .80 | **Agree** |
| 51 | Reciprocal peer tutoring | 3.89 | .81 | **Agree** |
| 52 | Computer Assisted Instructions (CAI) method | 3.97 | .80 | **Agree** |
| 53 | Modular Approach | 3.99 | .83 | **Agree** |
| 54 | Discussion method | 4.01 | .89 | **Agreed** |

Xt= Average Mean, SDt= Average Standard Deviation

Table 4.3 shows thirteen items mean responses and standard deviations of the appropriate method of teaching CCTV and Solar Photovoltaic Technology Course. Eleven out of which have average means that ranges between 3.80 to 4.01 which are above 3.50 cutoff point and indicating that they are agreed to be included in the method of the course. However, items 45 and 48 have average mean responses of 3.39and 3.37 respectively which are below the cutoff point and implying that they are not agreed to be included in the objectives of the course. The standard deviations of all items range from 0.74 to 0.93. This means that the responses did not deviate from each other and the standard deviation added validity to the mean.

### 4.1.4 Research Question 4

What are the appropriate materials, tools and equipment for teaching CCTV and Solar Photovoltaic Technology Course? The data used to answer this research question is shown in Table 4.4

**Table 4.4:** Mean and Standard Deviation Responses of Basic Technology Electrical and Electronic Lecturer and Industrial Expert on the Appropriate Materials, Tools and Equipment for Inclusion in CCTV and Solar Photovoltaic Technology Course

| SN | Materials, Tools and Equipment for teaching CCTV and Solar Photovoltaic Technology Course | Xt | SDt | Decision |
|---|---|---|---|---|
| | **CCTV** | | | |
| 55 | Camera | 4.04 | .86 | **Required** |
| 56 | Digital video recorder | 4.07 | .79 | **Required** |
| 57 | Network video recorder | 3.96 | .79 | **Required** |
| 58 | Balum | 4.09 | .79 | **Required** |
| 59 | Crimper | 4.13 | .83 | **Required** |
| 60 | Coaxial cable | 4.04 | .81 | **Required** |
| 61 | Cat5 cable | 4.09 | .85 | **Required** |
| 62 | Multiplexer | 3.84 | .79 | **Required** |
| 63 | Monitor | 4.04 | .86 | **Required** |
| 64 | IP Camera configuring software | 3.93 | .86 | **Required** |
| | **SPVT** | | | |
| 65 | Photovoltaic panel | 3.97 | .85 | **Required** |
| 66 | Pyranometer | 3.97 | .87 | **Required** |
| 67 | Charge controller | 4.04 | .89 | **Required** |
| 68 | Inverter | 4.03 | .82 | **Required** |

**Table 4.4 Continue**

| | | | | |
|---|---|---|---|---|
| 69 | Solid state relay | 4.14 | .86 | **Required** |
| 70 | Circuit breaker | 3.90 | .82 | **Required** |
| 71 | Inclinometer | 3.80 | .67 | **Required** |
| 72 | Measuring tape | 3.90 | .82 | **Required** |
| 73 | Wire strippers | 3.99 | .81 | **Required** |
| 74 | Torpedo level | 4.09 | .85 | **Required** |
| 75 | GPS | 3.35 | .90 | **Not Required** |
| 76 | Earthing system | 4.04 | .82 | **Required** |
| 77 | Hand glob | 3.93 | .86 | **Required** |
| 78 | Head gear (Helmet) | 3.37 | .98 | **Not Required** |
| 79 | Safety boot | 3.84 | .85 | **Required** |

Xt= Average Mean, SDt= Average Standard Deviation

Table 4.4 presents twenty-five items mean responses and standard deviations of the appropriate material, tools and equipment for teaching CCTV and Solar Photovoltaic Technology Course. Twenty-three out of which has average means that ranges between 3.80 to 4.14 which are above 3.50 cutoff point and indicating that they are required to be included in the material, tool and equipment for required for teaching the course. However, items 75 and 78 have average mean responses of 3.35and 3.37 respectively which are below the cutoff point and implying that they are not agreed to be included in the material, tools and equipment of the course. The standard deviations of all items range from 0.67 to 0.98. This means that the responses did not deviate from each other and the standard deviation added validity to the mean.

### 4.1.5 Research Question 5

What are the appropriate evaluation activities for inclusion in CCTV and Solar Photovoltaic Technology Course? The data used to answer this research question is shown in Table 4.5

**Table 4.5:** Mean and Standard Deviation Responses of Basic Technology Electrical and Electronic Lecturer and Industrial Expert on the Appropriate Evaluation Activities for Inclusion in CCTV and Solar Photovoltaic Technology Course

| SN | Evaluation activities for inclusion in CCTV and Solar Photovoltaic Technology Course | Xt | SDt | Decision |
|---|---|---|---|---|
| | **CCTV** | | | |
| 80 | Explain the concept of Closed Circuit Television Technology | 3.83 | .85 | **Agreed** |
| 81 | List and explain at least five safety precautions in CCTV industry. | 4.07 | .79 | **Agreed** |
| 82 | List and explain at least five personal protective equipment (PPE) used in CCTV installation | 4.03 | .85 | **Agreed** |
| 83 | Mention and explain at least five IEEE regulation applicable to CCTV practices | 3.50 | 1.02 | **Agreed** |
| 84 | Describe at least five components of CCTV system with their functions. | 4.06 | .85 | **Agreed** |
| 85 | Mention and explain at least ten materials, tools and equipment used in CCTV system installation | 3.91 | .83 | **Agreed** |
| 86 | Design a CCTV system for a school workshop | 4.01 | .79 | **Agreed** |
| 87 | Describe Installation steps of a CCTV system for a school workshop | 3.96 | .79 | **Agreed** |
| 88 | Mention and explain basic types of Internet Protocols used in CCTV practices | 4.07 | .82 | **Agreed** |
| 89 | Explain the installation and configuration procedure for remote viewing with an IP camera | 4.16 | .79 | **Agreed** |
| | **SPVT** | | | |
| 90 | Explain the concept of Solar energy and its conversion process | 4.01 | .81 | **Agreed** |
| 91 | Describe the construction of solar Photovoltaic module | 3.94 | .85 | **Agreed** |
| 92 | Explain the basic types of solar photovoltaic modules stating their advantages and disadvantages | 3.89 | .84 | **Agreed** |
| 93 | Differentiate properly between on-grid and off-grid solar PV systems | 3.93 | .84 | **Agreed** |
| 94 | State and explain at least five Safety precaution in solar photovoltaic industry | 4.10 | .82 | **Agreed** |
| 95 | List and explain at least five National Electric Code applicable to solar photovoltaic practice | 3.50 | .97 | **Agreed** |
| 96 | Describe at least five components of solar photovoltaic system with their functions | 4.00 | .76 | **Agreed** |
| 97 | Design a solar photovoltaic system for a small house hold with a load of 20 Watts Hour. | 4.13 | .76 | **Agreed** |
| 98 | State the steps of installing a solar photovoltaic system for a small house hold. | 3.94 | .85 | **Agreed** |
| 99 | Describe troubleshoot procedure for a solar photovoltaic system for a small house hold. | 3.89 | .75 | **Agreed** |
| 100 | Discuss the maintenance principle of a solar photovoltaic system for a small house hold. | 4.00 | .80 | **Agreed** |

Xt= Average Mean, SDt= Average Standard Deviation

Table 4.5 presents twenty-one items mean responses and standard deviations of the appropriate evaluation activities for inclusion in CCTV and Solar Photovoltaic Technology Course. All twenty-one items have average means that ranges between 3.83 to 4.13 which are above 3.50 cutoff point and indicating that they are agreed to be included in the Evaluation activities of the course. The standard deviations of all items

range from 0.75 to 1.02. This means that the responses did not deviate from each other and the standard deviation added validity to the mean.

### 4.2.1 Hypothesis One

**$Ho_1$:** There is no significant difference in the mean responses of Electrical/Electronic Technology Lecturers of NCE (T) and CCTV & SPVT industry experts on the appropriate objectives for inclusion in CCTV and Solar Photovoltaic Technology Course;

The data used in testing this hypothesis is presented in Table 4.6

**Table 4.6:** Analysis of Variance (ANOVA) of the mean responses of Basic Technology Electrical and Electronic Technology lecturer, CCTV and SPVT Industrial Expert on objectives for inclusion in CCTV and SPVT Course

| Mean | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Between Groups | .350 | 2 | .175 | 3.845 | .056 |
| Within Groups | 3.049 | 67 | .046 | | |
| Total | 3.398 | 69 | | | |

Result of table 4.6 presents the Analysis of Variance of objective for inclusion in CCTV and SPVT course. From the table, the F value is 3.85 which reach significance with p-value of 0.56 that is above the 0.05 alpha level. This means, the Null hypothesis of no significance is accepted. Therefore, there is no statistically significant difference among the means of lecturers of federal institution, lecturers of state institution and industrial expert on the objectives for inclusion in CCTV and SPVT course. This implies that the three groups of respondent unanimous agreement is relatively the same.

### 4.2.2 Hypothesis Two:

**$Ho_2$:** There is no significant difference in the mean responses of Electrical/Electronic Technology Lecturerss and CCTV & SPVT experts on the appropriate contents for inclusion in CCTV and Solar Photovoltaic Technology Course;

The data used in testing this hypothesis is presented in Table 4.7

**Table 4.7:** Analysis of Variance (ANOVA) of the mean responses of Basic Technology Electrical and Electronic Technology and industrial expert on content for inclusion in CCTV and SPVT Course

| Mean | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Between Groups | .646 | 2 | .323 | 9.727 | .06 |
| Within Groups | 2.226 | 67 | .033 | | |
| Total | 2.872 | 69 | | | |

Result of table 4.7 presents the Analysis of Variance of content for inclusion in CCTV and SPVT course. From the table, the F value is 9.73 which reach significance with p-value of 0.06 that is greater than the 0.05 alpha level. This means, the Null hypothesis of no significance is accepted. Therefore, there is no statistically significant difference among the means of lecturers, CCTV and SPVT industrial expert on the content for inclusion in CCTV and SPVT course. This shows that, the means of the groups of respondents are statistically and relative the same.

### 4.2.3 Hypothesis Three:

**$Ho_3$:** There is no significant difference in the mean responses of Electrical/Electronic Technology Lecturers and CCTV & SPVT industry experts on the appropriate methods of teaching CCTV and Solar Photovoltaic Technology Course;

The data used in testing this hypothesis is presented in Table 4.8

**Table 4.8:** Analysis of Variance (ANOVA) of the mean responses of Basic Technology Electrical and Electronic Technology Lecturer, CCTV and SPVT Industrial Expert on method of teaching CCTV and SPVT Course

| Mean | Sum of Squares | Df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Between Groups | 1.373 | 2 | .686 | 13.162 | .06 |
| Within Groups | 3.493 | 67 | .052 | | |
| Total | 4.866 | 69 | | | |

Result of table 4.8 presents the Analysis of Variance of method of teaching CCTV and SPVT course. From the table, the F value is 13.17 which reach significance with p-

value of 0.06 that is greater than 0.05 alpha level. This means, the Null hypothesis of no significance is accepted. Therefore, there is no statistically significant difference among the means of lecturers and CCTV & SPVT industrial expert on the method of teaching CCTV and SPVT course.

### 4.2.4 Hypothesis Four

**$Ho_4$:** There is no significant difference in the mean responses of Electrical/Electronic Technology Lecturerss of NCE (T) and CCTV & SPVT industry experts on the appropriate materials, tools and equipment used in CCTV and Solar Photovoltaic Technology Course;

The data used in testing this hypothesis is presented in Table 4.9

**Table 4.9:** Analysis of Variance (ANOVA) of the mean responses of Basic Technology Electrical and Electronic Technology Lecturer, CCTV and SPVT Industrial Expert on material, tool and equipment of CCTV and SPVT Course

| Mean | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Between Groups | 1.394 | 2 | .697 | 12.189 | .06 |
| Within Groups | 3.832 | 67 | .057 | | |
| Total | 5.227 | 69 | | | |

Result of table Result of table 4.9 presents the Analysis of Variance of material, tool and equipment of CCTV and SPVT course. From the table, the F value is 12.19 which reach significance with p-value of 0.06 that is greater than the 0.05 alpha level. This means, the Null hypothesis of no significance is accepted. Therefore, there is no statistically significant difference among the means of lecturers and CCTV & SPVT industrial expert on the material, tool and equipment of CCTV and SPVT course.

### 4.2.5 Hypothesis Five

**$Ho_5$:** There is no significant difference in the mean responses of Electrical/Electronic Technology Lecturers of NCE (T)and CCTV & SPVT industry experts on the appropriate evaluation activities for inclusion in CCTV and Solar Photovoltaic Technology Course.

The data used in testing hypothesis one is presented in Table 4.10

**Table 4.10:** Analysis of Variance (ANOVA) of the mean responses of Basic Technology Electrical and Electronic Technology Lecturer, CCTV and SPVT Industrial Expert on evaluation activities for inclusion in CCTV and SPVT Course

| Mean | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Between Groups | 1.515 | 2 | .757 | 22.969 | .06 |
| Within Groups | 2.209 | 67 | .033 | | |
| Total | 3.724 | 69 | | | |

Result of table 4.10 presents the Analysis of Variance of evaluation activities for inclusion in CCTV and SPVT course. From the table, the F value is 22.97 which reach significance with p-value of 0.06 that is equal to the 0.05 alpha level. This means, the Null hypothesis of no significance is accepted. Therefore, there is no statistically significant difference among the means of lecturers and CCTV & SPVT industrial expert on the evaluation activities of CCTV and SPVT course.

## 4.3 Findings of the Study

The following are findings of the study:

1. The finding reveals that all proposed appropriate objectives for inclusion in CCTV and Solar Photovoltaic Technology Course are accepted for inclusion into the Course by the respondents.
2. The finding reveals that all proposed appropriate contents for inclusion in CCTV and Solar Photovoltaic Technology Course are accepted for inclusion into the Course by the respondents.

3. The finding reveals that all proposed appropriate methods of teaching for inclusion in CCTV and Solar Photovoltaic Technology Course are accepted for inclusion into the Course by the respondents except panel discussion and discovery method.
4. The finding reveals that all proposed appropriate Material, Tools and Equipment for inclusion in CCTV and Solar Photovoltaic Technology Course are accepted for inclusion into the Course by the respondents except GPS and head gear that are rejected.
5. The finding reveals that all proposed appropriate Evaluation Activities for inclusion in CCTV and Solar Photovoltaic Technology Course are accepted for inclusion into the Course by the respondents.
6. There is no statistically significant difference among the means response and industrial expert on the objectives for inclusion in CCTV and SPVT course.
7. There is no statistically significant difference among the means response of lecturers, CCTV and SPVT industrial expert on the content for inclusion in CCTV and SPVT course.
8. There is no statistically significant difference among the means response of lecturers, CCTV and SPVT industrial expert on the method of teaching CCTV and SPVT course.
9. There is no statistically significant difference among the means response lecturers, CCTV and SPVT industrial expert on the material, tool and equipment of CCTV and SPVT course.
10. There is no statistically significant difference among the means response lecturers, CCTV and SPVT industrial expert on the evaluation activities for inclusion in CCTV and SPVT course.

## 4.4 Discussion of Findings

The data presented about appropriate objectives provides answer to research question one. It is very clear from this finding that all twenty-two objectives are agreed to be included in the CCTV and SPVT course. This means that the propose objectives are in line with the knowledge, skill and attitude required for the best implementation of the course. Similarly, there is no statistically significant difference among the means response and industrial expert on the objectives for inclusion in CCTV and SPVT course. This can be as a result of same level of understanding of the concept. This is supported by the view of Bakare (2014), that Objectives of a programme serve as guide for the implementation of a training programme. In addition, James (2017), reported that every curriculum is planned and developed for a purpose and this purpose of the curriculum is what is referred to as curriculum objective.

The finding of research question two provides answer to research question two. It can be seen clearly from this finding that all nineteen items of the content are agreed to be included in the CCTV and SPVT course. In the same vain, there is no statistically significant difference among the means response of lecturers, CCTV and SPVT industrial expert on the content for inclusion in CCTV and SPVT course. This implies that the respondent share common idea about the content of the course and the content is very relevant to the societal need in which the curriculum will be implemented and is in agreement with the objectives of the course. According to Cecilia (n.d), content of any curriculum is an embodiment of the attitudes, knowledge and skills which a society intends to impart to her citizens through the school and other socializing agencies.

The finding of the study provides answer to research question three. The finding signifies that eleven out of the thirteen methods of teaching are selected to be used in teaching the CCTV and SPVT course. This means that the methods have all that is

needed to achieve the objectives of the course. Likewise, there is no statistically significant difference among the means response of lecturers, CCTV and SPVT industrial expert on the method of teaching CCTV and SPVT course. This shows that the three groups of respondents have relatively same thought about the methods of teaching the course and this is in agreement with the view of Gill *et al. (*2017) that stated, method refers to the procedure within an approach used for the effective presentation of the specific content of the subject which helps the student to understand better. They aligned with the best way of attaining knowledge, skill and attitude required for the best implementation of the course.

The finding of the study also revealed the outcomes of the respondents on the choice of material, tools and equipment required for implementation of the course. Twenty-three out of the twenty-five are selected by the respondents to be included in the course to facilitate better understanding and achievement of the outlined objectives of the course. Also, there is no statistically significant difference among the means response and industrial expert on the material, tool and equipment of CCTV and SPVT course. This is supported by the view of Uwameiye (2016), Tools and Equipments influence the academic performance of students and prepare them for useful living. Uwameiye (2016) and Egunsola and Abdulmumini (2012) expressed many factors affect the teaching and learning of practical subjects and one of such factors is the availability and utilization of Tools and Equipment. In the opinion of McCubbin *et al.* (2016), adequate Tools and Equipment are required to train a well-prepared and competent workforce that will be prepared for the problems of the future.

The result of this study also shows the evaluation activities to be used for ensuring the level of achieving the outlined objectives of the course. It is very clear from this finding that all twenty-one items presented to the respondents are confirmed to be used in

evaluating the objectives and are agreed to be included in the CCTV and SPVT course. In addition, there is no statistically significant difference among the means response of lecturers, CCTV and SPVT industrial expert on the evaluation activities for inclusion in CCTV and SPVT course. Chibuzor (2014) opined that Evaluation is therefore the systematic collection of relevant data, analyzing the data using appropriate statistical tool(s) and using the information obtained from the analysis of data to make informed decision or judgment. The term used to identify Evaluation Activities in the study are demonstrate ability, Identify steps, communicate information, create information, define, discuss, state, interpret and explain (Efanimjor and Okolocha, 2015).

# CHAPTER FIVE

## 5.0 CONCLUSION AND RECOMMENDATIONS

### 5.1 Conclusion

Closed Circuit Television and Solar Photovoltaic Technologies are very paramount technological systems that contribute immensely to the growth and development of society especially in this moment of insecurity challenges. Closed Circuit Television system provides twenty-four-seven surveillance service capable of revealing images, audio and video footage of and any criminal activities perpetrated to destroy a society. The operation of this security system and many other technological systems depend largely on the availability of electrical power mostly generated from hydro-electric, gas power plant and chemical conversion systems which are associated with so many challenges.

However, controlling the water dams due to effect of climate change and cost of distribution and maintenance are some of the major problems affecting the hydro-electric power plants. Similarly, the hazard of explosion, environmental negative effect of fossil fuel, noise and environmental pollution are some of the problems associated with gas and chemical electrical power plants. On the other hand, solar photovoltaic power system is free from these challenges and provides employment opportunities to the graduate.

Consequently, breakdown of law and order, kidnapping and many more criminal activities ravaging the society need intervention of technological institution to train the students in these two areas. It is in this regard that this study is carried out to develop a course of study for integration in Nigeria Certificate in Education Technical Programme so that the product of the programme could face this societal problem while creating an employment opportunities in both CCTV and Solar photovoltaic technologies.

## 5.2 Recommendations

In line with the findings of this study, the following were recommended;

1. Due to the advance technology required for implementation of this course, government should make provision for training the lecturers of Basic Technology Electric and Electronics in line with the objectives of this course.
2. To ease the implementation of this course, government should make provision for training the lecturers of Basic Technology Electric and Electronics in line with the content of this course.
3. Government should organise seminars and conferences that will sensitize the lecturers about the choice of best methods of teaching this course.
4. Government should provide training material, tools and equipment needed for implementation of this course for better productivity.
5. The lecturers of this course should use these evaluation activities to ascertain the achievement of the objective of the course at the end of the course.

## 5.3 Contribution to Knowledge

This study had eventually developed a course of study for Nigeria Certificate in Education (Technical), Electrical Electronic Option titled: Closed Circuit Television and Solar Photovoltaic Technology with detail as follows. All objectives, content and evaluation activities were unanimously accepted at agreed level likewise, methods of teaching and material, tools and equipment were accepted at required and agreed level respectively. This is surely a great contribution to knowledge.

## 5.4 Suggestion for Further Studies

These suggestions were made for further studies:

1. Competencies needed by Nigeria Certificate in Education Technical Lecturers for Implementation of Closed Circuit Television and Solar Photovoltaic Technology Course.

2. Development of CCTV and Solar Photovoltaic Technology Capacity Building Training Manual for Technical Skill Acquisition Centres in Nigeria.
3. Closed Circuit Television and Solar Photovoltaic Installation Skill Required by Electrical Installation Technicians in Nigeria.
4. Development and Validation of Electronic Home Automation System Technology Course for Colleges of Education (Technical) in Nigeria.

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## APPENDIX A

## DISTRIBUTION OF POPULATION OF THE STUDY (RESPONDENT)

| SN | CATEGORY & ORGANISATION | POPULTION | SAMPLE |
|---|---|---|---|
| | **LECTURES** | 54 | |
| 1 | FCE T GOMBE | 13 | |
| 2 | FCE T POTISKUM | 14 | |
| 3 | AMINU SALE COE AZARE BAUCHI STATE | 5 | |
| 4 | UMAR IBN ELKANEMI COE OF SCIENCE AND TECHNOLOGY BAMA BORNO STATE | 5 | |
| 5 | COE HONG ADAMAWA STATE | 6 | |
| 6 | ABUBAKAR TATARI ALI POLYTECHNICS BAUCHI | 6 | |
| 7 | RAMAT POLYTECHNICS BORNO | 5 | |
| | | | |
| | **CCTV & SPVT INDUSTRIAL EXPERT** | 81 | |
| 1 | HALI ABOKIN TAFIYA GOMBE | | 4 |
| 2 | RSM DAMATURU YOBE 08064172120/ KALIBSON ELECTRICAL TECHNOCRIME SOLUTION 08191222280 | | 4 |
| 3 | DACHI TECHNOLOGIES BAUCHI 08023351250/ DUREXX ICT SOLUTION 08071854637 | | 3 |
| 4 | AESOD GLOBAL COMPANY MAIDUGURI BORNO 08024565500 / JITECH ICT AND ENGINEERING SOLUTION LTD 08134703298 | | 5 |
| 5 | EJK RENEWABLE ENERGY SOLUTIONS JIMETA ADAMAWA 08059636036 | | 5 |
| 6 | GATEWAY TECHNOLOGY TARABA 09060161770 | | 3 |
| | **SAMPLED EXPERT RESPONDENT** | | 24 |
| | **TOTAL RESPONDENT** | 78 | |

## APPENDIX B

## CLOSED CIRCUIT TELEVISION AND SOLAR PHOTOVOLTAIC TECHNOLOGY COURSE QUESTIONNAIRE (CCTV& SPTCQ)

**Project Topic:** Development of Closed Circuit Television and Solar Photovoltaic Technology Course (CCTV & SPVTC) for Integration into Nigeria Certificate in Education (Technical) Programme.

**Part A:**

**Instruction**: Please complete the information below as appropriate by checking in the respective boxes:

**Personal Information:**

**Category of Respondents:**

Electrical/Electronic Technology Lecturers ☐

CCTV Technology Industry Expert ☐

Solar Photovoltaic Technology Industry Expert ☐

Organisation: _____

**Part B:**

**Degrees of Respond to the Items of the Questionnaire**

| Response | Acronym | Likert Scale Points |
|---|---|---|
| Strongly Agree/Highly Required | SA/HR | 5 |
| Agree/Required | A/R | 4 |
| Undecided | UD | 3 |
| Disagree/Not Required | D/NR | 2 |
| Strongly Disagree/ Highly Not Require | SD/HNR | 1 |

**Section 1: Objective of CCTV and Solar Photovoltaic Technology Course**

**Instruction:** Please check (√) in the response column the best response that represents your opinion in accordance with the level of agreement or disagreement in the respective item of the objective of CCTV and Solar Photovoltaic Technology Course.

**Research Question 1: What are the appropriate Objectives for inclusion in CCTV and Solar Photovoltaic Technology Course?**

| SN | At the end of the CCTV & SPVTC, student should be able to: | Responses | | | | |
|---|---|---|---|---|---|---|
| | | SA | A | UD | D | SD |
| | **CCTV** | | | | | |
| 1 | Explain the concept of Closed Circuit Television Technology | | | | | |
| 2 | List and explain safety precautions in CCTV industry. | | | | | |
| 3 | List and explain Personal Protective Equipment (PPE) used in CCTV system installation | | | | | |
| 4 | Mention and explain relevant Institute of Electrical Electronic Engineering (IEEE) regulations applicable to CCTV practices | | | | | |
| 5 | Explain the basic types of Internet Protocols (IP) addresses used in CCTV Installation | | | | | |
| 6 | Describe basic components of CCTV system with their functions. | | | | | |
| 7 | List and explain materials, tools and equipment used in CCTV installation | | | | | |
| 8 | Design a CCTV system for a school workshop | | | | | |
| 9 | Install an analogue CCTV system in a school workshop | | | | | |
| 10 | Install IP CCTV system | | | | | |
| 11 | Configure a CCTV system for remote viewing | | | | | |
| | **SPVT** | | | | | |
| 12 | Explain the concept of Solar energy and its conversion process | | | | | |
| 13 | Describe the construction of solar Photovoltaic module | | | | | |
| 14 | Explain the basic types of solar photovoltaic modules stating their advantages and disadvantages | | | | | |
| 15 | Differentiate properly between on-grid and off-grid solar PV systems | | | | | |
| 16 | State and explain Safety precaution in solar photovoltaic industry | | | | | |
| 17 | List and explain five National Electric Code applicable to solar photovoltaic practice | | | | | |
| 18 | Describe at basic components of solar photovoltaic system | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | with their functions | | | | | |
| 19 | Design a solar photovoltaic system for a small house hold. | | | | | |
| 20 | Install a solar photovoltaic system for a small house hold. | | | | | |
| 21 | Troubleshoot a solar photovoltaic system for fault detection. | | | | | |
| 22 | Maintain a solar photovoltaic system for a small house hold. | | | | | |

**Section 2: Contents of CCTV and Solar Photovoltaic Technology Course**

**Instruction:** Please check (√) in the response column the best response that represents your opinion in accordance with the level of your agreement or disagreement in the respective item of the Content of CCTV and Solar Photovoltaic Technology Course.

**Research Question 2: What are the appropriate Contents for inclusion in CCTV and Solar Photovoltaic Technology Course?**

| SN | The following are the appropriate Contents of CCTV & SPVTC | Responses | | | | |
|---|---|---|---|---|---|---|
| | | SA | A | UD | D | SD |
| | **CCTV** | | | | | |
| 23 | The concept of Closed Circuit Television Technology | | | | | |
| 24 | Safety precaution in CCTV industry and Personal Protective Equipment (PPE) | | | | | |
| 25 | Relevant Institute of Electrical Electronic Engineering (IEEE) Regulation on CCTV installation | | | | | |
| 26 | Components of CCTV system with their functions: cameras, lenses, video monitors, housing and mount, switchers, multiplexers, video recorder, PTZ, Video Balun, multichannel DVR&NVR, power adaptor, cable tester | | | | | |
| 27 | Material, Tools and Equipment used in CCTV practices | | | | | |
| 28 | Design of CCTV system: defining system requirement, design consideration, block and schematic diagrams | | | | | |
| 29 | Installation of an analogue CCTV system | | | | | |
| 30 | CCTV signal transmission: wired (coaxial, Cat5), wireless and IP network transmission | | | | | |
| 31 | IP address and its basic classes | | | | | |
| 32 | Installation of CCTV system with IP cameras and use of | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | CCTV software: Sadptool, V-connect | | | | | |
| 33 | Configuration of CCTV system for video and audio storage, retrieval and remote viewing | | | | | |
| | **SPVT** | | | | | |
| 34 | Concept of Solar energy: meaning, uses, conversion processes tracking system, converging system, use of pyranometer | | | | | |
| 35 | Construction of solar photovoltaic module: types, features, advantages and disadvantages. | | | | | |
| 36 | Solar PV systems: Grid-connected and Off-grid systems | | | | | |
| 37 | Safety precaution in solar photovoltaic industry | | | | | |
| 38 | IEEE and National electric code regulation for solar power practices | | | | | |
| 39 | Components of solar photovoltaic system with their functions: photovoltaic module, battery, controller, inverter, wire, solid state relay etc. | | | | | |
| 40 | Solar photovoltaic system design: site survey, site plan reading | | | | | |
| 41 | Solar photovoltaic wiring, installation, troubleshooting and maintenance | | | | | |

**Section 3: Methods of Teaching CCTV and Solar Photovoltaic Technology Course**

**Instruction:** Please check (√) in the response column the best response that represents your opinion in accordance with the level of your agreement or disagreement in the respective item of the Mode of Teaching of CCTV and Solar Photovoltaic Technology Course.

**Research Question 3: What are the appropriate Methods of Teaching CCTV and Solar Photovoltaic Technology Course?**

| SN | The following are the appropriate Methods of Teaching CCTV & SPVTC | Responses | | | | |
|---|---|---|---|---|---|---|
| | | SA | A | UD | D | SD |
| 42 | Lecture method | | | | | |
| 43 | Tutorials | | | | | |
| 44 | Laboratory work/practical | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 45 | Panel discussion | | | | | |
| 46 | Simulation method | | | | | |
| 47 | Activity Approach method | | | | | |
| 48 | Discovery method | | | | | |
| 49 | Demonstration method | | | | | |
| 50 | Individualized Instruction method | | | | | |
| 51 | Reciprocal peer tutoring | | | | | |
| 52 | Computer Assisted Instructions (CAI) method | | | | | |
| 53 | Modular Approach | | | | | |
| 54 | Discussion method | | | | | |

**Section 4: Materials, Tools and Equipment for teaching CCTV and Solar Photovoltaic Technology Course**

**Instruction:** Please check (√) in the response column the best response that represents your opinion in accordance with the level of your agreement or disagreement in the respective item of the Materials, Tools and Equipment for CCTV and Solar Photovoltaic Technology Course.

**Research Question 4: What are the appropriate Materials, Tools and Equipment of CCTV and Solar Photovoltaic Technology Course?**

| SN | The following are the appropriate Materials, Tools and Equipment for teaching CCTV & SPVTC | Responses | | | | |
|---|---|---|---|---|---|---|
| | | HR | R | UD | NR | HNR |
| | **CCTV** | | | | | |
| 55 | Camera | | | | | |
| 56 | Digital video recorder | | | | | |
| 57 | Network video recorder | | | | | |
| 58 | Balum | | | | | |
| 59 | Crimper | | | | | |
| 60 | Coaxial cable | | | | | |
| 61 | Cat5 cable | | | | | |
| 62 | Multiplexer | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 63 | Monitor | | | | | |
| 64 | IP Camera configuring soft wares | | | | | |
| | **SPVT** | | | | | |
| 65 | Photovoltaic panel | | | | | |
| 66 | Pyranometer | | | | | |
| 67 | Charge controller | | | | | |
| 68 | Inverter | | | | | |
| 69 | Solid state relay | | | | | |
| 70 | Circuit breaker | | | | | |
| 71 | Inclinometer | | | | | |
| 72 | Measuring tape | | | | | |
| 73 | Wire strippers | | | | | |
| 74 | Torpedo level | | | | | |
| 75 | GPS | | | | | |
| 76 | Earthing system | | | | | |
| 77 | Hand glob | | | | | |
| 78 | Head gear (Helmet) | | | | | |
| 79 | Safety boot | | | | | |

**Section 5: Evaluation activity of CCTV and Solar Photovoltaic Technology Course**

**Instruction:** Please check (√) in the response column the best response that represents your opinion in accordance with the level of your agreement or disagreement in the respective item of the Evaluation activities of CCTV and Solar Photovoltaic Technology Course.

**Research Question 5: What are the appropriate Evaluation Activities for inclusion in CCTV and Solar Photovoltaic Technology Course?**

| SN | The following are the appropriate Evaluation Activities for CCTV& SPVTC | Responses | | | | |
|---|---|---|---|---|---|---|
| | | SA | A | UD | D | SD |
| | **CCTV** | | | | | |
| 80 | Explain the concept of Closed Circuit Television Technology | | | | | |
| 81 | List and explain at least five safety precautions in CCTV industry. | | | | | |
| 82 | List and explain at least five personal protective equipment (PPE) used in CCTV installation | | | | | |
| 83 | Mention and explain at least five IEEE regulation applicable to CCTV practices | | | | | |
| 84 | Describe at least five components of CCTV system with their functions. | | | | | |
| 85 | Mention and explain at least ten materials, tools and equipment used in CCTV system installation | | | | | |
| 86 | Design a CCTV system for a school workshop | | | | | |
| 87 | Describe Installation steps of a CCTV system for a school workshop | | | | | |
| 88 | Mention and explain basic types of Internet Protocols used in CCTV practices | | | | | |
| 89 | Explain the installation and configuration procedure for remote viewing with an IP camera | | | | | |
| | **SPVT** | | | | | |
| 90 | Explain the concept of Solar energy and its conversion process | | | | | |
| 91 | Describe the construction of solar Photovoltaic module | | | | | |
| 92 | Explain the basic types of solar photovoltaic modules stating their advantages and disadvantages | | | | | |
| 93 | Differentiate properly between on-grid and off-grid solar PV systems | | | | | |
| 94 | State and explain at least five Safety precaution in solar photovoltaic industry | | | | | |
| 95 | List and explain at least five National Electric Code applicable to solar photovoltaic practice | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 96 | Describe at least five components of solar photovoltaic system with their functions | | | | | |
| 97 | Design a solar photovoltaic system for a small house hold with a load of 20 Watts Hour. | | | | | |
| 98 | State the steps of installing a solar photovoltaic system for a small house hold. | | | | | |
| 99 | Describe troubleshoot procedure for a solar photovoltaic system for a small house hold. | | | | | |
| 100 | Discuss the maintenance principle of a solar photovoltaic system for a small house hold. | | | | | |

## APPENDIX C

Department of Industrial Technology Education,
School of Science and Technology Education,
Federal University of Technology, Minna,
Niger State.
10th September, 2021.

Dear Sir/Madam,

**REQUEST FOR VALIDATION OF RESEARCH INSTRUMENT**

I am a post-graduate student with registration number: M.Tech/SSTE/2018/8701 conducting a study titled: **Development of Closed Circuit Television and Solar Photovoltaic Technology Course for Integration into Nigeria Certificate in Education (Technical) Minimum Standards in Nigeria.**

Attached hereby is a copy of research question, objective and a drafted questionnaire for data collection of the study. You are requested to validate the items for adequacy, clarity and appropriateness for data collection in the conduct of this study. You are to add, delete, reword comment or make suggestion about the items where necessary to improve the instrument toward achieving the objective of the study.

Thanks

Yours faithfully

**Mohammed Bello**
08030559779

Validate's Names: _____ Signature: _____

Comments: _____

_____

_____

## APPENDIX D

**FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA DEPARTMENT OF INDUSTRIAL AND TECHNOLOGY EDUCATION RESEARCH INSTRUMENTS' VALIDATION CERTIFICATE**

**Students Name: Mohammed Bello**
**Registration Number: M.Tech./SSTE/2018/8701**
**Programme: M. Tech. Electrical/ Electronic Technology Education**
**Topic: Development of Closed Circuit Television and Solar Photovoltaic Technology Course for Integration into Nigeria Certificate in Education (Technical) Minimum Standards in Nigeria**

Name of Validate: Dr S A Oluwajuni
Area of specialization: Electrical/Electronic
Name of Institution: FUT Minna
Signature: _____ Date: 13/10/21

Name of Validate: Ar. Abdulwahab, S.
Area of specialization: Electrical/Electronic Technology
Name of Institution: FCE(T) Gombe
Signature: Alfabet Date: 22-09-2021

Name of Validate: DR. UMAR ADAMU KWAMI
Area of specialization: Electrical and Electronic Technology
Name of Institution: NCCE
Signature: _____ Date: 02-09-2021

Name of Validate: _____
Area of specialization: _____
Name of Institution: _____
Signature: _____ Date: _____

Name of Validate: _____
Area of specialization: _____
Name of Institution: _____
Signature: _____ Date: _____

Name of Validator: _____
Area of specialization: _____
Name of Institution: _____
Signature: _____ Date: _____

## APPENDIX E

## RESEARCH ASSISTANCE TRAINING MANUAL

**Objective**: At the end of this training, the trainee should be able to:

1- Introduce the CCTV & SPVT questionnaire,

2- Make clarification to the respondents where necessary,

3- Administer the CCTV & SPVT questionnaire,

4- Retrieve the questionnaire after completion by the respondents.

### Introduction

The Research Assistant will introduce the Research Instrument: Closed Circuit Television and Solar Photovoltaic Technology Course Questionnaire (CCTV&SPVTCQ) for data collection on Project Topic: Development of Closed Circuit Television and Solar Photovoltaic Technology Course for Integration into Nigeria Certificate in Education (Technical) Minimum Standards in Nigeria. He will explain: The Objectives of the study, concern to the privacy of the Respondents, Parts and Sections of the questionnaire, Category of respondent, Degrees of Responds to the Items of the Questionnaire, Instruction in respect to each section of the questionnaire and how to complete the questionnaire. He will make clarification where necessary in respect to the questions asked by the respondents.

### Instrument Administration Procedure

The instrument will be administered to the respondents after the introduction and clarification. Attention will be paid to the categories of respondent while sharing the instrument to the respective respondents and a minimum of one week will be given to the respondents to complete the questionnaire.

**Instrument Retrieval Procedure**

After a period of one week, the Assistant will meet the respondent and collect the completed questionnaire from those that are ready and agree with those that are not ready on when (additional three days) to collect the questionnaires.

**Conclusion**

The assistant will meet the respondents and appreciate their input to the conduct of the study assuring them how this study will be of great significant to their area of specialisation (School, NCCE or Industry) as well as confidentiality of their personality.

# APPENDIX F

Reliability of Instrument Using Crobach's Alpha (SPSS Version 20)

**Reliability**

Scale: Objectives of CCTV & SPVT Course

**Case Processing Summary**

| | | N | % |
|---|---|---|---|
| Case | Valid | 20 | 100.0 |
| | Excluded[a] | 0 | .0 |
| | Total | 20 | 100.0 |

**Reliability Statistics**

| Cronbach's Alpha | N of Items |
|---|---|
| .87 | 22 |

**Reliability**

Scale: Contents of CCTV & SPVT Course

**Case Processing Summary**

| | | N | % |
|---|---|---|---|
| Case | Valid | 20 | 100.0 |
| | Excluded[a] | 0 | .0 |
| | Total | 20 | 100.0 |

**Reliability Statistics**

| Cronbach's Alpha | N of Items |
|---|---|
| .89 | 19 |

**Reliability**

Scale: Evaluation Activities of CCTV & SPVT Course

**Case Processing Summary**

| | | N | % |
|---|---|---|---|
| Case | Valid | 20 | 100.0 |
| | Excluded[a] | 0 | .0 |
| | Total | 20 | 100.0 |

**Reliability Statistics**

| Cronbach's Alpha | N of Items |
|---|---|
| .89 | 21 |

**Reliability**

Scale: Over roll Reliability of the Instrument

**Case Processing Summary**

| | | N | % |
|---|---|---|---|
| Case | Valid | 20 | 100.0 |
| | Excluded[a] | 0 | .0 |
| | Total | 20 | 100.0 |

**Reliability Statistics**

| Cronbach's Alpha | N of Items |
|---|---|
| .88 | 141 |

**Reliability**

Scale: Mode of Teaching CCTV & SPVT Course

**Case Processing Summary**

| | N | % |
|---|---|---|
| Valid | 20 | 100.0 |
| Case Excluded[a] | 0 | .0 |
| Total | 20 | 100.0 |

**Reliability Statistics**

| Cronbach's Alpha | N of Items |
|---|---|
| .87 | 23 |

**Reliability**

Scale: Materials Tools and Equipment for Teaching CCTV & SPVT Course

**Case Processing Summary**

| | N | % |
|---|---|---|
| Valid | 20 | 100.0 |
| Case Excluded[a] | 0 | .0 |
| Total | 20 | 100.0 |

**Reliability Statistics**

| Cronbach's Alpha | N of Items |
|---|---|
| .88 | 56 |