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Fault Detections and Diagnosis of Electrical/ Electronic Appliances Training Requirement of Technical Colleges as a Tool for Empowering Electrical Engineering Trade Students in Nigeria

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Abstract
The major purpose of the study was to investigate the fault detection and diagnosis training requirement of technical colleges as a tool for empowering electrical/electronics trade students. Two research Questions were answered. The study adopted a descriptive survey design. The population for the study was ninety two (92) comprised of all sixty six (66) electrical /electronics technical college teachers in Oyo and Ogun states and 24 electrical/electronics technologists which were sampled in the two states using purposive sampling techniques. The internal consistency of the instrument was ascertained using Cronbach Alpha method and reliability coefficient obtained for the instrument was 0.89. Structured questionnaire containing 153 items was designed and used for data collection. Mean and standard deviation were used to analyze research questions. The findings of the study revealed that ability to detect faulty components, ability to diagnose appliances components, ability to work with multiple technologies and keep up to date with new technologies are required for the training electrical/electronics students on fault detection and diagnosis of electrical/ electronic appliances in Nigeria technical colleges. The findings of the study also revealed that magnifying lens, oscilloscope, personal computer, screwdrivers, drills soldering iron, fire extinguishers, and first aid box among others are the required instrument training electrical/electronics students on fault detection and diagnosis of electrical/ electronic appliances in Nigeria technical colleges. It was recommended that necessary effort should be made by stakeholders of education and curriculum development to integrate the relevant skills on fault detection and diagnosis of electrical/electronic appliances into the curriculum of electrical/electronic students of technical colleges of Nigeria.
Keywords: Appliances, Fault detection and Diagnosis, Repair, Technical Colleges, Technicians and Technologists.

Technical and Vocational Education and Training (TVET) is a conglomeration of school and training based type of learning experiences which aims to inculcate in students practical skills, scientific know how, social and academic traits and entrepreneurship fitness to enable students to be self dependent or perform excellently in world of work. International Labour Organization (2010) claimed that TVET is a range of learning experience that are relevant for employability, portability of competencies and qualifications and recognition of skills, decent work opportunities and lifelong learning in and related to the world of work. Technical and Vocational Education and Training in an ideal situation offers career development opportunity to the students. TVET, according to Henry, Jack and Getrude (2014), plays an orientation role towards the world of work and its curriculum emphasizes on the acquisition of such employable skills, which is a fundamental necessity for driving the industrial and economic growth. The author stated further that TVET is a key to build this type of technical and entrepreneurial workforce which Africa needs to create wealth and emerge out of poverty. This is because Technical and Vocational Education and Training produces educated, skilled and motivated citizen who can profit society by creating enterprise or gain employment from employers. Okwelle (2011) submitted that Technical and vocational education and training is an integral part of National development strategies in many society because of the many impact on human resource development, productivity and economic growth.

The major aim of Technical and Vocational Education and Training is to produce citizen who can be self dependent and reliance. UNESCO in Henry, Jack and Getrude (2014) claimed that the objective of TVET is to train the workforce for self employment and the necessity to raise the productivity of the informal sectors.

Aklhilianand and Eci (2008) claimed that most commonly articulated goal of Technical and Vocational Education and Training are to:

Facilitate economic development by transmitting to local citizen certain value, knowledge and attitudes that necessary to perform certain skill in modern sector of economy;

Provide young people with the skills needed for employment in a wide range of job categories including self employment and wage employment;

Promote a work ethic and sensitize learners to the importance of practical work skills and dignity of manual labour;

Promote sustainable development, save the environment and improve the quality of living;

Alleviate unemployment as well as poverty;

Reduce the mass movement of school learners from rural to urban area;

And provide an alternative route to higher academic education for secondary learners (page 5) .

Due to immerse impact of Technical and Vocational Education and Training (TVET) to the development of advanced or developed nations, countries in Africa invested in it. Henry, Jack and Getrude (2014) reported that in countries of sub Saharan Africa, in particular government are renewing efforts to promote TVET with the conviction that development of the skills enhances productivity and sustain competitiveness in the global economy. Specifically, Nigeria government invested in TVET programme through the establishment of technical colleges among others.

Technical college is a version of senior secondary schools that is established to produce young man power that can gain employment or create an enterprise. Abdulrauf (2012) defined technical colleges as institutions where specific knowledge and practical skills required for specific trade, employment or professional craftsmen, technicians, or similar level in business and industry are imparted or taught. Technical college give admission to students who have attained age of fourteen and above and successfully completed three years of junior secondary education or its equivalent (United National Education Social and Cultural Organization, UNESCO and National Board for Technical Education, NBTE (2001). UNESCO and NBTE (2001) claimed that the aim of technical colleges is to give training and impact the necessary skills leading to the production of craftsmen, technicians and other skilled personnel who will be enterprising and reliant. Various courses including electrical engineering trades are offering at technical colleges (Federal Republic of Nigeria, 2004).

Engineering is the field or discipline, practice, profession and art that relates to the development, acquisition and application of technical, scientific and mathematical knowledge about the understanding, design, development, invention, innovation and use of materials, machines, structures, systems and processes for specific purposes. Engineering, according to James (2008), is a profession in which knowledge of the mathematical and natural science gained by study, experience and practices are applied with the judgment to utilize economically natural and man -made materials. Thus, electrical engineering trade includes a profession where technical, mathematical and scientific knowledge, skill and attitude are acquired through study, experience and practice to develop, design, create, manufacture and repair system, device and appliance that use high and low electric power or signal. Electrical engineering trade according to Yekinni (2015) covers electricity/electronics subjects which includes series of tasks and skills which technical college (electrical/electronics) student are required to learn. The task and skills include appliance repair among others (Federal Republic of Nigeria, 2004).

Appliances are mechanically or electrically operated devices or machines used to perform specific task by transforming one energy to another. Frank (1978) defined appliances as utilization item of electric equipment usually complete in itself, generally other than industrial, normally built in standardize size or type that transform electrical energy into another form usually heat or mechanical motion, at the point of utilization. Also, Mark (2003) opined that appliances are pieces of equipment that draw electric or other energy and produce a desired work-saving or other result. Appliances exist in different form with different performance depending on their purpose of creation. In the process of appliances utilization, appliances become malfunctioning or faulty.

Fault is a deviation from a prescribed function of a system due to undesirable deviation in the property of a system. Fault according to Joseph (2009) is deviation between perfect performance and complete failure. Venkat; Raghunathan; Kewen and Surya (2003) opined that fault is generally defined as a departure from acceptable range of an observed variable as a calculated parameters associated with a process. Also, Rolf (1984) claimed fault as no permitted deviation of a characteristics property which lead to the inability to fulfill the intended purpose. A faulty or malfunctioning appliance occurs when the expected value of output is diminishing or equal to zero. Rolf (1984) claimed that plant is faulty when the limited value of measurable output signals is transgressed.

Malfunctioning or faulty appliances are most of time dumped into dustbin or abandoned in an unsecured area which is an act of resources mismanagement and thereby caused environmental pollution. The Environmental Protection Agency in Olaitan, Asogwa and Abu (2013) reported that about 50 million tons of electronics-wastes are produced every year especially from developing countries. Electronic waste in this content is electronics equipments, device, machine or appliances which are not functioning anymore because they are obsolete, or faulty. Thus, malfunctioning or faulty appliance can be revived if it is subjected to repair. However, this will reduce the act of electronics wastage.

Repair means the act of renewing, restoring or reviving a damaged item to sound condition. Frank (1978) defined repair as restoration or replacement of part or component of a material as necessitated by wear and tear, damage, failure or the like in other to maintain the specific item or material in efficient operating condition. Samson and Chris (2014) claimed that Repairs involves the activities taken for the restoration of a broken, damaged or failed component, device, equipment, part, or appliance to an acceptable operating or stable state. Thus, appliances repair means all routine action performed through which damage part or component of appliances are restored or replaced with the aim of restoring, reviving, renewing and maintaining the appliances

in a good operating condition. Appliances repairs are processes that involve examination of appliances, location and identification of faults In appliances and rectification of fault. Thus, appliances repair is basically fault detection and diagnosis (FDD).

Fault detection and diagnosis means monitoring the appliance to detect any failed or faulty components or part of appliances, quantifying the fault and determining its causes, assessing the sizes and the impact on system performance and finally making decision on how to respond to the fault. Fault detection and diagnosis according to Rolf (1984) is checking through a faulty/ malfunctioning system to see if a particular measurable or immeasurable estimated variables are within a certain tolerance of the normal value or not and location of the fault and establishment of the causes. Srinivas and Micheal (2005) claimed that the primary objectives of fault detection and diagnosis of a system is early detection of fault and diagnosis of their causes, enabling correction of faults before additional damage to the system or loss of services occurs. Fault detection and diagnosis of appliances connotes process of examining faulty/ malfunctioning appliances to locate and identify fault and their related causes, weighing the extent and consequences of the fault on the appliances performances and design appropriate decision to correct the identified fault using appropriate instruments to prevent additional damages on appliances and to prevent the occurrence of total loss of service to appliances.

The process of fault detection and diagnosis of appliances requires certain instruments for the task to be done effectively and efficiently. Instruments are tools, equipment or devices that are required to make some tasks easily accomplished. Stan (2001) claimed instrument to mean device for measuring electrical quantities or the performance of electronic equipment. Mark (2003) opined that instrument is a device for measuring and sometimes also recording and controlling the value of quantity under observation They are manipulated items needed to dismantle/assemble, test, measure, diagnose, repair and maintain safety during Fault detection and diagnosis of appliances. Thus, in Fault detection and diagnosis of appliances, specific safety, testing, measuring, dismantling/assembling and repairing tools, devices and equipments may be required.

Fault detection and diagnosis is a common term in industries with the aim of ensuring reliability and safety of industrial equipment. In houses and offices, where electrical and electronic appliances are use for social and commercial purposes among other, fault detection and diagnosis is also essential. The appliances may untimely breakdown due to personal, social and environmental factors. The faults or malfunctioning in appliance can be caused by poor handling, poor maintenance, poor design, age of an appliance, and inconsistence nature of Nigeria electricity. Luiz, Jefferson, Tiago, Marcelo, Eduado, and Renato (2011) claimed that hostile environment, poor operating condition, lack or insufficient maintenance, allied to an increasing occurrence of failures. Thus, fault detection and diagnosis is required to reduce electrical/electronic appliances waste. Gazette in Olaitan Asogwa and Abu (2013) opined that manufacturing companies such as Sony Erickson, Panasonic Motorola, Nokia and Samsung have certified that maintenance, servicing and repairing of electronics devices for re-use remain the best electronics waste management. The task of detecting and diagnosing fault on appliances lies on technicians. James (1994) opined that veteran equipment has worked at one time but because of a normal failure or abuse it no longer functions properly or has failed altogether. He stated further that majority of electronic technicians find employment in this kind of job.

Technical college students according to UNESCO and NBTE (2001) are training to become craftsmen, technicians and other skilled personnel who can be enterprising or gaining employment. Ohanu and Ogbuanya (2014) also stated that Technical colleges are concerned with production of technicians who are skilled in different fields of human endeavour. Thus, the task of fault detection and diagnosis of electrical /electronics appliances lies on technical colleges graduate specifically electrical engineering trade graduate of technical college called technicians. Technicians according to United Nations Educational, Scientific and Cultural Organization (2010) are those who involved in applying proven techniques and procedures to the solution of practical engineering problems. Author stated further that Technician: carry out supervisory or technical responsibility; are competent to exercise creative aptitudes and skills within defined fields of technology; contribute to the design, development, manufacture, commissioning, operation or maintenance of products, equipment, processes or services; and create and apply safe systems of work.

Ibezim, Ohanu and Shodeinde (2014) asserted that Electronics technicians are mostly trained in the technical colleges trained to carryout repair of electronic gadget/ appliances. Most of technicians in Nigeria are not so skilled on fault detection and diagnosis of all electrical /electronics appliances. This may be due to inadequate provisions of the skill requirements in the curriculum running in technical colleges. Ohanu (2012) stated that most electronic technicians lack knowledge and skills required to service, diagnose faults, and repair of electronics appliances such as LCD televisions.

For the goal of technical colleges to be well acknowledged, technical colleges ought to be upgraded and built with adequate capacity that will enhance them to give and inculcate adequate training and skills on fault detection and diagnosis to electrical engineering trade students.

Training is a process of subjecting learners into series of activities both practical and theories for such learner to gain competency in a specific occupational area. Olayiwola and Onaolapo (2000) claimed that training

is a process of imparting to someone the skills to perform some operations or set of operations (mental/ physical). Training according to Onuka (2008) is a skill acquisition process through which learners are taught new knowledge and skills and how to apply them. The author stated further that the objective of training individuals in an occupation is to assist them to acquire professional skills for establishing and or improving their business. Thus, technical college is required to subject students specifically electrical engineering trade students to standard learning experience (curriculum) that will enhance skill, knowledge and attitude of electrical/electronics student on fault detection and diagnosis of appliances. This will empower technical college graduates better in Nigerian society. However, the duty of imparting necessary skills and training at technical colleges' level lies on the hand of technical college teachers and workshop technologists.

Teachers are trained individuals who are professionally qualified to disseminate knowledge, skills and worthwhile value to learners with the aim of bringing positive changes in them. Ogbaunya and Usoro (2009) explained that technical teachers are those who obtained technical training/theories and practice of education that are related to the advancement of knowledge, skills and attitude among youths, who will later use the knowledge and skills acquired to improve and solve environmental problems. Teachers at technical colleges' level implement curriculum at the classroom level. However, technologists are trained individuals who are very verse practically and make use of mathematical and scientific principles and available materials to develop, design, create, manufacture and repair system, device and appliance. United Nations Educational, Scientific and Cultural Organization (2010) claimed technologist as those who will: exercise independent technical judgment at an appropriate level; assume responsibility, as an individual or as a member of a team, for the management of resources and / or guidance of technical staff; and design, develop, manufacture, commission, operate and maintain products, equipment, processes and services.

They help technical colleges' students during on-the-job training, internship and apprenticeship program which (Ogbuanya and Abdullahi, 2014) termed school to work transition. Thus, teachers and other workshops instructors guided technical students in acquiring knowledge and practical skills in line with approved curriculum whereas technologist introduced students on training to real world of work.

Problem of the study

Technical college is design to graduate technicians who are very competent and skillful, among others, in maintenance and repair of electrical/electronics appliances using at various home in Nigeria.

The information obtained from users of appliances affirmed that number of appliances have been wasted or dumped unjustly in an unsecured environment. This is because competent technicians who can handle and repair appliances are very scarce and limited. Electrical engineering trade students of technical colleges are taught basically how to repair radio and television. Other appliances repair and maintenance have not gain any recognition in the curriculum of technical colleges in Nigeria.

Secondly, those road side technicians who are claiming to be competent in appliances repair and maintenance are undoubtedly not. They base their operation on try and error methods which in most of the time fail and expensive. This is because they do not receive standard training on fault detection and diagnosis of electrical/electronics appliances.

To stop untimely wastage and unjust dumping of appliances technical colleges need to graduate technicians who are very competent in fault detection and diagnosis of electrical/electronics appliances. This is therefore the focus of this paper.

Purpose of the study

The general purpose of this study was to investigate the fault detection and diagnosis of electrical/ electronics appliances training requirement of technical colleges as a tool for empowering electrical/electronics trade students. Specifically, the study sought to:

Examine required skills for fault detection and diagnosis of electrical/ electronic appliances for the training of electrical/ electronic technical college students in Nigeria.

Examine required instruments for fault detection and diagnosis of electrical/ electronic appliances for the training of electrical/ electronic technical college students in Nigeria

METHODOLOGY

The study adopted descriptive survey research design. The study was conducted in Oyo and Ogun states, Nigeria. The population for the study was ninety two (92) technical college teachers and technologists. The population comprised of forty two (42) electrical/electronics teachers in technical colleges in Ogun state and twenty four (24) electrical/electronics teachers in technical colleges in Oyo states. In addition, 24 electrical/electronic technologists were sampled from the two states using purposive sampling techniques. The entire sixty six electrical/electronics teachers in technical colleges in two states and 24 electrical/electronics technologists sampled were used for the study.

The instrument used for data collection from respondents was a structured questionnaire. The questionnaire contained one hundred and fifty three (153) items which was used to obtain information from electrical/electronics teachers in technical colleges and electrical/electronics technologists in Oyo and Ogun states. The questionnaire was divided into three sections: A, B and C. Sections A was used to seek personal information from electrical/electronics technical college teachers and electrical/electronics technologists. Section B and C consisted of items relevant for answering the research questions posed for the study. Section B and C of the questionnaire was structured on six-point rating scale with value as 6, 5, 4, 3, 2, and 1 in descending order. The response options for the section B and C of the questionnaire were: Very Highly Required (VHR) – 6, Highly Required (HR) – 5, Required (R) – 4, Not Required (NR) – 3, Highly Not Required (HNR) – 2 and Very Highly Not Required (VHNR) – 1.

The questionnaire was validated by three experts. Cronbach Alpha method was used to determine the internal consistency of the questionnaire items. Thus, a reliability coefficient of 0.89 was obtained which means that the instrument was reliable for the study.

Ninety two copies of questionnaire were administered to the respondents by the researcher with the help of two research assistants through personal contact with the technical college teachers and technologists in Oyo and Ogun States.

The data collected for this study were analyzed using mean and standard deviation. The decision rule for section B and C of questionnaire were based on the mean benchmark (cut off point) of 3.50. Thus, for section B and C, any item with mean of 3.50 or above was considered required; whereas any item with a mean below 3.50 was considered not required

Result

The presentation and analysis are done in tables and arranged according to the research questions posed for the study.

Research Question 1: *What are the* required skills for fault detection and diagnosis of electrical/ electronic appliances for the training of electrical/ electronic technical college students in Nigeria*?*

Table 1:

Mean ratings and standard deviation of Responses of technical college Teachers and technologist on required skills for fault detection and diagnosis of electrical/ electronic appliances for the training of electrical/ electronic technical college students in Nigeria.

S/N	SKILLS FOR FAULT DETECTION AND DIAGNOSIS OF ELECTRICAL/ ELECTRONIC	Teacher Mean1	Technologists Mean 2	AGGREGATE mean	SD	REMARKS
1	Ability to diagnose appliances' components	4.82	4.92	4.85	0.78	Required
2	Ability to undertake fault diagnosis of entire appliances.	5.02	5.08	5.03	0.67	Required
3	Ability to detect faulty components	4.95	5.08	4.99	0.65	Required
4	Ability to isolate fault	5.03	5.12	5.05	0.67	Required
5	Ability to make proper evaluation of fault for proper estimation of cost.	5.06	5.08	5.07	0.63	Required
6	Ability to handle and work with multiple technologies	5.17	5.27	5.20	0.60	Required
7	Ability to keep up to date with new technology and performance issue	5.33	5.23	5.23	0.65	Required
8	Ability to use protective equipments that are required during fault detection and diagnosis process	5.23	5.15	5.21	0.66	Required
9	Ability to carry out first aid requirement in case of an accident during repair process	5.17	4.92	5.10	0.70	Required
10	Ability to understand the functions, features and working principles of appliances	5.24	5.00	5.17	0.66	Required
11	Ability to understand procedure for dismantling and assembling appliances under repair	5.09	5.00	5.07	0.68	Required
12	Ability to understand range of tools and testing equipment needed for fault detection and diagnosis process and their functionality	5.09	5.08	5.09	0.67	Required
13	Ability to understand standard fault finding techniques	5.08	5.19	5.11	0.69	Required
14	Ability to use basic computer knowledge to be able to run diagnostic tools and equipment	5.00	4.96	4.99	0.67	Required
15	Ability to understand the function of hardware component and software application that are required to be used during repair process	5.05	4.88	5.00	0.65	Required
16	Ability to display and use standard repairing process	4.98	4.92	4.97	0.64	Required
17	Ability to carry out operational performance test	5.03	4.96	5.01	0.65	Required
18	Ability to operate testing and measuring tools/equipment.	5.08	4.96	5.04	0.59	Required
19	Ability to connect appliance to PC/test equipment for diagnosis	5.08	4.92	5.03	0.69	Required
20	Ability to interpret test results to identify and localize faults	4.95	4.88	4.93	0.68	Required
21	Ability to use appropriate mechanisms and tools to rectify	4.91	4.77	4.87	0.63	Required

	faults					
22	Ability to use appropriate communication channels to relay or report unresolved problems	4.97	4.88	4.95	0.64	Required
23	Ability to test appliances to confirm and resolve the reported fault	5.08	5.00	5.05	0.58	Required
24	Ability to undertake corrective repairing process using software porting/updates	5.06	5.19	5.09	0.63	Required
25	Ability to check appliances to confirm that the problem is resolved	5.03	4.81	4.96	0.69	Required
26	Ability to safely dismantle/assemble appliance using the right tools	5.00	4.81	4.95	0.75	Required
27	Ability to safely remove and replace components using right tools	5.00	4.96	4.99	0.69	Required
28	Ability to understand correct way of approaching a defect on appliances.	5.03	5.00	5.02	0.68	Required
29	Ability to interpret intermediate result and progress to fault rectification accordingly	4.97	4.96	4.97	0.70	Required
30	Ability to read and understand technical manuals, working order and reports	5.05	4.96	5.02	0.66	Required
31	Ability to read and understand appliance safety instruction	5.06	4.96	5.03	0.64	Required
32	Ability to fill up record sheets clearly, concisely and accurately as per company procedures	5.05	4.92	5.01	0.60	Required
33	Ability to clearly communicate relevant information to client	5.05	5.00	5.03	0,62	Required
34	Ability to make appropriate enquiry on appliance	5.08	5.00	5.05	0.62	Required
35	Ability to use information from enquiry or repair	5.06	5.08	5.07	0.64	Required
36	Ability to prioritize and execute task in a high pressure environment	5.05	5.00	5.03	0.69	Required
37	Ability to use and maintain resources efficiently and effectively	5.08	4.96	5.04	0.61	Required
38	Ability to analyze and understand manufacturing process of appliances	5.11	5.08	5.09	0.66	Required
39	Ability to interpret reports, reading and numerical data	5.15	5.08	5.13	0.62	Required
40	Ability to create and maintain affective working relationship and team environment through collaboration	5.15	4.96	5.10	0.66	Required
41	Ability to share knowledge concerning equipment with other team member and colleagues.	5.09	4.73	4.99	0.73	Required
42	Ability to apply theoretical knowledge of electrical electronic components on repairing and diagnosis.	5.12	4.81	5.03	0.78	Required
43	Ability to use soldering and de-soldering techniques	5.08	4.69	4.97	0.72	Required
44	Ability to use soldering pump	5.09	4.81	5.01	0.73	Required
45	Ability to understand soldering requirement	5.21	4.92	5.13	0.71	Required
46	Ability to use soldering iron safely and effectively	5.20	5.12	5.17	0.69	Required
47	Ability to understand installation / handling instruction of appliance	5.17	5.12	5.15	0.71	Required
48	Ability to understand and apply symbols of electrical/ electronic components	5.15	5.12	5.14	0.70	Required
49	Ability to understand various methods of testing electronics component and equipments.	5.15	5.23	5.17	0.69	Required
50	Ability to carry out fault detection and diagnosis through circuit diagram	5.09	5.27	5.14	0.70	Required
51	Ability to remove and replace faulty component	5.05	5.27	5.11	0.67	Required
52	Ability to keep/ store tools/equipments used during fault detection and diagnosis process in a good condition	5.09	5.19	5.12	0.71	Required
53	Ability to go online and search for manufacture data base as regards appliance details	5.12	5.23	5.15	0.63	Required
54	Ability to relate certain symptom to certain fault on appliance	5.14	5.19	5.15	0.59	Required
55	Ability to confirm fault before dive in to the repair	5.12	5.12	5.12	0.61	Required
56	Ability to take proper note of the position of each component of appliance when dismantling complex or high precision appliance	5.20	5.12	5.17	0.59	Required
57	Ability to keep dismantling component in a well secured area	5.23	5.12	5.20	0.63	Required
58	Ability to locate appropriate working area for the job	5.24	5.12	5.21	0.60	Required
59	Ability to work safely and complying with health and safety and other relevant regulations guidelines	5.23	5.08	5.18	0.66	Required
60	Ability to review and use relevant information on the symptoms and problem associated with the appliance	5.20	5.12	5.17	0.69	Required
61	Ability to investigate and establish the most likely causes of the faults	5.20	5.08	5.16	0.72	Required
62	Ability to select, use and apply diagnosis techniques, tools and aids to locate faults	5.21	5.12	5.18	0.68	Required

63	Ability to complete the fault diagnosis and detection within the agree time and inform the appropriate people when they cannot be achieved	5.18	5.15	5.17	0.66	Required
64	Ability to determine the implications of the faulty equipments on other work and for safety consideration	5.12	5.00	5.09	0.67	Required
65	Ability to use the evidences gained to draw valid conclusion about the nature and probable cause of the fault	5.09	5.04	5.08	0.68	Required
66	Ability to record details of the extent and location of the faults in an appropriate format	5.11	4.92	5.05	0.67	Required
67	Ability to understand specific safety precaution to be taken when working with appliance	5.08	4.85	5.01	0.64	Required
68	Ability to understand code of practice that apply to the type of appliance diagnosing and repairing.	5.11	4.81	5.02	0.74	Required
69	Ability to understand and apply customer care procedure and techniques	5.11	4.96	5.07	0.69	Required
70	Ability to understand risk of fault reoccurrences and how to minimize it.	5.05	5.04	5.04	0.69	Required
71	Ability to understand hazards associated when carrying out fault diagnosis on appliance and how they can be minimized	5.00	5.04	5.01	0.69	Required
72	Ability to understand, use and evaluate the various type of aids, reports and information available for fault detection and diagnosis	4.86	4.85	4.86	0.67	Required
73	Ability to understand procedure to be adopted to establish the background of the fault	4.92	4.96	4.93	0.68	Required
74	Ability to clear waste and restore good working area after fault detection and diagnosis process.	4.89	5.04	4.93	0.74	Required
75	Ability to reconnect and check terminals to ensure that they are electrically and mechanically sound.	4.89	4.96	4.91	0.74	Required
76	Ability to repair and replace faulty worn and damaged components effectively.	4.97	4.92	4.96	0.74	Required
77	Ability to carry out analysis of evidence and evaluate possible characteristics and causes of specific fault/problem	4.98	4.96	4.98	0.73	Required
78	Ability to relate previous report/records of similar fault conditions	4.95	4.92	4.95	0.72	Required
79	Ability to calibrate electrical testing instrument and check that they are free from damage and defects	5.02	5.00	5.01	0.69	Required
80	Ability to obtain and interpret drawings, circuit, physical layout , charts, specifications, manufacture's, history/ maintenance report, graphical electrical symbols, IEE wiring regulations and other document needed in service process	5.03	5.08	5.04	0.59	Required
81	Ability to prepare a report or take follow up action which satisfies the circuit need to ensure a good, properly bonded earth for the appliance	5.06	5.04	5.05	0.60	Required
82	Ability to understand basic principles of how the appliance functions, the operating sequence, the purpose of individual units/ components and how they interact	5.05	4.96	5.02	0.59	Required
83	Ability to understand and apply service requirement of the product	5.05	4.96	5.02	0.59	Required
84	Ability to demonstrate lab safety at all times	5.08	5.04	5.07	0.59	Required
85	Ability to source, obtain and use historical behavioral data of appliances under monitoring	5.05	4.92	5.01	0.65	Required
86	Ability to refer complicated work to other experts when one is not capable of repairing appliances.	5.06	4.92	5.02	0.66	Required

The data represented in Table 1 revealed that the mean responses of Technical college teachers and Technologies ranged from 4.82 to 5.27 and 4.69 to 5.27 respectively. The aggregate mean responses ranged between 4.85 and 5.23 while the aggregate values of the standard deviation ranged between 0.57 and 0.78. The table indicated that all skills for fault detection and diagnosis of electrical/electronics appliances highlighted for technical colleges were required. The standard deviation range values implied that the opinion of technical college teachers and technologists were very close and similar.

Research Question 2: *What are the* required instrument for fault detection and diagnosis of electrical/ electronic appliances for the training of electrical/ electronic technical college students in Nigeria*?*

Table 2:
Mean ratings and standard deviation of Responses of technical college Teachers and technologist on required instrument for fault detection and diagnosis of electrical/ electronic appliances for the training of electrical/ electronic technical college students in Nigeria.

S/N	INSTRUMENTS (TOOLS/ EQUIPMENT) FOR FAULT DETECTION AND DIAGNOSIS	TEACHER Mean1	TECHNICIAN Mean2	AGGREGATE Mean	S.D	Remarks
	TEST, MEASURING AND DIAGNOSTIC TOOLS, DEVICE AND EQUIPMENT					
1	Microscope/ magnifying lens	5.06	4.88	5.01	0.67	Required
2	Measuring tape / Steel rule	4.95	4.57	4.85	0.78	Required
3	Signal Generator	4.94	4.81	4.90	0.74	Required
4	Wire gauge.	5.00	4.92	4.98	0.68	Required
5	personal computer	5.08	4.96	5.04	0.66	Required
6	cable length metre	5.05	4.96	5.02	0.66	Required
7	capacitance metre	5.09	4.92	5.05	0.67	Required
8	conductivity metre	5.07	4.88	5.02	0.71	Required
9	electric tester	5.15	4.80	5.03	0.73	Required
10	electrostatic metre	5.06	4.85	5.00	0.80	Required
11	Frequency metre	5.19	4.97	5.10	0.73	Required
12	insulation metre	5.82	4.18	5.05	0.76	Required
13	Neon tester	5.14	5.12	5.13	0.73	Required
14	Magnetometer	5.03	4.99	5.00	0.74	Required
15	monitoring system	5.11	5.00	5.08	0.49	Required
16	photovoltaic metre	5.22	5.02	5.12	0.71	Required
17	Resistance inductance and capacitance (RLC) metre	5.17	5.27	5.20	0.74	Required
18	logic analyzer	5.19	5.41	5.30	0.75	Required
19	Signal tracer	5.15	5.31	5.20	0.70	Required
20	Oscilloscope	5.11	5.19	5.13	0.68	Required
21	test light	5.25	5.05	5.14	0.66	Required
22	transistor tester	5.08	4.83	5.01	0.67	Required
23	watt metre	5.05	4.88	5.00	0.70	Required
	ASSEMBLING, DISMANTLING AND REPAIRING TOOLS/ EQUIPMENTS					
24	Screw drivers	4.95	4.96	4.96	0.66	Required
25	Strippers	4.94	5.08	4.98	0.68	Required
26	Hammers	5.06	5.12	5.08	0.70	Required
27	Cutters	5.02	5.18	5.11	0.73	Required
28	Hacksaws	5.06	5.04	5.05	0.73	Required
29	Mallets	5.09	4.01	5.05	0.76	Required
30	Spanners (flat, ring, socket)	5.05	4.88	5.00	0.77	Required
31	Files	4.95	4.77	4.90	0.74	Required
32	Chisels	4.91	4.92	4.92	0.77	Required
33	Taps and dies	5.05	5.12	5.07	0.78	Required
34	Drills (manual, electric)	4.97	5.12	5.01	0.76	Required
35	Reamers	4.92	5.11	4.97	0.75	Required
36	Knives	4.97	5.23	5.04	0.70	Required
37	Centre punch	4.94	5.15	5.00	0.70	Required
38	Brush	4.92	5.00	4.95	0.75	Required
39	Spirit	4.98	4.88	4.96	0.74	Required
40	Pliers	5.01	4.89	4.98	0.73	Required
41	Blowing	4.94	5.12	4.99	0.89	Required
42	Hard and flexible boards	4.94	5.04	4.97	0.69	Required
43	Adjustable dc power supply	4.97	4.96	4.97	0.65	Required
44	Soldering lead	5.00	4.96	4.99	0.64	Required
45	Insulation varnish	4.98	4.96	4.98	0.61	Required
46	Soldering iron	5.01	5.93	4.99	0.73	Required
47	Lead sucker	4.92	4.88	4.91	0.77	Required
48	Soldering Bit	4.92	4.88	4.21	0.72	Required
49	Clamp	5.06	4.92	5.02	0.75	Required
50	Work bench	5.03	5.09	5.05	0.75	Required
51	Winding Machine	5.06	5.08	5.07	0.72	Required
	SAFETY TOOLS/ EQUIPMENTS					
52	Fire extinguisher	5.05	5.27	5.11	0.70	Required
53	Sand bucket/ Flame retardant clothing/ Fire	5.05	5.19	5.09	0.67	Required

	blanket					
54	Safety posters	5.03	5.15	5.07	0.72	Required
55	Safety helmet	5.09	5.19	5.12	0.66	Required
56	Ear protection	5.05	5.07	5.05	0.65	Required
57	Nose protective equipment	4.50	5.55	5.03	0.70	Required
58	Safety boot	4.19	5.79	4.99	0.69	Required
59	Safety gloves	5.00	4.92	4.98	0.73	Required
60	Safety overall	5.09	4.84	5.02	0.73	Required
61	Face protection equipment	5.06	4.81	4.99	0.72	Required
62	First aid box	4.98	4.85	4.95	0.75	Required
63	Safety Symbols/Signs	4.93	4.92	4.93	0.72	Required
64	emergency telephones	4.39	5.47	4.96	0.71	Required
65	Safety alarm	5.01	5.04	4.02	0.70	Required
66	Hand glove	5.19	4.94	5.04	0.69	Required
67	Fire detector/ Temperature controlling equipment	5.07	5.16	5.12	0.70	Required

The data presented in Table 2 revealed that the mean responses of technical college teachers and Technologists ranged from 4.19 to 5.82 and 4.01 to 5.93 respectively. The aggregate mean responses ranged between 4.02 and 5.30 while the aggregate values of the standard deviation ranged between 0.30 and 0.89. The table indicated that all instruments (tools/equipments) for fault detection and diagnosis of electrical/electronic appliances highlighted for technical colleges required. The reason was that the mean ratings above the benchmark (cut off point) of 3.50.

Discussion of the findings

The findings of the study revealed that eighty six skills for fault detection and diagnosis of electrical/electronic appliances are required for training Technical college students in Nigeria. These required skills according to technical colleges teachers and technologists include: ability to detect faulty components, ability to diagnose appliances components, ability to work with multiple technologies and keep up to date with new technologies, ability to understand various ways of testing appliances component, ability to interpret reports, readings and numerical data among others are required for the training of electrical/electronics students in technical colleges. The findings are in line with the findings of Ibezim, Ohanu and Shodeinde (2014) who claimed that the skill required in identifying audio faults in mobile phones is ability to identify either the earpiece is working or not or there is distorted sound from the earpiece. The findings are also in support of Samson and Anthony (2015) work who remarked that technical college students required ability to test capacitors, diode, transistor with millimeter; assembling and disassembling home theatre player.

The result of the finding also revealed that all the sixty seven instruments (into test, measuring and diagnostic tools and equipment; assembly dismantling and repairing tools and equipment and safety tools and equipment) for fault detection and diagnosis of electrical/electronics appliances are required for the training of technical college students in Nigeria. The tools and equipments include: magnifying lens, oscilloscope, personal computer, screwdrivers, drills soldering iron, fire extinguishers, and first aid box among others. The findings correspond with Samson and Anthony (2015) work who revealed that soldering iron, drilling, Allen key, signal generator, hand glove and oscilloscope among others are the necessary tools and equipments for the corrective maintenance of DVD home theatre sound system. The findings are also in line with Nwachukwu, Bakare and Jika (2011) work who reported that wearing of hand gloves while working in laboratory and make use of recommended extinguisher in the laboratory are safety practice skills required by electrical/electronic students in working in the laboratories of Technical colleges in Ekiti state.

Conclusion

Nigeria is rated among the country where issue of unemployment is reoccurring. The reason according to series of report is lack of adequate skills required by youths to gain employment or to be self dependent or self employed. To resolve unemployment issues in Nigeria, youths need to undergo training which will equip them with necessary skills that will enable them to gain entry to and progress in a selected occupation or which will enable them to be self employed. However, the study identified required skills for the training of technical college students in Nigeria. The study also identifies required instruments for the training of technical college students in Nigeria.

Recommendation

In line with the findings of the study, the following recommendations were made:

Necessary effort should be made by stakeholders of education and curriculum development to integrate the relevant skills on fault detection and diagnosis of electrical/electronic appliances into the curriculum of electrical/electronic students of technical colleges of Nigeria.

Necessary attempt should be made by government to equip electrical/electronics workshop in technical colleges with adequate tools and equipment which are necessary to train students on fault detection and diagnosis of electrical/electronics appliances.

Competent workshop technologists should be employed into electrical/electronics workshop of technical colleges in Nigeria.

Teachers in technical colleges should also be given training regarding teaching of appliances repairs.

Adequate supervision and monitoring should always be planned and implemented by teachers and technologists of electrical/electronics anytime students are in practical section of their training.

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