

Developing an Instrument for Assessment of Students' Psychomotor Skills in Fabrication and Welding Trade in Akwa Ibom State Technical Colleges

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Abstract

The study sought to determine developing an instrument for assessment of students' psychomotor skills in fabrication and welding trade in Akwa Ibom State Technical College. Three objectives three research questions and three null hypotheses were poised to guide the study. The researchers adopted the Research and Development design (R & D) for the study. The population for the study was 226 students in Fabrication and welding in Technical Colleges in Akwa Ibom State. The sample size was 97 respondents. Simple random sampling was used in sampling the instructors and experts for the study. Two technical schools were purposively sampled for the study. One school was assigned as control group and the other school as experimental group. The researcher developed instrument titled, "Check List for Assessing Students Psychomotor Skill Performance in Fabrication and Welding Work (CASPSPFW) was used to collect data for the study. All the items were constructed with the help of Table of Specification developed for matching of items on skills areas. The instrument will be graded on a five- point scale of Very Highly Appropriate (VHA), Highly Appropriate (HA), Moderately Appropriate (MA), Less Appropriate (LA) and Not Appropriate (NA) with 5-points, 4-points, 3-points, 2-points, and 1-point respectively. A multistage validation process was employed for the study. Mean with standard deviation and Lawshe's Content Validity Ratio (CVR) were used in answering research questions and for data analysis. Findings showed that students assessed using CASPSPFW had higher marks than students assessed using teacher-made tests. It was Recommended that the National Board for Technical Education (NBTE) as well related agencies should adopt the developed "Check List for Assessing Students Psychomotor Skill Performance in Fabrication and Welding Work (CASPSPFW)" for the fabrication and welding programmes in technical colleges across Nigeria

Keywords: Developing, Instrument, Assessment, Psychomotor, Fabrication.

Introduction

Fabrication and Welding Trade is a component of technical education training where students can effectively set up and manage Fabrication and Welding occupation upon graduation is one of the practical oriented Trade areas taught in Technical Colleges to develop students' knowledge, skills and attitude needed in Fabrication and Welding work. It is an aspect of TVET. Fabrication and Welding trade involves theoretical (classroom session) and practical (workshop/laboratory) activities. The workshop/ laboratory session provides hands-on training on Fabrication and Welding equipment to reinforce the lessons taught in the classroom. The practical skills of Fabrication and Welding lead to the development of psychomotor skills which are those skills performed by hand or with the help of human

intervention using tools, machines and equipment. Psychomotor skills, according to Akpan (2018), require manual dexterity although an understanding of principles, processes and sequence are also essential especially for more complex skill. Iyare (2014) describe skills as the human capability to technical work efficiency with dexterity and competence. Onweh (2016) maintained that skills are made up of three main components namely: Knowledge – a worker knows what to do, and how to do it. Dexterity – a worker knows how to put his knowledge into practice at the right pace; Stamina – a worker knows how to keep up the pace with facility.

The relative important of these three components of skill are highly critical in Fabrication and Welding jobs. Fabrication, according to Akpan (2018), is the general term given to the art of construction, building, forming or assembling of an object or an article. In this study, metal fabrication is viewed as a process of blue print reading; layout, cutting and preparing metallic materials for assembly of an article or component (Spokane, 2013). Welding is a process of joining pieces of metals (parent metal) together by means of heat produced at the tip of electrode if arc welding is used or by heat produced by gas flame if gas (oxy-acetylene) is used to melt the edges or parts of metal together (Akpan, 2018).

According to Parmar (2013), there are over 50 different welding processes practiced around the world but few are taught in Akwa Ibom State Technical Colleges. These few include arc welding, and gas (oxy-acetylene) welding. In this work, the researcher focuses on arc welding. In arc welding process, according to Parmer (2013), coated electrodes are used for the production of an arc to act as a source of heat. The electrode covering provides the necessary shield to protect the molten metal from the ill effect of oxygen and nitrogen from the surrounding atmosphere. Arc welding is the process of joining metal by using heat produced by electric arc with or without pressure. It is the process in which metal pieces (parent metal) are joined by heating the metals to a suitable temperature of about 5,000-6,000°C to cause the pieces to melt and fuse together into a single piece.

Fabrication and Welding involves several operations such as setting up of arc welding equipment, cutting of metal, joint preparation (designed), arc welding, metal surfacing (finishing), and others. Cutting is the process of breaking iron and steel into parent metal (work piece) of various sizes and shapes through the use of different devices (Akpan *et al.* 2018). Hacksaw, machine hack saw, oxy-acetylene cutting technique and others are some of the cutting equipment and tools used in Fabrication and Welding industry. In arc welding, there are many different welding positions such as flat position, horizontal position, vertical upward and downward position, overhead position.

Psychomotor Performance Level of Students in Fabrication and Welding Work

Psychomotor domain includes those objectives, which emphasize manipulation of skill area. Psychomotor skills are need at all levels of the child's development in the school. This domain emphasizes motor skills manipulation like laboratory skills, operating machines, handwriting etc. The psychomotor domain consists of objectives which emphasise some

muscular or motor skills, some manipulation of materials and objects, or some acts which require neuromuscular coordination (Odinka, 2013). The psychomotor domain, which involves physical skills, that is what the students can do or make in addition to what they know are most often neglected in classroom evaluation. According to Falaye and Akorede (2013), assessment of educational objectives in practical examinations falls under the psychomotor domain. Evaluation of practical tests involves two aspects: assessment of the degree of performance skills exhibited by the students, that is, process at performing the tasks set in the practical examination and assessment of the quality of the output, that is, the product emanating from the process.

The psychomotor domain includes physical movement, coordination and use of the motor-skill areas. Development of these skills requires practice and is measured in terms of speed, precision, distance, procedures or techniques in execution. Richter (2022) contended that psychomotor domain is one of the domains of learning and it is related to the execution of physical activities. It links mental activity with physical movements, skills and reactions to environmental stimuli. The psychomotor learning domain involves our physicality and how that develops from basic motor skills to intricate performance.

Psychomotor performance is dependent on vigilance, attention and the speed, accuracy and coordination of sensorimotor behaviour, and most importantly, the speed, capacity and flexibility of the cognitive system. Hindmarch (2014) noted that humans have an innate capacity to react to environmental stimulation which, by way of learning and experience, develops into a range of coordinated motor behaviors that are appropriate responses to the sensory information perceived by an individual. Psychomotor ability, according to Mcloughlin (2022), refers to a wide range of actions involving physical movement related to conscious cognitive processing. Psychomotor ability may be measured by accuracy or speed (speed time).

There are different levels of skills. Dalto (2014) enlisted the five levels, in order from the most basic to most advanced as follows: imitation, manipulation, precision, articulation and naturalization.

- i. Imitation: Learner watches actions of another person and imitates them.
- ii. Manipulation: Learner performs actions by memory or by following directions.
- iii. Precision: Learner's performance becomes more exact.
- iv. Articulation: Learner can perform several skills together in harmonious manner.
- v. Naturalization: Learner achieves high level of performance and actions, became natural with little or no thought about them. The level of the skills domain are often represented as different levels of pyramid, with imitation, the simplest level, making up the bottom of the pyramid and naturalization, the most complex level, making up the top.

Test Blueprint and the Assessment of Instrument in Fabrication and Welding

The test blueprint is a list of major contents (skills) area. Intended to be included in each test form. It is sometime referring to as table of specification. It includes the number of items each test form should be include within each of these content and psychomotor area. The test blue print helps instructors and teachers to develop a balance examination which include

objectives, types of questions and the level of the question are all taken into consideration where developing an assessment instrument.

Udo (2019) described test blue print as a test plan which contents and the objectives are put together and relative weight assigned. Udo also maintained that contents and the objective are the two areas in which a test plan is fitted. These two areas need to be put together to see which objectives especially related to which segment of content and provide complete framework for the evaluation of a unit. Udo further noted that when constructing the test, it is important to ensure that the test plan covers all objectives and add a column to the blue print indicating the methods to be used in the evaluating as well as how the testee will achieve each objective. The researcher observed that when constructing a test blue print, the instructor/teacher should consider the percentage assigned to each content area and the objective as well. The instructor needs to decide on the item that are appropriate to be used, take into consideration the level of understanding of the students involves, the duration of the test and the number of questions to be included in the test. Test blueprint items that are appropriate for inclusion in Fabrication and Welding work assessment instrument for assessing student's psychomotor performance in Technical Collage in Akwa Ibom State are grouped under: setting up welding equipment, cutting, joint preparation, arc welding and metal surfacing.

Content Validity of the Developed Psychomotor Assessment Instrument

Content validity has to do with the representativeness or sampling adequacy of the content (topics or items) of an instrument (Udoh, 2019). Content validity, according to Joshua (2016), refers to the extent to which items on a test adequately sample or represent or cover the content (area of knowledge) the test is designed to measure. Content validation is the process of determining the extent to which a set of test tasks provides a relevant and representative sample of the domain of tasks under consideration. Joshua (2013) noted that content validity involves systematic comparison of test content with course/subject content by experts in the subject area. It is more of a judgmental affair by an equally competent colleague or group of colleagues or by an expert or group of experts in the same discipline. Uzoagulu (2011) in Inyang (2023) affirmed that in content validity, the validator is asked to check whether the instrument (test items, questionnaire, interview schedules etc.) contains all the aspects of the subject that should be included in the test or the questionnaire. If there are five topics, sections, branches, features, parts, the researcher must ensure that the five topics are well represented in the instrument. Uzoagulu in Ukpong (2021) specified that content validity is therefore the extent to which the items of an instrument are representative of the content and behaviours specified by the theoretical concept being measured. This can be estimated by comparing the sample of the items with the content and behaviours which they should represent and if the sample of the items cover all aspects of the content and behaviours, then a high degree of content validity may have been achieved. To carry out content validity, Uzoagulu (2011) cited in Inyang (2013) advised that the instrument be sent to validators and specify what

they should do. The more validators that are involved the better for the instrument. The validators should be the experts in the area who should have the idea of what should be included and what should not be included. The research questions and the hypotheses (if any) should be made available to the validators. Falaye and Akorede (2013) explained that content validity is determined by experts who are knowledgeable in the subject area. Its level of subjectivity can be reduced if test items are constructed using a table of specification or test blue-print.

Assessment Instrument in Fabrication and Welding Work

Assessment is defined as the processes of using instruments to measure learners' performance, normally after they have undertaken a learning programme or the other (Falaye and Akorede, 2013). According to Ndem *et al.* (2023), assessment refers to the global process of synthesizing information about individuals so as to describe, understand and perhaps help them better. Assessment is a process and involves the collection of meaningful information to understand and help people cope with problems. It has also been presented as a process of developing images making decisions, and checking hypothesis about another person's behaviour in interaction with the environment. In the process of assessment, tests are frequently used, but a variety of sources of information, both formal and informal may be used. It is however, not restricted to formal measurement procedures, but may also encompass other methods of obtaining information about individuals (Ndem *et al.*, 2023). It is an interpretation, based on internal standard, of the results of measurement in an attempt to ascertain the level and value or worth of progress made or change observed. Thus, assessment subsumes tests, measurement and evaluation of the cognitive, psychomotor and effective skills

Purpose of the Study

The purpose of the study was to develop an instrument for assessment of students' psychomotor skills in Fabrication and Welding Trade in Akwa Ibom State Technical Colleges.

Specifically, the study sought to:

- i. determine the skills that are appropriate to be assessed in Fabrication and Welding trade assessment instrument for assessing students' psychomotor performance (measuring, cutting, welding, joint preparation and setting up arc welding) in Technical Colleges in Akwa Ibom State.
- ii. determine the test blue print items that are appropriate for inclusion in Fabrication and Welding Trade assessment instrument for assessing students' psychomotor performance in Technical College in Akwa Ibom State.
- iii. develop the assessment instrument in Fabrication and Welding Trade for assessing students' psychomotor performance in Technical Colleges in Akwa Ibom State.

Research Questions

The following research questions guided the study.

- i. What are the skills that are appropriate to be assessed in Fabrication and Welding trade assessment instrument for assessing students' psychomotor performance (measuring,

- cutting, welding, joint preparation and setting up arc welding) in Technical Colleges in Akwa Ibom State?
- ii. What is the test blue print items that are appropriate for inclusion in Fabrication and Welding trade assessment instrument for assessing students' psychomotor performance in Technical Colleges in Akwa Ibom State?
 - iv. What is the develop assessment instrument in Fabrication and Welding trade for assessing students' psychomotor performance of Technical Colleges in Akwa Ibom State?

Methodology

The researcher adopted the Research and Development design (R and D) for the study. The population for the study was 226 respondents consisting 201 Senior Technical II (ST2) students in Fabrication and welding in Technical Colleges in Akwa Ibom State. The sample size was 97 respondents. This comprises 90 ST 2 students and seven instructors. Simple random sampling was used in sampling the instructors and experts for the study. Two technical schools were purposively sampled for the study. Because of the provisions for practical work. One school was assigned as control group and the other school as experimental group. The researcher developed instrument titled, "Check List for Assessing Students Psychomotor Skill Performance in Fabrication and Welding Work (CASPSPFW) was used to collect data for the study. The instrument has 105 Psychomotor test items. Based on the suggestion Robert (2017), the procedure adopted in the development of the instrument is multistage approach.

All the items were constructed with the help of Table of Specification developed for matching of items on skills areas. The instrument will be graded on a five- point scale of Very Highly Appropriate (VHA), Highly Appropriate (HA), Moderately Appropriate (MA), Less Appropriate (LA) and Not Appropriate (NA) with 5-points, 4-points, 3-points, 2-points, and 1-point respectively. A multistage validation process was employed for the study. The first phase involved the face validation of assessment instrument while the second face was content validation for assessing students' performance in psychomotor skills checklist. The instrument was given to three experts for face validation and five experts for content validation. The developed psychomotor task items were subjected to a trial tested procedure on 20 technical colleges teachers with specialization in fabrication and welding. The reliability was carried out in Akwa Ibom State. Cronbach alpha formula was used to estimate the reliability coefficient of the instrument which stood at .82. The researcher obtained permission from the principals of the Technical Colleges to carry out research study in their respective schools. Copies of the check list were administered on the respondents by the researcher with the aid of research assistants who were briefed on the procedures for questionnaire administration and collection and completely filled copies of the questionnaire will be retrieved and collated for data analysis. Mean with standard deviation and Lawshe's Content Validity Ratio (CVR) were used in answering research questions and for data analysis. For answering research question, the appropriateness of the item for inclusion in the test blue print in psychomotor skill in Fabrication and Welding work was determined based on the real limit values as presented:

Response Options		Value	Real Limit
Very Highly Appropriate	(VHA)	5	4.50 – 5.00
Highly Appropriate	(HP)	4	3.50 – 4.49
Moderately Appropriate	(MA)	3	2.50 – 3.49
Less Appropriate	(LA)	2	1.50 – 2.49
Not Appropriate	(NA)	1	1.00 – 1.49

Result and Discussion

The result of the study is presented based on research questions and hypotheses.

Research Question 1: What are the skills that are appropriate to be assessed in Fabrication and Welding trade assessment instrument for assessing students' psychomotor performance (measuring, cutting, welding, joint preparation and setting up arc welding) in Technical Colleges in Akwa Ibom State?

Table 1: Summary of Mean statistics of Differences in Skills Performance in Fabrication and welding when assessed using Check List for Assessing Students Psychomotor Skill Performance in Fabrication and Welding Work (CASPSPFW)

Group	n	Pretset		Posttest		Mean Difference Posttest-Pretst
		Mean	SD	Mean	SD	
CASPSPFW	50	9.46	5.25	50.28	12.47	40.82
Teacher made test	40	9.75	3.54	42.40	14.32	32.65

The result presented in Table 1 shows the summary of the mean and standard deviation of students' scores in fabrication and welding when assessed using the developed Check List for Assessing Students Psychomotor Skill Performance in Fabrication and Welding Work (CASPSPFW) and teacher-made assessment tool. The result shows that mean difference for students assessed using CASPSPFW is 40.82 as against 32.65 for teacher-made instrument. This shows that students assessed using CASPSPFW had higher marks than students assessed using teacher-made tests.

Research Question 2: What is the test blue print items that are appropriate for inclusion in Fabrication and Welding trade assessment instrument for assessing students' psychomotor performance in Technical Colleges in Akwa Ibom State?

Table 2: Table of Specifications on Psychomotor Skills in Fabrication and Welding

Context	Naturalization (20%)	Articulation (30%)	Precision (20%)	Manipulation (10%)	Initiation (20%)	Total
Setting up arc welding equipment (14.3%)	3	4	3	2	3	15
Arc cutting skills (14.3%)	3	4	3	2	3	15
Oxyacetylene cutting (14.3%)	3	4	3	2	3	15
Arc carbon cutting skill (14.3%)	3	4	3	2	3	15
Joint preparation skill (14.3%)	3	4	3	2	3	15
Arc welding skills (14.3%)	3	4	3	2	3	15
Metal surfacing (14.3%)	3	4	3	2	3	15
Total	21	28	21	14	21	105

The Bloom's taxonomy was applied in designing the psychomotor domain, which includes naturalization, articulation, precision, manipulation, and initiation. Table of specifications on 2 shows the psychomotor domain of the task instructional sheet was constructed using the Bloom's model for psychomotor skills. Out of the 105 items on psychomotor skills, 21 items were on naturalization, 28 on articulation, 21 on precision, 14 on manipulation, and 21 on initiation.

Research Question 3: What is the develop assessment instrument in Fabrication and Welding trade for assessing students' psychomotor performance of Technical Colleges in Akwa Ibom State?

Table 3: Summary of Skills that are Appropriate to be Assessed in Fabrication and Welding Trade Assessment Instrument for Assessing Students' Psychomotor Performance

S/N	Specific Skills in Fabrication and Welding	Mean	SD	Remarks
1	Setting Up Arc Welding Equipment	4.05	1.05	*HA
2	Arc Cutting Skill	3.89	1.04	HA
3	Oxyacetylene Cutting Skill	4.18	1.02	HA
4	Air Carbon Arc Cutting Skill	4.26	1.13	HA
5	Joint Preparation Skill	3.66	1.22	HA
6	Arc Welding Skill	3.97	1.05	HA
7	Metal Surfacing Skill	4.01	1.08	HA

***HA- Highly Appropriate, Source: Researcher's field computation**

Table 3 presents the summary of the item analysis on the skills to be assessed in Fabrication and Welding trade. The result shows that all the items have mean responses above 3.50, indicating that all the respondents agreed that all the stated skills were essential and to be developed by students for Fabrication and Welding trade. Hence, the identified psychomotor skills areas in setting out and strip foundation laying are to be assessed.

Discussion of Findings

Psychomotor Skills Assessment in Fabrication and Welding Technology

The study identified seven skill areas in fabrication and welding to be assessed by technical teachers. All the expert responses had mean values above 3.0, the weighted mean. This indicates that all the experts agreed on the items as psychomotor skills in fabrication and welding. Thus, the identified psychomotor skills areas in fabrication and welding are to be assessed. The identified skill areas in fabrication and welding are Setting up arc welding equipment, Arc cutting, Oxyacetylene cutting, Arc carbon cutting, Joint preparation skill, Arc welding and Metal surfacing. This finding is similar to the findings of Ukpong (2023) who identified Arc cutting skills, Oxyacetylene cutting, Arc carbon cutting skill, Joint preparation skill, Arc welding skills as skills for fabrication and welding works.

Skills Level of Students in Fabrication and Welding Using Check List for Assessing Students Psychomotor Skill Performance in Fabrication and Welding Work (CASPSFW)

The developed instrument was used to assess students practical work in fabrication. The result of analysis shows that students assessed using the teacher-made test had a mean gain of 32.65 as against 40.82 for those assessed using the developed instrument. This shows that students assessed using the developed Check List for Assessing Students Psychomotor Skill Performance in Fabrication and Welding Work performed better than students assessed using the teacher-made test. The developed “Check List for Assessing Students Psychomotor Skill Performance in Fabrication and Welding Work” allowed the teacher to be objective in their assessment and scoring. This implies that students will have to perform the tasks and the teacher observe the students to be able to award the right marks using the developed instrument. This finding is supported by Robert (2017) who assessed students’ skills using a developed instrument and found that students scored higher using the standardized assessment instrument than teacher-made assessment tools.

Validation and Reliability of the Developed Psychomotor Assessment Checklist for Technical College (FSPACTC)

The developed Check List for Assessing Students Psychomotor Skill Performance in Fabrication and Welding Work (CASPSFW) was checked for content validity. Lawshe content validity analysis was used to determine the quantitative content validity of the developed “Check List for Assessing Students Psychomotor Skill Performance in Fabrication and Welding Work (CASPSFW). This gave a content validity index (CVI) of 0.85. Based on the high CVI, the instrument was deemed fit for use. This Content Validity ratio (CVR) ranges from 0.428- 1.0. Items with CVR of 0.428 and were expunged from the instrument, while items with CVR of 0.71-0.79 were revised and items with CVR of 0.80-1.0, indicated that the tasks were appropriate and should be included. This finding is in line with Sangoseni *et al.* which proposed a S-CVI of ≥ 0.78 as significant level for inclusion of an item into the study. Furthermore, the findings agree with Okoye and Caleb (2019) who also used a similar criterion for determining items to be included in the task sheet.

Conclusion

Based on the findings of the study, it is concluded that the developed “Check List for Assessing Students Psychomotor Skill Performance in Fabrication and Welding Work (CASPSFW)” is valid and reliable to be used by technical teachers for assessing practical skills in fabrication and welding. The psychomotor assessment instrument (Check List for Assessing Students Psychomotor Skill Performance in Fabrication and Welding Work) if followed by the fabrication and welding instructors in technical colleges, would help in

developing skills in Setting up arc welding equipment, Arc cutting skills, Oxyacetylene cutting, Arc carbon cutting skill, Joint preparation skill, Arc welding skills and Metal surfacing.

Recommendations

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

- i. The National Board for Technical Education (NBTE) as well related agencies should adopt the developed “Check List for Assessing Students Psychomotor Skill Performance in Fabrication and Welding Work (CASPSFW)” for the fabrication and welding programmes in technical colleges across Nigeria.
- ii. Teachers should endeavour to carry out practical assessment of students, so as to ensure that psychomotor skills are assessed.
- iii. The National Board for Technical Education (NBTE) as well related agencies should adopt the developed “Check List for Assessing Students Psychomotor Skill Performance in Fabrication and Welding Work (CASPSFW)” for the fabrication and welding programmes in technical colleges across Nigeria.

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