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The Validity and Reliability of Developing Assessment Instruments for Students in Electrical Installation and Maintenance Work: Concentration on Psychomotor Skills Assessment

Surajudeen Rotimi ADELAJA & Fatai Oladotun DAHUNSI

Department of Electrical and Electronics, College of Information and Technology Education, Lagos State University of Education, Lagos Nigeria

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Abstract: Electrical installation and maintenance work is one of the trades in the curriculum of technical colleges. For the proper installation of electrical appliances, pupils are expected to develop psychomotor skills. Only the cognitive component of electrical installation work is evaluated by the NAtional Business and Technical Examination Board (NABTEB). According to the study, even though students graduate with good GPAs, they lack psychomotor abilities. Therefore, using flawed and unreliable instruments results in inaccurate assessments of pupils' improvement of psychomotor skills. Therefore, the study established the practical tasks in electrical installation and maintenance work to be completed by the students, validated the developed process assessment instrument in electrical installation and maintenance work, and also proved the reliability of the progressed process evaluation instrument in electrical installation and maintenance work. The developed instrument has provided a readily available process assessment instrument of high quality for the study. The following actions were advised for adoption by the study:1. For the purpose of certifying students, the external examination boards (NABTEB, NECO, and WAEC) should incorporate electrical installation and maintenance work skill assessment instrument items into their examinations.2. To train teachers of electrical installation and maintenance work how to apply the established electrical installation and maintenance work skill assessment instrument, the government should host seminars and workshops. 3. Technical education evaluators should examine their curricula, organize the material into pertinent activities, and create exams like to them in their particular subject areas using electrical installation and maintenance work skill evaluation instruments. 4. To evaluate students in electrical installation and maintenance work that is related to construction, teachers of electrical installation and maintenance work should be encouraged to use the created electrical installation and maintenance work skill evaluation instrument.

Keywords: Electrical installation and maintenance work, Assessment Instruments, Validity, Reliability, Psychomotor Skills

I. Introduction

One of the trades covered in the curriculum of technical colleges is electrical installation and maintenance work, where students are required to develop the psychomotor skills necessary for efficient electrical appliance installation and maintenance. The methodology and procedures used by the NAtional Business and Technical Examination Board (NABTEB) to evaluate students' psychomotor skills in electrical installation and maintenance work do not accurately reflect the actual number of skills that students have acquired in this field. This inspecting body has been using a marking system checklist as a product evaluation technique. Only the cognitive aspects of electrical installation and maintenance work are assessed by the NABTEB. This approach has allowed for end-product evaluation without the development of pupils' psychomotor abilities. It is essential that teachers have more understanding of the many evaluation techniques that can be used to ensure impartiality and fair judgment in a vocational and technical education program like electrical installation and maintenance work. Utilizing faulty and unreliable tools results in inaccurate assessments of pupils' progress in psychomotor skills. The study's flaw is that electrical installation and maintenance work students graduate with excellent grades and marks on their final exam, but they still lack the psychomotor competence needed to do practical tasks. The classical test theory and the Simpson psychomotor theory/model serve as the foundation for the current study. Traub introduced the traditional test theory in 1997. This theory is a collection of connected, logically organized, and interconnected psychometric claims. These hypotheses are employed to forecast the results of psychological tests, including the difficulty of the items and the aptitude of the most recent test-takers. The traditional test theory makes the assumption that item attributes are depending on context or sample. As a result, the sample of examinees under consideration will affect the p-value, mean, standard deviation, standard error, skewness, kurtosis, and other indices. The Simpson psychomotor model was created in 1972 in a similar manner. According to Simpson (1972), the psychomotor domain is focused on how muscles develop and are used, as well as how well the body can coordinate its motions. Simpson suggested a seven-category or seven-level classification scheme, some of which are further subdivided. From perception to origination, each succeeding category necessitates a higher level of

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expertise from a simple to a complicated set of skills. The taxonomy Simpson (1972) used to classify the psychomotor domain was usually viewed as the more palatable one because it dealt with physical behaviour.

The National Business and Technical Examination Board assesses student proficiency or learning outcomes in electrical installation and maintenance work in order to grant National Technical Certificates (NTC) and Advanced National Technical Certificates (ANTC). According to the National Board for Technical Education (NBTE), electrical installation and maintenance work at Nigerian technical schools is designed to produce craftsmen with the knowledge and abilities needed to satisfy the demands of industries and society at large. For instance, technical institutions provide training for craftspeople in home and industrial installation, among other fields. According to Akinduro (2006), students gain the fundamental practical skills necessary to install, operate, maintain, and repair electrical and electronic equipment and machinery in electrical installation and maintenance work. The students are required to learn the fundamentals of problem discovery and diagnosis, cable termination, soldering and de-soldering of cable and joint connections, and the use of various diagnostic procedures. The following were listed as the goals of electrical installation and maintenance work by NBTE (2007): to carry out domestic and industrial electrical installation works with expertise; to identify and fix faults in home and business appliances; to perform various tests on new and existing electrical installation; to install and rewind electrical machines and other portable electrical devices; and to interpret electrical working drawings and manuals. Technical colleges could use a valid and effective assessment tool to assess whether these goals have been met. Technical colleges offer opportunity to master electrical installation and maintenance knowledge and abilities as well as to create a personality for practical living.

As learning outcomes that a student has gained at the conclusion (or as a result of) his or her participation in a specific set of learning experiences, mastery of knowledge and skills can be considered. Roy (2014) asserts that learning outcomes are more concerned with student accomplishments than instructor intentions (represented in the goals of a module or course). According to Lile & Bran (2014), the need that society has expressed to acquire skilled graduates in a variety of domains of activity has increased the concern for the assessment of learning outcomes in the present. A psychomotor skill is any aptitude whose operation necessitates the integration of cognitive and motor processes, according to Nugent (2013). Psychomotor skills do not involve physical responses like sneezing and take some work to become proficient. According to Okorie (2004), the development of psychomotor abilities permits individual students or workers to carry out a variety of duties in a profession. According to Ikpe (2009), the ability to interpret external sensory cues along with the muscular sensations involved in the activity is what determines how well one performs psychomotor tasks. Therefore, the psychomotor skills in electrical installation and maintenance work are typically assessed using assessment tools that reflect all levels of Simpson's taxonomy: perception, set, guided response, complex overt response mechanism, adaptation, and origination (Olaitan, 2013). According to Williams (2009), a teacher needs an appropriate tool to assess the psychomotor skills of the students. Moskal (2013) found that, in contrast, there was a lack of relevant and trustworthy tools for evaluating the practical abilities picked up by technical college students during practical work in electrical installation and maintenance. According to Olaitan (2013), teachers of vocational and technical education frequently ignore the evaluation of the processes involved in their students' practical work in favour of focusing solely on the finished product. Garba (1993) attributed this unfavourable trend to the absence of standardized tools for evaluating the procedures used in carrying out students' practical projects. In (2017), Onoh & Onyebuenyi said that the development of skills, particularly in the electrical installation and maintenance trades, will undoubtedly result in the creation of jobs and a greater sense of self-reliance, as unemployment is a sign that technical college graduates lack marketable abilities. The validity and reliability of the scales employed in the research, according to Sürücü & Maslakç (2020), are crucial components that allow the research to produce useful results. For this reason, it is helpful to comprehend how researchers appropriately measure the validity and reliability of the scales.

Assessment can be used to describe the measurement of students' learning outcomes in tasks like electrical installation and maintenance. Adiran (2012) defined evaluation as the process of generating an opinion after thoroughly considering something or someone. Aggarwal (2007) defined evaluation as the process of generating decisions that will be applied to future planning. Nwachukwu (2006) defined assessment as the consideration and evaluation of pupils' abilities and competence. Teachers or other responsible parties frequently conduct assessments in closed spaces like classrooms, halls, internet cafes, workshops, or laboratories. In order to improve future performance and learning outcomes, assessment gives feedback on knowledge, abilities, procedures, qualities, attitudes, and work products (Bukar, 2006). The assessment method that asks test-takers to choose each answer from a list of predetermined possibilities is the most well-known. According to Robert (2016), such an assessment is referred to as a "selected-responses assessment" since the test-taker selects an answer from a list of options rather than coming up with an original response. A student may also be required to create their own reaction to a stimulus, or prompt, as part of an assessment. Constructed-response assessment refers to this kind of evaluation, such as one that calls for an essay or a solution to a mathematical puzzle (John, 2017). To evaluate a person's work performance or a student's learning outcomes, both selected and built response evaluations are used. Therefore, assessment refers to a process or action used by an individual, a group of individuals, or an examination body to assess how well pupils execute and achieve learning objectives in electrical installation and maintenance work. So how do you

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evaluate the validity and reliability of the evaluation tool? According to Elias (2021), validity is divided into four categories: construct, criterion-reference, content, and face.

The degree to which the items in the process skills assessment instrument measure the learning objectives is known as construct validity. It concerns how accurately a test assesses the idea it was intended to assess. It's essential to proving a method's general validity. When researching something that cannot be immediately measured or witnessed, such as intelligence, self-confidence, or pleasure, assessing construct validity is extremely crucial. To quantify those components, a researcher must use a variety of observable or quantifiable indicators or else face the danger of injecting study bias into their findings (Bhandari, 2023). Construct validity, according to Muhammad (2006), entails connecting a test to a larger theoretical framework to guarantee that the test is truly logical to other concepts in the framework. Construct validity basically examines how well test score variations match up to hypotheses about a person's traits that are based on an underlying theory or construct. The exam or assessment based on a hypothesis about the skills, abilities, or attributes yields nothing in the fields of electrical installation, cable junctions and termination, electrical machine operation, and wind activities.

By contrasting a measuring technique with another that has been shown to be valid, a measuring procedure's accuracy can be proven by using criteria-reference validity, according to Enyi (2009). In this context, criterion-related validity refers to the degree to which items in the process skills assessment tool indicate the level of student performance that can be seen to be both acceptable and sustainable in the field or workplace. The correlation of an instrument with reputable external measures with comparable goals and requirements was a component of criterion-related validity. Similar to what Stedman (2006) stated, performance on a test or procedure's ability to predict performance in a real-world setting.

It is determined by the instrument's face validity if it appears to be measuring the study's target construct. It establishes how accurately the instrument seems to measure the target value. Face validity is defined as what a tool or test seems to measure on the surface. According to Anyakoha (2009), a test is considered to have face validity if it appears to be measuring what it is intended to assess. The degree to which test items look to assess what they are supposed to measure is referred to as face validation. Although, face validity cannot be determined empirically, it is significant when administering tests or using instruments. Students who take the test believe it measures what it is intended to assess; hence, they may become more motivated and cooperative, while poor scorers may experience less dissatisfaction. Thus, the degree to which the items in the process skills assessment instrument seem to measure the process skills in the curriculum for electrical installation and maintenance work for technical college students is known as face validity.

The degree to which an assessment tool delivers steady and consistent results is known as the reliability of the assessment instrument. Ombugus (2013) defined dependability as an instrument's capacity to yield the same score from the same student during various administrations under the same circumstances. Test-retest, parallel forms, internal consistency, and inter-rater reliability analyses can all be performed. Internal consistency is a metric of dependability used to assess how closely results from various test items that examine the same construct match up. A reliability measure called inter-rater reliability is used to determine how closely various judges or raters agree on their assessments. Because human observers do not always interpret responses in the same way, inter-rater reliability is important (Cozby, 2004). According to Ombugus (2013), inter-rater reliability is a gauge of how closely various judges or raters agree when evaluating the process abilities of electrical installation and maintenance students. However, one of the crucial characteristics an assessment tool must have is reliability in order to accurately test students' psychomotor abilities in electrical installation and maintenance work. Students will be taught the right technique to do tasks and operations if a valid and trustworthy instrument is used to test them in electrical installation and maintenance work.

The capacity to complete tasks as expected demonstrates skill. Skills come in a variety of forms. Technical, vocational, occupational, work-related, productive, practical, and psychomotor skills, for instance, are necessary to carry out given tasks in technical and vocational education. Electrical installation and maintenance work is one of the trades in technical education where psychomotor skill is learned or required for the job. Electrical installation and maintenance practice students are expected to install, maintain, and repair any electrically electrified systems, such as residential and commercial installations, claims Akinduro (2006). Thus, in order for pupils to graduate from electrical and installation maintenance job, psychomotor skills are a requirement. Hence, the below research questions guide the study:

1. Is there any significant role validity of instruments in electrical installation and maintenance work play in ensuring proper assessment of Psychomotor Skills of students in technical colleges/schools?
2. Is there any significant implication of carrying out the reliability of the instrument in electrical installation and maintenance work on ensuring proper assessment of Psychomotor Skills of students in technical colleges/schools?

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II. Related Work

The study's authors and experts in the field of technical education have evaluated and studied relevant works in the past. Among their contributions are:

In order to create jobs and increase their level of independence in Enugu State, Onoh & Onyebuenyi (2017) performed research to identify the electrical installation and maintenance skill requirements for technical college graduates. Using 33 grads in rural Enugu State and 64 graduates in metropolitan areas. The study used a descriptive (survey) research approach, and the researcher-developed structured questionnaire was used to collect data. According to the study's findings, there is a high demand for electrical installation and maintenance work skills such as planning the layout and installation of wiring, testing electrical work for safety, tool proficiency, efficient material use, inspecting electrical installations, interpreting wiring drawings, and the like. Suggestion was made that the government should work to finance and equip technical college workshops in order to encourage more training and equipping of students with the necessary skills for job creation and self-reliance upon graduation in Enugu State. Then, recommendation was made after all the identified skills were integrated into technical colleges' curricula for student training.

In order to evaluate the technical skill competency requirements of the electrical installation and maintenance work trade teachers instructing in the Yobe State skills acquisition centres, Mbaga et al. (2017) conducted a study. The evaluation was based on the electrical installation and maintenance work trade NABTEB module. Twenty-eight (28) electrical installation and maintenance work trade teachers were given the test in the centres. According to the findings, most respondents said they required technical competency retraining for all trade modules of electrical installation and maintenance work. The study suggested that in order to give the students employable skills, teachers at the trade centres should undergo retraining. By using structural equation modelling, Kozlinska et al. (2020) developed a novel tripartite framework for evaluating the success of entrepreneurship education (EE). Statistics demonstrate, based on the major fit, reliability, and validity factors, that the tested framework may be used as a tool for gauging EE learning results. Additionally, this innovative tool served as a replacement for the prevalently employed entrepreneurial intention-based models in EE for assessing learning outcomes. The study demonstrated a considerable and generally high correlation between cognitive and skill-based outcomes. A Psychomotor Skills Assessment Guide for the Repair of Radio Receivers in Electronics Work for Technical Colleges was created and verified by Godwin et al. in 2019. Two technical colleges' entire classrooms were employed in the research. The study included a sample of 62 Senior Technical Three (ST3) students and 18 teachers. Data for the study were gathered using a 21-item Radio Repairs Assessment Guide Questionnaire (RRAGQ) and an 18-item Radio Repairs Assessment Guide (RRAG). Data analysis demonstrated the validity and reliability of the Radio Repairs Assessment Guide (RRAG), so it is advised that Electronics Work instructors at technical colleges reduce their reliance on product assessment alone and instead combine it with the process-based RRAG.

Additionally, the STEM Teachers' Instructional Preparedness Instrument (STEMTIP) was recently developed and validated by Ramli et al. (2020). The study is divided into ten stages, from development to validation. The development of the instrument was guided by social constructivist theory, the 5E instructional paradigm, and the STEM teaching and learning approach model. The 51 items were initially created using inductive and deductive methods, and the statistical findings of the Rasch model and regression analysis, as well as the experts' assessments, proved their face validity, content validity, construct validity, and criterion validity. Additionally, the reliability investigation showed that the instrument had adequate consistency. Full details of reliability analysis, validation, and implications for practice were discussed. In view of what should be ideal technical competency needs of students for the installation of wall-mounted split system air conditioners for self-employment, Onyebuenyi et al., (2018) adopted a survey research design in Abia State of Nigeria with a population of 82 respondents. According to a report, technical college students must be trained in the identification of tools for installing wall-mounted split-system air conditioners as well as practical skills such as mounting on a wall that can support the weight of the appliance and understanding wiring diagrams. Therefore, it was advised that these skills be included in technical college curricula in order to prepare students and give them the best possibility of being self-employed in Nigeria after graduation. In keeping with the development and validation of assessment skills, Mbaga et al. (2022) conducted a study at Modibbo Adama University Yola to create and validate the EIMW trade psychomotor skill assessment instrument for technical colleges in Nigeria. The study's conclusions showed that the EIMWTPSAT's content accurately assesses what it was intended to measure. The EIMWTPSAT also showed a respectable level of inter-rater agreement and was consistent. Finally, it was suggested that all technical colleges in Nigeria implement the created and validated EIMWTPSAT in order to eliminate the inconsistencies related to performance assessment in workshops for the electrical installation and maintenance works trade.

As a scale-up of assessment methods in technology education, Aniekan et al. (2019) also created and validated a Psychomotor Skills Assessment Guide for the diagnosis and repair of electrical circuits at Technical Colleges. The sample for the study consisted of 62 Senior Technical Three (ST3) students and 18 teachers from the two technical colleges that were chosen. Data for the study were gathered using a 22-item Electronic Circuit Repair Assessment Guide Questionnaire (ECRAGQ) and a 17-item Electronic Circuit

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Repair Assessment Guide (ECRAG). It was advised that Electronics Work teachers at technical colleges reduce their use of product assessment alone and instead combine it with the process-based ECRAG after the results of the analysis using SPSS (Statistical Package for Social Sciences) showed that the ECRAG developed was valid and reliable. In order to teach researchers about the validity and reliability of the scales they used in their empirical investigations and to provide resources for future research, Sürücü & Maslakç (2020) conducted research. The ideas of validity and reliability were taught and vividly explained using examples from various literary works. The correctness and consistency of the survey/questionnaire were the main emphasis of the study carried out by Taherdoost (2016). The articles under evaluation examined and analyzed numerous validity and reliability tests, as well as the validity and reliability of a questionnaire or survey.

At the technical college level, Eze et al. (2020) created and validated an instrument for evaluating students' practical joinery skills. A null hypothesis and four research questions were established to direct the investigation. The investigation was conducted in Adamawa State and used the instrumentation design. Sixty-four (64) respondents made up the study's population. The instrument underwent validation and reliability testing, and the task-by-task reliability coefficient measured by the Cronbach Alpha coefficient ranged from 0.67 to 0.98. When a practical skill component was eliminated from the factor analysis, the instrument was in danger. Nine (9) activities and eighty-three (83) practical skills were created based on the findings. In order to measure students' practical skills in Nigerian technical colleges, the Joinery Skill Assessment Instrument (JSAI) should be used, according to the study's. It was recommended that the teachers should be encouraged to learn about and get familiar with the application of JSAI and also recommended that stakeholders (institutions and ministries) should cooperate to provide forums (workshops and conferences) where the usage of this new evaluation tool can be promoted.

III. Methodology

The study used an instrumentation design, which is a style of design appropriate for use when introducing new procedures, technologies, or developing instruments for educational practices, according to Ali (2006). Since the focus of the study was on producing a new instrument or material for educational practices, the instrumentation research design was appropriate for this study. The development of the instrument included steps including creating a test blueprint, authoring test items, trial testing (pilot testing), text assembly, final assembly, final testing, printing, and production. Due to their manageable size, the study included all 25 students enrolled in the last year of electrical installation and maintenance work, 32 teachers, and 15 technicians. For the study, there was no sampling. Electrical Installation and Maintenance Work Process Skill Questionnaire (EIMWPSQ) and Electrical Installation and Maintenance Work Rating Scale (EIMWRS) were the names of the instruments used to collect the data. These instruments were made up of 313 process skill items, 40 tasks, and 3 operations (electrical installation, cable jointing and termination, and winding of electrical machines), which were all built using the following strategy, which was based on the recommendations of Tuckman (1995), Igbo (1997), and UNESCO (2002), respectively. Five experts examined the instruments' faces, and content evaluation was done using a Table of Specifications. The internal consistency of the electrical installation and maintenance work process skill test was assessed using the Cronbach alpha reliability method, and a reliability coefficient of 0.85 was obtained. The electrical installation and maintenance work rating scale's inter-rater reliability was assessed using the Kendall coefficient of concordance (Tau), and a reliability coefficient of 0.87 was obtained. Five raters were used to administer an electrical installation and maintenance job rating scale that included process skills to a sample of 25 students at the government-established technical college in Ikotun, Lagos State. Three times week practical assignments were required of the students, and for a term, the supervisors graded them on how well they executed the tasks associated with each operation. The raters were guided by the created process skill test. In order to help the teachers who served as the research assistants understand the specifics of delivering the test and the basic needs of the study, briefings were given to them. The research assistants at Ikotun Technical College ordered and numbered the relevant equipment and tools in the electrical installation and maintenance work laboratories according to the task. The researcher and school administration made sure there was a standby generator to give power during a blackout. Students received instructions on how to do practical tasks. The research assistants called each student one by one into the lab. There were 25 minutes allotted for each job. To evaluate the student’s performance, one of the study assistants used the electrical installation and maintenance work process rating scale. The evaluation of pupils in grades 5 through 25 was carried out by another four research assistants. The results of the students' practical assessments were noted and used as information to address research issues and test hypotheses. In addition to validation, which involved evaluating all of the comments from experts in industrial technical education and measurement and evaluation to assess the face validity of the skill items, the data used to answer research question one underwent factor analysis. Data from the tryout were evaluated using the Cronbach alpha reliability method and Kendall coefficient of concordance to address research hypotheses. For the creation of the psychomotor skill assessment tool, Omeje (2001) identified operations and tasks with reliability coefficients ranging from 0.56-0.99 as reliable.

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IV. Results

Research question 1

Is there any significant role validity of the instrument in electrical installation and maintenance work play in ensuring proper assessment of the Psychomotor Skills of students in technical colleges/schools?

Table 1: Face and Content Validated Tasks and corresponding Skills in Electrical Installation, Cable Jointing and Termination and Electrical Machine Winding Operations

S/N	Tasks	No of skill items	Remarks
A: Electrical Installation Tasks			
1	Construct a point of light controlled by a switch	14	Valid
2	Construct two points of light controlled by a switch	14	Valid
3	Installation of cut-out/fuse	12	Valid
4	Installation of earth leakage circuit breaker	6	Valid
5	Installation of single-phase meter	16	Valid
6	Installation of three phase meter	16	Valid
7	Installation of the distribution control board	10	Valid
8	Making of surface wiring	11	Valid
9	Preparing materials for conduit wiring	3	Valid
10	Carry out polarity test	3	Valid
11	Conduct insulation test	4	Valid
12	Carry out earth leakage test	4	Valid
13	Carryout continuity test	7	Valid
14	Carryout surface wiring using a demonstration board	11	Valid
15	Preparation of PVC cables for electrical installation	8	Valid
16	Construct a point of light controlled by two- 2-way switches using steel conduit wire	15	Valid
17	Maintaining electronic measuring instrument	8	Valid
18	Assemble fluorescent fittings	14	Valid
19	Carry out tests to demonstrate overloading faults	4	Valid
B: Cable Jointing and Termination Tasks			
20	Make a married joint	8	Valid
21	Prepare Britannica joint	6	Valid
22	Prepare PVC taped and braided cable for termination	3	Valid
23	Join armoured cable at an intermediate position	9	Valid
24	Terminate armoured cable at an intermediate position	9	Valid
25	Using a pot and ladle for cable jointing	8	Valid
26	Repair damaged underground cable	7	Valid

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27	Prepare the ground for laying underground cable	5	Valid
28	Use Megger to test for continuity	3	Valid
29	Erection of low-tension pole	7	Valid
30	Installation of stay wire	7	Valid
C: Winding of Electrical Machines Tasks			
31	Prepare simple wave winding	5	Valid
32	Make lap winding	5	Valid
33	Dismantle electric motor	6	Valid
34	Construct winding formers	3	Valid
35	Fix the winding coil inside the slots	4	Valid
36	Connect the winding using the prepared data	5	Valid
37	Carry out earthling on an electric motor	5	Valid
38	Test for supply voltage	12	Valid
39	Test for incoming current	11	Valid
40	Test run the machine	5	Valid

According to the Table of Specifications, which was created using Simpson's (1972) model of the psychomotor domain, 9 skill items, or 8% of the 313 process skills, were used to assess the perception level, which is research question 1's first inquiry. 10% of the skill items evaluated the set level; 25% of the skill items evaluated the guided response level; and 25% of the skill items evaluated the mechanism level. Assessments of the complicated overt response level included 30 skill items totalling 25%, and assessments of the adaptability level included 9 skill items totalling 8%. These findings demonstrate that the evaluation approach adequately covered the domain's six tiers. This indicates that the 313 skill items were all admissible for inclusion in the tool used to assess the skills needed for electrical installation and maintenance work.

Research question 2

Is there any significant implication of carrying out the reliability of the instrument in electrical installation and maintenance work on ensuring proper assessment of the Psychomotor Skills of students in technical colleges/schools?

Table 2: Reliability Estimates (Cronbach alpha) for Items in Electrical Installation and Maintenance Psychomotor Assessment Instrument

S/N	Tasks	Reliability Coefficient	No of items	Remarks
1	Construct a point of light controlled by a switch	0.78	14	Reliable
2	Construct two points of light controlled by a switch	0.81	14	Reliable
3	Installation of cut-out/fuse	0.72	12	Reliable
4	Installation of earth leakage circuit breaker	0.69	6	Reliable
5	Installation of single-phase meter	0.77	16	Reliable
6	Installation of three phase meter	0.76	16	Reliable
7	Installation of the distribution control board	0.68	10	Reliable
8	Making of surface wiring	0.78	11	Reliable

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9	Preparing materials for conduit wiring	0.66	3	Reliable
10	Carry out polarity test	0.61	3	Reliable
11	Conduct insulation test	0.65	4	Reliable
12	Carry out earth leakage test	0.71	4	Reliable
13	Carryout continuity test	0.76	7	Reliable
14	Carryout surface wiring using a demonstration board	0.79	11	Reliable
15	Preparation of PVC cables for electrical installation	0.74	8	Reliable
16	Construct a point of light controlled by two- 2-way switches using steel conduit wire	0.82	15	Reliable
17	Maintaining electronic measuring instrument	0.79	8	Reliable
18	Assemble fluorescent fittings	0.84	14	Reliable
19	Carry out tests to demonstrate overloading faults	0.62	4	Reliable
20	Make a married joint	0.76	8	Reliable
21	Prepare Britannica joint	0.66	6	Reliable
22	Prepare PVC taped and braided cable for termination	0.60	3	Reliable
23	Join armoured cable at an intermediate position	0.77	9	Reliable
24	Terminate armoured cable at an intermediate position	0.78	9	Reliable
25	Using a pot and ladle for cable jointing	0.75	8	Reliable
26	Repair damaged underground cable	0.76	7	Reliable
27	Prepare the ground for laying underground cable	0.65	5	Reliable
28	Use Megger to test for continuity	0.60	3	Reliable
29	Erection of low-tension pole	0.73	7	Reliable
30	Installation of stay wire	0.71	7	Reliable
31	Prepare simple wave winding	0.62	5	Reliable
32	Make lap winding	0.64	5	Reliable
33	Dismantle electric motor	0.66	6	Reliable
34	Construct winding formers	0.60	3	Reliable
35	Fix the winding coil inside the slots	0.71	4	Reliable
36	Connect the winding using the prepared data	0.77	5	Reliable
37	Carry out earthling on an electric motor	0.75	5	Reliable
38	Test for supply voltage	0.83	12	Reliable
39	Test for incoming current	0.84	11	Reliable

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40	Test run the machine	0.81	5	Reliable

Each of the 40 electrical installation and maintenance work jobs exhibited strong Cronbach alpha reliability values, ranging from 0.60-0.84, according to analysis in Table 2. Additionally, the entire item's reliability coefficient was calculated to be 0.834, indicating that the assessment tool was refined in accordance with the advice of (Landis & Koch, 1977), which stated that acceptable reliability of tests or raters' agreement on tests given to students in education is typically in the range of 0.41 to 1.00.

Therefore, the answer to the research hypothesis about the reliability of the tests would be in the affirmative given the high reliability coefficients or strong agreement for diverse tasks in the instrument. As a result, the items in the instrument for evaluating students' psychomotor skills in electrical installation and maintenance work were valid and could be used to evaluate students' psychomotor skills in technical colleges.

V. Discussion

The study's findings show that 313 matching skill items and 40 tasks are legitimate. Five specialists from the Department of Industrial Technical Education at the University of Nigeria, Nsukka, participated in the investigation to determine this. The copies of the instrument were supplied to these experts so they could review and comment on how applicable the skill items were for evaluating the student's performance in practical activities involving electrical installation and maintenance work. According to Bakare (2014; Elias 2021), face validity or validation is the first stage of the instrument development process. During this phase, experts are hired to vet, remove, reword, and replace any ineffective components of the instrument with ones that will be useful. The results were in agreement with Olaitan (2003) and Elias (2021) who believed that face validity of psychomotor learning activities could be pursued by having the list of skill items created for use reviewed by experts in order to produce compromise or consensual agreement on the importance of the items. In this study, this was the case.

A table of specifications was created based on Simpson's (1972) six levels of the psychomotor domain to determine the content validity of the electrical installation and maintenance work psychomotor skills assessment tool. This revealed that 8% of the 118 skill items assessed the perception level, 9% assessed the set level, 25% assessed the guided response level, 25% of the 118 items assessed the mechanism level, 25% assessed the complex overt response level, and 8% assessed the level of 8%. The results are in line with those of Amuka (2002), who determined content validity using a thorough and precise table of specifications and the views of a few specialists in vocational teacher education at the University of Nigeria, Nsukka. The study's findings also agreed with those of Ombugus (2013), who created and validated workshop-based process skill tests in mechanical engineering craft for evaluating students in technical colleges in Nassarawa State and discovered that 40 tasks and 305 skill items were valid using a table of specifications. The content validity was achieved by Okeme (2011), who created and validated psycho-productive skill multiple choice items for students studying agricultural science in secondary schools, by conducting task analyses pertinent to the field of study and soliciting input from specialists in agricultural education on the items' applicability for inclusion in the developed instrument. Job/task analysis aids in establishing the validity of an instrument, according to Garba (1993).

In addition to the face and content validation of the electrical installation and maintenance work psychomotor skills assessment instrument, a factorial validity test using factor analysis was carried out, and it was determined that 40 tasks and 313 skill items were valid enough to be included in the assessment tool. This result was consistent with that of Bakare (2014), who used factor analysis in his research and discovered that 140 out of 143 tasks could be used to create training modules for national diploma students on cell phone repair. The authors of the studies concluded that it is crucial to select test items with high factor loading and other psychometric qualities.

Similar to this, the reliability coefficients for the 40 tasks and the 313 corresponding skill items ranged from 0.65 to 0.85 and 0.87 respectively. This indicates that all of the tasks and their items are reliable enough to be included in the electrical installation and maintenance work psychomotor skills assessment instrument. These results are consistent with those of Ombugus (2013) who discovered that the instrument had high reliability, with Cronbach alpha coefficients of 0.71 for grinding operations with 86 items, 0.82 for drilling operations with 86 items, and 0.83 for fitting operations with 134 skill items. These results are consistent with those of Azizi-Ur-Rehman (2007), who created and approved objective test questions in physics for class nine students in Rawalpindi City, Pakistan, and discovered that the test had a high-reliability coefficient of 0.75. These results concur with those of Yalams (2001), who conducted a study on the design and validation of a metalwork process evaluation scheme and found that the instrument had a high level of reliability with a Cronbach alpha coefficient of 0.83. This demonstrated that all of the things in the six levels of Simpson's taxonomy assessed were trustworthy. These findings concur with those made by Cohen, Manion, and Morrison (2011) in a study on the creation and validation of a scheme for evaluating the metalworking process, which indicated that the instrument had a high level of reliability with a Cronbach alpha coefficient of 0.83. The results concur with Zhang and Lam's (2013) research on the creation and validation of the Racquet Ball Skills Test for Adult Beginners in Cleveland, which found that the test had a high

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reliability of coefficient of 0.68. Additionally, these results supported those of Bukar (2006), whose research focused on the design and validation of laboratory-based tests for evaluating the practical abilities of students pursuing higher national diplomas in electronic maintenance and repairs. In that study, it was discovered that the reliability coefficient values of the tests on measuring instruments and testing, fault finding and repairs, and alignment were, respectively, 0.71, 0.55, and 0.47. The authors' findings above supported the conclusions of this investigation.

VI. Conclusion

The goal of electrical installation and maintenance work in a technical college is to give students knowledge, practical skills, and a solid moral foundation. However, the goal cannot be realized if all three domains—cognitive, affective, and psychomotor—are not evaluated by examination bodies to determine how well the students have mastered their studies. There aren't any assessment tools available under the current NBTE minimum standard, and there aren't many trustworthy and valid tools available to evaluate the abilities technical college students gained while working on electrical installations and maintenance projects in the field. Technical instructors frequently focus solely on the finished product and overlook evaluating the processes involved in students' practical work. Technical colleges were unable to realize student skill growth because of the current method of assessment, which solely focuses on the product and cognitive capacity success of students in electrical installation and maintenance work. As a result, students with little to no process skills for employment graduated from technical institutes. In order to close the gap in the teaching and learning of electrical installation and maintenance work, it was necessary to develop and validate an instrument for testing students' psychomotor skills in technical colleges. To this end, all best practices for the development and validation of test instruments were followed. Therefore, the study established the practical tasks in electrical installation and maintenance work that students would complete, validated the developed process assessment instrument in electrical installation and maintenance work, and also established the validity and dependability of the developed process assessment instrument in electrical installation and maintenance work.

The created tool has made a readily accessible, high-quality process assessment tool for the realization of skill development in electrical installation and maintenance work for students in technical colleges available.

VII. Recommendation

The study recommended the following for implementation:

- ✓ The external examination bodies (NABTEB, NECO and WAEC) should integrate electrical installation and maintenance work skill assessment instrument items in their examination for the certification of the students.
- ✓ Government should organize seminars and workshops for teachers of electrical installation and maintenance work on how to make use of the developed electrical installation and maintenance work skill assessment instrument
- ✓ Evaluators in technical education should use electrical installation and maintenance work skill assessment instruments to study their curriculum, structure the contents into relevant tasks and develop similar tests in their respective subject areas
- ✓ Teachers of electrical installation and maintenance work should be encouraged to make use of the developed electrical installation and maintenance work skill assessment instrument for assessing students in electrical installation and maintenance work that relates to construction.

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