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Development and Validation of an Instrument for Assessing Workshop Based Process Skills in Metalwork Fitting Operations in Technical Colleges in North Eastern Nigeria

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Abstract: *The aim of the study was to develop and validate workshop-based process skill assessment instrument for students in fitting operations in general metalwork in technical colleges. Two purposes and two research questions guided the study. The study adopted the instrumentation research design. The area of the study was North Eastern Nigeria. The population of the study was 776. This number consist 712 NTC 111 students and 64 general metalwork teachers. The sample size of the study was 86 students in the selected schools and four (4) teachers were randomly selected as assessors in the four purposively selected schools. The instrument was subjected to face and content validation. The validation exercise was carried out by four experts in the School of Technology and Science Education, Modibbo Adama University of Technology, Yola and Department of Vocational and Technology Education,Abubakar Tafawa Balewa University, Bauchi. The content validation was carried out using a table of specification constructed based on the Simpson's (1972) model of psychomotor domain by subject matter experts in the area of fitting operation. The data generated were analysed using Mean statistics and Pearson Product Moment Correlation for calculating the reliability using the statistical package for the social sciences (SPSS). The decision rule was based on true limit of numbers. Based on the results of the validation of the Workshop-Based Process Skill Assessment (WBPSA), 21 tasks and 79 process skills were developed. The results of the data analyzed relating to reliability of the WBPSA revealed coefficients of 0.86 for fitting operation. It was found out from the study that 12 tasks with their corresponding skill items of 79 were important to the teachers of General Metalwork in assessing students' skills in fitting operation in technical colleges. The study recommended among others that external examination bodies such as NABTEB and WAEC should adopt the Workshop-Based Process Skill Assessment items in their examination for certification of the students. It was also recommended that teachers should be encouraged by government to make use of workshop-based process skill assessment items during teaching and assessing productive learning aspect of General Metalwork students.*

Keywords: *Development, Validation, Skills, Assessment, Process*

Introduction

The national Policy on education (Federal Republic of Nigeria, 2013) defines post basic education and career development education as the type of education children receive after primary school and before tertiary stage. Technical Colleges are designed to provide trained manpower in the applied sciences, technology and commerce, particularly at sub-professional level, to give an introductory professional studies in engineering and other technologies; to give

training and impart the necessary skills to individuals who shall be self-reliant and enterprising economically, provide people who can apply technical knowledge to the improvement and solution of environmental problems (FRN, 2013).

Mechanical Engineering Craft Practice Trade is one of the trades found in technical colleges, which is aimed at training and imparting necessary skills leading to the production of craftsmen who will be self-reliant and enterprising in job areas, such as metal fitting, machining, welding, fabrication (under general metal work) and auto vehicle mechanics works (National Board of Technical Education, NBTE, 2008). General metalwork is one of several job related courses offered in technical colleges in Nigeria. Students offering different aspects of metalwork programme are examined by the National Business and Technical Examination Board (NABTEB) for the award of National Technical Certificate (NTC).

The psychomotor objectives of general metalwork are meant to achieve adequate development of skills which can make the recipient employable. To achieve this goal at the NTC level, learners need to be well assessed. At present, the assessment instrument used by NABTEB only helps to determine students' achievement of general metalwork objectives in cognitive domain (Aminu, 2015). General metal work practical examinations conducted by NABTEB and teachers in technical colleges in Nigeria are mere product ratings, i.e. judging only the end product not minding the processes involved and not skill manipulation ratings which involves step by step completion of a given task. Similarly, the assessment of manipulative activities as acquired by the students in the production processes need to be ascertained through workshop-based process skill assessment (Bukar, 2012). Workshop-based process skill assessment connotes the presentation of step-by-step practical skills acquired by the learners in a typical workshop setting (Kaide, 2013). Step by step or logical method of accomplishing activity aids perfection.

Ezeji (2004) noted that assessment with process skill rating is an appropriate procedure for finding out the extent to which vocational and technical education has attained its stated objectives. In the same vein, Bukar (2006) stated that any evaluation instrument with process rating is suitable for assessing skills possessed by students in vocational and technology education. Similarly, Effiong (2006) stressed the need for observing and rating of step-by-step procedures in assessing manipulative skills in vocational and technology education programmes. In measuring the extent to which mastery has been achieved or attained in the psychomotor skill of student in general metalwork at the technical college level, and for the assessment instrument to be good enough to measure the expected performance of students, it is expected that the assessment instrument must possess and satisfy certain psychometrics properties.

Psychometric properties of an assessment instrument involves the mental measuring abilities certain peculiarities or characteristics that helps to distinguish it or expected to be possessed by the assessment item such as item reliability and item validity (Gall, Gall & Borg, 2007).Validation according to UNESCO in Ifeoma (2012) is the process of establishing or confirming the ability of a research document to solve the problem which it was designed to solve. The validity of assessment instrument as stated by Cohen, Manion and Morrison (2011) is the extent to which practical skills assessment items or psychomotor skill assessment items outlined in the curriculum for general metalwork measures what it is designed to measure. In other words, the validity of workshop based process skill assessment is the extent to which the student intended practical competencies outlined in the National Technical Certificate (NTC) curriculum are covered by the assessment items. The validity of workshop based process skill

assessment in general metalwork is then the extent to which the students intended practical competencies outlined in the curriculum are covered by the assessment instrument. Mohammed (2006) opined that whenever one is selecting or constructing a test instrument the important question to ask is, to what extent will the result serve the particular uses for which they are intended? In a related opinion, Osuala (2005) stated that a test is valid to the extent to which the result of an evaluation procedure serve the particular uses for which they are intended, i.e. of the results are to be used to describe pupil achievement, we should like them to represent the specific achievement we wish to describe, to represent all aspects of the achievement we wish to describe, and represent nothing else. Validity can be classified into six (6) categories, namely: content validity, face validity, concurrent validity, construct validity, predictive validity and criterion referenced validity.

Content validity: Content validity considers whether or not the items on a given test accurately reflect the theoretical domain of the latent construct it claims to measure (Fairchild, 2008). Items need to effectively act as a representative sample of all the possible questions that could have been desired from the construct.

Face Validity: Uzoagulu (2011) is of the opinions that face validity judges at the face value, the appropriateness of a measuring instrument. By mere reading a questions paper, a student can judge whether the questions cover the topics which the teacher taught or not, or whether the question paper contains items that are beyond the class level.

Concurrent Validity: Concurrent validity and predictive validity are the sub-classification based on the time interval between the predictor variable and the criterion variable. These two sub-classes are known as the criterion-related validity (Nworgu, 2006). He stated further that if the both predictor variable and criterion variable are obtained at the same time, it is referred to as concurrent validity.

Construct Validity: According to Fairchild (2008) construct validity is directly concerned with the theoretical relationship of a variable (e.g. a score on some scale) to other variables. It is the extent to which a measure behaves the way that the construct it purports to measure should behave with regards to established measures of other construct.

Predictive Validity: This is concerned with the degree to which success in a particular test can be used to predict success or failure in another test or activity. It is obtained by testing at intervals of two different tests.

Criterion – Referenced Validity: The criterion related validity of a test for assessing skills is of two types viz; concurrent and predictive. Concurrent validity has to do with the extent to which performance in one test or activity could be used to predict performance in another test or activity taking place at the same time (Denga, 1987). This type of validity is necessary when a test for assessing skills especially in general metalwork is constructed with a view to replacing less efficient one in use.

Table of Specifications

Ombugus (2014) defined a table of specification as a table that provides general outline of intended emphasis of assessment and the assessment approaches. Similarly, Anene and Ndubuisi (2003) refers to a test blue print or table of specification as a two way grid table, which specifies the level of objectives as they relate to the content of the subject, a means of ensuring content validity of the assessment, they stressed further that, values in a test blue print or table of specification is used as a guide in test development and construction, there is tendency to

overhead the assessment with items that cover only limited content area of limited levels of objectives.

UNESCO (2002) described the Table of specification as a two chart in which content of a course/topic are correlated to the outcome/competencies, which describe the skills to be achieved from the course of the study. Similarly, UNESCO (2002) suggested the following steps for developing Table of Specification:

1. Referring to the syllabus to isolate the objectives or skills to be assessed.
2. Developing a two way chart using the objectives or skills and domain relevant to the objectives or skills.
3. Developing the test format to match the specification in the chart
4. Designing a marking scheme

Denga (1987) suggested the steps for developing Table of Specification: selecting content areas relevant to objective; and deciding on the relative importance of the various content areas and assigning appropriate weights in percentages.

A well-constructed table of specification has a very high degree of distribution of test items along the various levels of the skills or competencies being assessed (Anatasi, 1987; and Martens 1998).Cohen et al (2011) explained that the content validation of a test can be achieved by subjecting such a test to factor analysis. The authors further suggested that the factorial analysis would discard the test items with factor loading less than 3.50 as cut-off point. To ensure that the workshop based process skill assessment is properly content validated; some the suggestions were considered and used. For this study, the table of specifications includes activities involving operations in fitting and the psychomotor domain levels and number of assessment items allocated.

Factors to Consider in **Developing Workshop Based Process Skill Assessment Items in General Metalwork**

Santrock (2009) noted that good assessment instrument do not just emerge, it involves proper planning and careful considerations. Assessing psychomotor or manipulative skills cannot be successfully carried out by using written test or interview, Osinem (2008) and Ogwo and Oranu (2006) explained that, the psychomotor test is used when paper-and pencil test would not be a valid predictor because of the nature of the aptitude to be tested; they referred to such test as the psychomotor test. According to Jones and Hambleton, (1999), psychomotor assessment incorporates the following features: by placing the emphasis on performance, they assess not only what a student knows, but also what a student can do. Whenever possible, direct methods of assessment are used that is designed specifically to measure directly the actual job performance of students in the area being taught.

Psychomotor assessment is necessary, as explained by Santrock (2009) when it is found to closely evaluate manipulative skills needed to perform a particular job or process. To assess performance, Swanson (1999) stated that, the teacher owns a duty to devise methods which could be used to assess the student, and that an appropriate measure should be taken to prepare assessment instruments which should be constructed to contain factual data, and give an accurate measure of what is being assessed. Wiersma and Jurs in Opeyemi (2014) suggested a four step procedure for developing workshop based assessment that includes:

1. Defining task to be performed by stating what the students are expected to do.
2. Defining constraints or conditions necessary for executing the task such as tools and equipment.

3. Deciding on appropriate time
4. Developing evaluation criteria, process, product or both.

These procedures are relevant in constructing specific measure. The model does not include suggestions on assessment blue print. However, same steps were considered for this study.

Process and Product Assessment in General Metalwork

Simpson (1972) explained two main methods for assessing the amount of skills possessed by students. There are: (1) Process assessment and (2) Product assessment. Process assessment involves step by step of carrying out the practical activities in the workshop. For example, if a general metalwork student is to make a metal scoop, process assessment will include observing him in the sequence or step by step of selecting, measuring, cutting his stock and joining them to produce the metal chair. It is assumed that a good and useful product would result if all the steps/stages are correctly followed and carried out. Product assessment is not interested in observing the student in the construction or servicing of the article, it is only interested in final result. In product assessment, only the final product is assessed. In the example given above, product assessment would involve the evaluation of the scoop produced by the student if it satisfies certain criteria such as good design, strong joints, good finishing and usability. Good products would attract high marks even if it received outside assistance, achieved through trial and error method or even purchase from the market. The scores awarded are based on personal assessment by the rater not minding the process involved since the rater was absent when the item was produced. A hacksaw sawing test is also useful in illustrating the difference between process assessment and product assessment. If the teacher carries out process assessment, he would write down the processes such as measuring size, marking out, clamping work in vice, cutting speed and accuracy in sawing. Product assessment on the other hand would involve an assessment of the final sawn piece with reference to general appearance, squareness and straightness of cut.

From the above examples, this study is concerned with assessing the process skills in fitting operations using process skill tests developed through Simpson's taxonomy of psychomotor domain. Simpson (1972) gave direction for effective administration of process skill tests as:

a. Prepare work area and provide students with all necessary equipment, tools, and materials required to complete the test.
b. Inform students prior to the test about all points that will enter into their rating.
c. Create working conditions that are as nearly identical as possible for each student being tested, whether several students are being tested at one time or each is tested individually.
d. Do not offer any assistance other than to clarify directions during the test.
e. Instruct the students to follow directions carefully; make certain that students understand clearly what they are expected to do and how much time is available to complete the entire test.
f. The test should contain a rating scale options requiring a minimum of writing so that one can concentrate upon the observation of students' performance. Be familiar with scale items prior to the administration of the test.

This study viewed this segment of the literature reviewed very relevant because of its direct relationship with the mode of construction and administration of the instrument developed. Process skill tests are one means of assessing students' gains and acquisition of specific skills. Students are assessed under controlled conditions for psycho-performance in General metalwork

operations related to speed or rate of work, quality or precision of work and procedure compared with a pre-determined standard. The choice of process skill rating assessment method is based on the fact that it helps the evaluator to discriminate between groups of students. Thus, it is a very useful evaluation to be used for further placement of the students.

Workshop-based process skill assessment instrument is an instrument for determining the extent to which students can demonstrate the practical competencies in general metalwork using rating scale while the examiner is observing the students as they perform operations of the trade. For effective assessment, the workshop-based process skill assessment should be valid and reliable.

Assessment in any educational programme ascertains the outcome of the learners' achievement in terms of the knowledge, skills, attitudes, ability and intelligence acquired in the course of study (Bukar, 2006). This is why different organizations for different reasons carry out assessment in different forms. A very important criteria for objective and reliable assessment of tasks performance as suggested by Yalams (2001) is to construct and use a well-designed assessment instrument. According to him, assessing students without using valid assessment instruments, teachers will be generating and working with unreliable data which will mislead both the students and their future employers. Ogbozor (2006) sees development of assessment instrument as the process of producing or creating tools that can be used for assessing students' performance of practical task operations. For a valid and effective assessment instrument, Ogbozor further suggested that the following criteria should be considered when developing assessment instrument.

(i) Clearly defining the aim of the study in the instrument;
(ii) List out all the attributes or characteristics that need to be observed in the study;
(iii) Decide on the recording system to be used
(iv) Construct the required model for recording observations; the assessment instrument;

According to Gall and Borg (2007), assessment is any structured performance situation that can be analysed to yield numerical scores, from which inferences can be made about how individuals differ in the performance construct measured by the assessment. Ezeji (2004) noted that assessment with process skill rating is an appropriate procedure for finding out the extent to which vocational and technical education has attained its stated objectives. In the same vein, Bukar (2006) stated that any assessment instrument with process rating is suitable for assessing skills possessed by students in technical colleges.

Process skills assessment items connote the presentation of step-by-step practical activities to be executed by the learner in a workshop (Ombugus, 2014). Okwelle and Okoye (2012) conceived process skill test items as a device for determining the extent to which students can demonstrate observable skills taught and to perform them under conditions similar to working condition of the trade. In the same vein, Okwelle and Okeke (2012) viewed process skill test items as step by- step activities necessary to determine candidate's level of performance and to ascertain the possible skill gained after exposure to practical exercise. Process skills assessment cannot be achieved with the current mode of assessment carried out in general metalwork at the technical college level. The current mode of assessment adopts the use of an achievement test instrument developed in the cognitive domain of educational objective which measure only recall of facts that are considered unsuitable for such a skill oriented learning (Onyiliofie, 2008).

Assessment of students' skills in general metalwork examination at the technical college level in north eastern Nigeria is carried out after classroom instruction by the class teacher and by NABTEB at the end of the programme. The mode of assessment used by NABTEB only helps to determine student achievement in the cognitive domain and the practical assessment instrument made use of a rating scale which only rates a very few processes leaving out major procedural steps required to perform and finish tasks. This thereby renders students' skills assessment invalid and unreliable especially in general metalwork in technical colleges in north eastern Nigeria (Opeyemi, 2014). For assessment instrument to be result oriented, teacher and public examination bodies should design and develop appropriate assessment instrument in the psychomotor domain that can adequately assess the manipulative skills possessed by students.

In most vocational and technical institutions in Nigeria, there seems to be great difficulty on the part of the teachers in conducting adequate and unbiased assessment of practical skills and activities of students (Yalams, 2001). There are also negative practices inherent in the assessment of practical activities in general metalwork and other skilled related programme which is largely attributed to absence of adequate assessment instrument. According to Yalams (2001), most teachers in metalwork assess their students based on finished work not minding the process leading to the finished item. Others assess their students' work based on cursory look. Odu in Opeyemi (2014) noted that process assessment is subject to a number of different types of errors, consequently suggesting a well-constructed rating scale, accompanied by explicit instructions of what qualities to look for, step by step procedure in accomplishing each task which will result in instrument validity and reliability. Yalams (2001) noted some attributes of the process skill rating scale as ability to analyze and plan for work, skills/competencies and procedures in the use and care of tools and equipment could be observed and assessed, also safety practices, ability to read and apply easily technical information, the quality of work generally could be systematically observed, objectively and comprehensively assessed. On the other hand, assessment of student in practical activities based on the finished product alone can be considered as subjective and prone to abuse by the evaluators and it is equally prone to some malpractices on the part of the student and also not very feasible in skill oriented programme like general metalwork.

Experiences in technical colleges show that NABTEB sends her practical examination question papers to schools two weeks ahead of examination date. Students are left on their own to produce products in the workshop without their teachers' intervention. On the examination day, one examiner is sent to each college to rate finished products and marks are awarded based on mere looking and checking the end results of students' activities. This practice encourages examination malpractice as students can get assistance from outside to produce products presented for final assessment. This assessment practice is considered subjective and prone to abuse by both students and the raters. The practice of the examining body, has given room to product assessment without students process skill development. Most general metal work graduates lack skills and yet have good grades in their results. With product assessment, it is obvious that the objective of general metal work for productive skill development cannot be achieved. Against this back ground therefore, there is a need to develop a valid and reliable workshop- based skill assessment document that can be used to assess skills of student and can complement the present achievement test used by teachers and examination bodies in order to enable students to demonstrate the acquisition of manipulative skills in General metalwork trade at the technical colleges.

Statement of the Problem

NABTEB has been using product assessment technique in the form of marking scheme or checklist. This is done at the expense of judging the production process of students through Workshop Based Process Skill Assessment (WBPSA). Experience in technical colleges show that NABTEB sends their practical examination question papers to schools two week ahead of examination date. Students are left on their own to produce items in the workshop without their teachers' assistance or intervention. On the examination day, one examiner is sent to each college to rate finished products and marks are awarded based on mere looking and checking the end results of students' activities. Students can get assistance from outside to produce products presented for final assessment. This assessment practice is considered subjective and prone to abuse by both students and the raters. The practice of the examining body, has given room to product assessment without students process skill development. Most General metalwork graduates lack skills and yet have good grades in their results.

According to Aminu (2015), the current mode of assessing students` practical skills in technical colleges, through the use of marking scheme or checklist used by NABTEB in their examination is based on products assessment. Similarly, the approach used by the teachers after classroom instruction is tailored to the pattern used by NABTEB in measuring the performance of students. The implication of this is that the scores and grades assigned to students in practical works by the teachers or examiners may not be the true representative of the students' performance. Based on practices of using checklist for assessment by the teachers and the examination bodies, some of the performance objectives of each of the skill areas in general metalwork could not be attained. Evidence in the field of general metal work revealed that graduates of General metalwork cannot practice on their own or get sustainable employment. Hence the need to try out an alternative method of assessing the practical abilities of graduates of general metalwork in technical college.

Purpose of the Study

The major purpose of the study is to develop and validate workshop-based process skill assessment items in metalwork fitting operations for assessing students in technical colleges. Specifically, the study will seek to:

1. Determine major workshop based skills in fitting operations to be carried out by students of metalwork fitting operations in technical colleges in north eastern Nigeria.
2. Establish the validity of the developed instrument for assessing work-based process skills in metalwork fittings operations among students in technical colleges in north eastern Nigeria.

Research Questions

The study seek answers to the following research questions

1. What are the workshop-based process skill assessment items for assessing students' skills in fitting operations?
2. What is the validity of the developed workshop – based process skills in fitting operations general metalwork?

Methodology

The study will utilize instrumentation research design. This research design is appropriate for this study since the study will seek to develop an instrument for assessing skills of students in metalwork fitting operations.

The area of the study will be North eastern region of Nigeria. These states are; Adamawa, Bauchi, Borno, Gombe, Taraba and Yobe states. This region is located between longitude $11^{0}73^{1}$N and latitude $10^{0}14^{1}$E of the Greenwich Meridian and lies within the. North eastern region of Nigeria. Nigeria's total land area is 103,639sq/km2. (World Atlas Map). The study will be carried out in 4 technical colleges in the north eastern region of Nigeria.

The target population of the study will be 776. This will comprise 712 NTC III students offering general metalwork in all the 4 technical colleges in 2018/2019 academic session and 64 general metalwork teachers 'in the 4 technical colleges in north eastern Nigeria. There will be no sampling technique as the entire population in the affected states will be used.

All the research assistants that will be used in the metalwork fitting process skills assessment instrument to assess the performance of the students in fitting operations in metalwork. The instrument will be administered on metalwork students in the NTC III class under practical examination condition. Within each contact period a minimum of one and a maximum of three tasks will be assessed. The students will be briefed on how to undergo the assessment. Thereafter, each student will be assigned to a work station and will be instructed to carry out the tasks starting with task one. Each task will be given a specified time of between 20minutes and 1 hour. The raters will rate the students and submit the rated instrument to the principal of the school where the researcher will collects back the instrument after sometimes. The ratings of the students will be used as data for answering the research questions.

To answer Research Question 1 the process skill items will be analysed using SPSS version 23 to compute for the mean which will be used to determine the appropriateness of item inclusion in the WBPSA and standard deviation. Any item with mean 3.50 and above will be considered appropriate for inclusion in the assessment instrument and any item with a mean less than 3.50 will be discarded. To answer Research Question 2, the content validity will be determined using Simpson's (1972) taxonomy of psychomotor objectives in generating the assessment items. Also comments of experts in vocational Technical Education and measurement and evaluation will be utilized to determine the face validity of the assessment items. For Research Question 2, the data that will be collected from the four assessors A, B, C and D in each of the four schools will be paired into six AB, AC, AD, BC, BD and CD respectively. The reliability correlation coefficient between the paired scores will be determined using Pearson Product Moment Correlation Coefficient using SPSS version 22. To determine the reliability of an item or cluster, a cutoff point of 0.3 and above from at least 3 of the paired scores of AB, AC, AD, BC, BD and CD will be accepted for inclusion in the final draft of the instrument using the following PPMC guidelines.

	Coefficient, *r*	
Strength of Association	Positive	Negative
Lowly Reliable	0.1 to 0.29	-0.1 to -0.29
Reliable	0.3 to 0.49	-0.3 to -0.49
Highly Reliable	0.5 to 1.0	-0.5 to -1.0

Results of the Study

Research Question 1: What are the workshop-based process skill assessment items for assessing students' skills in fitting operations? This research question is answered in the table 3 below:

Table 1: Mean ratings of Respondents on the Appropriateness of the Skill Items for Inclusion in the Workshop-Based Process Skills Assessment (WBPSA) for Fitting Operation

S/N	n=57	$\bar{X}$	δ	Remark
Task 1: Producing a garden trowel				
1	Selecting appropriate materials	3.54	0.71	Appropriate
2	Selecting appropriate tools	3.65	0.70	Appropriate
3	Marking out to required measurements	3.68	0.77	Appropriate
4	Shearing out and filing to produce safe edges	3.75	0.69	Appropriate
5	Fastening work in a bench vice together with a hardwood cylinder	3.61	0.59	Appropriate
6	Hammering the blade to a suitable curve	3.88	0.75	Appropriate
7	Bend up the tang to the given measurement	3.53	0.57	Appropriate
Task 2: Drilling a hole with hand drill				
8	Selecting the correct drill bit	3.81	0.75	Appropriate
9	Pull back on the handle to open the chuck jaws	3.79	0.75	Appropriate
10	Holding the shell of the chuck to insert a drill bit	3.77	0.77	Appropriate
11	Turning the handle forward to tighten the drill	3.91	0.75	Appropriate
12	Clamping in a bench vice	3.61	0.59	Appropriate
13	Drilling the hole by turning handle in a clockwise direction	3.88	0.75	Appropriate
Task 3:Constructing a name plate				
14	Selecting the appropriate material	3.70	0.65	Appropriate
15	Measuring and marking out to specified dimensions	3.88	0.81	Appropriate
16	Filing of the edges and corners	3.74	0.68	Appropriate
17	Marking off the positions of the holes	3.77	0.66	Appropriate
18	Drilling the specified number of holes	3.74	0.68	Appropriate
19	Counter sinking for wood screws	3.81	0.81	Appropriate
20	Marking off two parallel lines of 3mm gap to act as guide lines for printing	3.79	0.65	Appropriate
21	Using letter punches, stamp in the name and address	3.68	0.73	Appropriate
22	Dipping in clean lacquer for surface protection	3.96	0.79	Appropriate
Task 4: Shearing a metal plate				Appropriate
23	Selecting the materials	3.96	0.81	Appropriate
24	Measuring out	4.07	0.77	Appropriate
25	Fixing work between plates	3.84	0.73	Appropriate
26	Aligning marked line with the cutting blade	3.86	0.70	Appropriate
27	Pressing shear handle down ward to shear off the work	3.53	0.56	Appropriate
Task 5:Soldering two metal pieces together				
28	Selecting the pieces	3.75	0.66	Appropriate
29	Selecting the tools	3.84	0.73	Appropriate
30	Clearing surfaces to be joined	3.88	0.70	Appropriate
31	Selecting correct soldering device	3.61	0.51	Appropriate
32	Selecting correct soldering flux	3.72	0.62	Appropriate
33	Heating soldering bit to appropriate temperature	3.63	0.65	Appropriate
34	Tinning the bit	3.60	0.61	Appropriate
35	Uniting parts together	3.63	0.72	Appropriate

Task 6: Bending a metal rod				
36	Selecting the material	3.79	0.84	Appropriate
37	Selecting the tools	3.77	0.66	Appropriate
38	Checking a full size drawing of the part to be bent	3.77	0.72	Appropriate
39	Measuring and marking out	3.88	0.76	Appropriate
40	Deciding which is to be made first(if more than one bend is required)	3.61	0.62	Appropriate
41	Bending the work piece by striking it with hammer near the bend line	3.72	0.64	Appropriate
Task 7: Filing a metal piece flat and square				
42	Measuring out	3.89	0.73	Appropriate
43	Cutting out to required length and breadth	3.58	0.67	Appropriate
44	Choosing the appropriate file	3.81	0.69	Appropriate
45	Clamping work in a bench vice	3.79	0.67	Appropriate
46	Filing the face side	3.58	0.69	Appropriate
47	Filing the face edge	3.89	0.72	Appropriate
48	Filing the second side and edge to required size	3.70	0.65	Appropriate
49	Polishing with emery cloth	3.86	0.70	Appropriate
Task 8: Threading a metal bolt				
50	Selecting the material	3.54	0.57	Appropriate
51	Measuring and marking out	3.74	0.65	Appropriate
52	Fastening the die in a die stock	3.65	0.69	Appropriate
53	Grinding a chamfer on one end of the work piece	3.63	0.62	Appropriate
54	Clamping the work piece in the vice and placing a die on chamfered end of the piece	3.84	0.73	Appropriate
55	Holding one hand over the centre of the work piece and applying pressure to get the first threads started	3.74	0.65	Appropriate
56	Turning the die stock back frequently to break the chips	3.93	0.72	Appropriate
57	Backing off the die when the desired length of thread is cut	3.74	0.65	Appropriate
Task 9: Heat treating a metal product				
58	Heating to the required temperature	3.61	0.58	Appropriate
59	Maintaining the temperature for a certain length of time	3.74	0.66	Appropriate
60	Putting off the heat	3.77	0.67	Appropriate
61	Cooling in a way that will give the desired result	3.58	0.65	Appropriate
Task 10: Assembling with metal fasteners				
62	Selecting the fastener	3.54	0.52	Appropriate
63	Checking the fastener for length	3.74	0.63	Appropriate
64	Inserting fastener in the holes	3.61	0.56	Appropriate
65	Pressing or tightening the parts together	3.60	0.57	Appropriate
Task 11: Making a vice clamp				
66	Selecting the material	3.72	0.64	Appropriate
67	Measuring the required size	3.65	0.62	Appropriate
68	Marking off the corners as given	3.68	0.60	Appropriate
69	Fastening in the vice and bend with a hammer	3.67	0.61	Appropriate
70	Rounding up the corners with a smooth file	3.74	0.68	Appropriate
Task 12: Production of a depth gauge				
71	Selecting the appropriate material	3.51	0.61	Appropriate
72	Measuring out to the required size	3.72	0.67	Appropriate
73	Marking out	3.65	0.67	Appropriate

74	Cutting to required size	3.68	0.61	Appropriate
75	Punching the centres	3.89	0.73	Appropriate
76	Drilling the required holes	3.51	0.55	Appropriate
77	Controlling threading taps	3.75	0.68	Appropriate
78	Providing the required metal bar	3.51	0.58	Appropriate
79	Finishing the metal surface	3.58	0.69	Appropriate

n = Number of Teachers

In Table 1**,** task 1, respondents rated the seven skill items in producing a garden trowel as relevant with mean ranging from 3.53 to 3.88. This shows that the seven skill items were accepted by the respondents as appropriate for inclusion in the process skill for assessing student's performance of task 10 in producing the garden trowel.

Task 2 revealed that respondents rated the six skill items in drilling a hole with a hand drill as relevant with mean ranging from 3.61 to 3.91. This indicated that the six skill items were accepted by all respondents as appropriate for inclusion in the process skill for assessing student's performance of task 2.

Task 3 shows that respondents rated the nine skill items in constructing a name plate as relevant with mean rating ranging from 3.68 to 3.96 This indicates that the nine skill items were accepted by all respondents as appropriate for inclusion in the process skill document for assessing student's performance of task 3.

Task 4 showed that respondents rated the 5 skill items in shearing a metal plate as relevant with mean rating ranging between 3.53 to 4.07. This indicates that the 5 skill items were accepted by all respondents as appropriate for inclusion in the process skill document for assessing student's performance in shearing a metal plate in task 4.

Task 5 revealed that respondents rated the eight skill items in soldering two metal pieces together as relevant with mean ranging from 3.60 to 3.88. This indicated that the eight skill items were accepted by all respondents as appropriate for inclusion in the process skill for assessing student's performance of task 5.

Task 6, in table 3 indicated that respondents rated the six skills in bending a metal rod as relevant with mean ranging from 3.61 to 3.88. This indicated that the six skill items were accepted by all respondents as appropriate for inclusion in the process skill for assessing student's performance in bending a metal rod of task 6.

Task 7 revealed that respondents rated the eight skill items in filing a metal flat and square as relevant with mean ranging from 3.58 to 3.89 and a standard deviation between 0.65 to 0.72 This means that the eight skill items were accepted by all respondents as appropriate for inclusion in the process skill for assessing student's performance of task 7.

In the same vein in task 8 respondents rated the eight skill items in threading a metal bolt as relevant with mean ranging from 3.54 to 3.93 and a standard deviation between 0.57 to 0.72 This means that the eight skill items were accepted by all respondents as appropriate for inclusion in the process skill for assessing student's performance of task 8.

Task 9 showed that respondents rated the four skill items in heat treating a metal productas relevant with mean ranging from 3.58 to 3.77. This implies that the 4 skill items were relevant and appropriate for inclusion in the process skill for assessing student's performance in heat treating a metal product of task 9.

Task 10 showed that the respondents rated the four skill items in assembling with metal fasteners as relevant with mean ranging from 3.54 to 3.74. This implies that the respondents were

close in their ratings of the items, also the 4 skill items were relevant and appropriate for inclusion in the process skill for assessing student's performance of task 10.

Task 11 indicated that the respondents rated all the 5 skill items in making a vice clamp as relevant with mean rating ranging from 3.65 to 3.74 . This implies that all the five skill items were relevant and appropriate for inclusion in the process skill for assessing student's performance of task 11.

Task 12 indicated that the respondents rated all the nine skill items in producing a depth gauge as relevant with mean rating ranging from 3.65 to 3.74. This implies that all the five skill items were relevant and appropriate for inclusion in the process skill for assessing student's performance of task 12.

Research Question 2

What is the validity of the developed workshop-based process skill assessment (WBPSA) for assessing Students' skills in general metalwork?

This research question is answered in Table 5:

Table 2: Validated Tasks and Skill Items in Fitting Operations in General Metalwork

S/No	Fitting Task	Before validation	After Validation	Loss	Remark
1	Producing a garden trowel	7	7	0	Valid
2	Constructing a name plate	12	9	-3	Valid
3	Shearing a metal plate	8	5	-3	Valid
4	Soldering two metal pieces together	11	8	-3	Valid
5	Bending a metal rod	9	6	-3	Valid
6	Filing a metal piece flat and square	10	8	-2	Valid
7	Threading a metal bolt	11	8	-3	Valid
8	Heat treating a metal product	5	4	-1	Valid
9	Assembling with metal fasteners	6	4	-2	Valid
10	Making a vice clamp	7	5	-2	Valid
11	Production of a depth gauge	10	9	-1	Valid
	Total skill items	**96**	**73**	**-15**	

To answer Research Question 2, the table of specifications constructed based on the Simpson's model of psychomotor domain revealed that out of the 79 skill items, 24.48% comprising 19 skill items were assessing the Perception level; 13.33% comprising 11 skill items were assessing the Set level; 17.78% comprising 14 skill items were assessing the Guided response level; 22.96% comprising 18 skill items were assessing the Mechanism level; 21.48% comprising 17 skill items were assessing the Complex overt response level and 5.93%

comprising 5 skill items were assessing the Adaptation level. The Origination level of Simpson's Model was not involved in the study because it was not in the NTC curriculum. These results showed that 6 levels of the domain were adequately covered in the assessment method. This means that all the 79 skill items were valid for inclusion in the assessment instrument (see Appendix VIII). The assessment items were submitted to experts in Vocational Technical Education who reviewed the appropriateness of the face validity of the items in measuring students' process skills. The experts reviewed, reworded and re-structured the assessment items and made satisfactory comments about the entire assessment. On the whole as shown in table 2, there was 1 task with 11 corresponding process skill items on fitting operation with 79 corresponding process skill items on fitting operation. See (Appendix I).

Findings and Discussion of the Study

The findings of the study revealed that:

1 Seventy three (79) psychomotor skill items were rated suitable by teachers of fitting operation in general metalwork for inclusion in the assessment instrument.

2 The content validity of the assessment instrument showed that 19 out of 79 process skills assessed perception level, 11 assessed Set levels, 14 assessed Guided response level, 18 assessed Mechanism level, 71 assessed Complex overt response level and 5 assessed Adaptation level. This signified a balanced in the spread of distribution of the process skill items across the six levels.

Discussion of the Findings

The discussions of the findings were based on the research questions answered.

Seventy-nine (79) psychomotor skill items were rated suitable by teachers of general metalwork for inclusion in the assessment instrument for fitting operations. The study revealed that there are 11 tasks with 79 corresponding skill items. The mean rating of skill items in the fitting operations ranged between 3.51- 4.07. This shows that the developed assessment instrument possessed a high content validity.

The content validity of the assessment instrument showed that 19 out of 79 process skills assessed perception level, 11 assessed Set levels, 14 assessed Guided response level, 18 assessed Mechanism level, 17 assessed Complex overt response level and 5 assessed Adaptation level (Appendix VIII). This signified a balance in the spread of distribution of the process skill items across the six levels. This result was in agreement with the assertion by Fatunsin (1996), Odu (2001) and Bukar (2006) that the fairer the degree of distribution of test items the better representation of the behavioural domain and the higher the content validity of the assessment. The findings on content validation of the assessment items by using four experts in the field of vocational and technical education revealed that 12 workshop-based tasks and 79 process skills items were well worded and representative enough in terms of the content areas specified in the curriculum. This signified adequacy of sampling of the content areas in the curriculum, which the assessment was designed to assess. These results were consistent with the views expressed by Igbo (1997) that a test is valid if the performance it assesses corresponds to the objective it is supposed to assess. The findings of the author above gave credence to the findings of this study.

The findings of the study further revealed that fitting operation had 0.86. This is good enough for new assessments/tests. This is so because the obtained coefficient exceeded the recommendation of 0.396 for a population sample less than one hundred and twenty (120) by Ogwo (1993), Harbor-Peters (1999); and Nworgu (2006). These also exceeded 0.65

recommended by Denga (1987), Enyi (2009) and Cohen, et al (2011). However, the findings disagree with the recommendations by Gay (1976) and UNESCO (2002) of 0.9 for a new standardized test. The low value of coefficient as compared to Gay's recommendation and that of the UNESCO is probably because the process skill assessment was yet to be standardized. For the standardization of the assessment/test, several administrations/field testing would be required.

Conclusion

The major findings of this study serve as a basis for drawing conclusion that Workshop-Based Process Skill Assessment (WBPSA) is a reliable and valid instrument that could be used in assessing NTC III students' skills for fitting operations in general metalwork in technical colleges in north eastern Nigeria. WBPSA will also improve assessment procedure of fitting operations for general metalwork teachers in technical colleges to effectively assess students' performance in general metalwork tasks. In so doing, teachers will be able to show proof the scores and grades they award in students performances in general metalwork in technical colleges in north eastern Nigeria. Also, it is believed that students' skills performances in general metalwork in technical colleges will be improved.

Based on these findings, fitting operation (workshop-based) process skill assessment consisting of 12 tasks and 79 process skill items was developed.

Recommendations

Based on the findings from the study, the following recommendations are suggested:

1. Examination body in charge of conducting and organizing examinations for the technical colleges (NABTEB) should integrate the process skill assessment items in their examination for certification of students in general metalwork at NTC level.
2. The developed process skill rating scale and the process skill assessment items in general metalwork should be adopted by the West African Examination Council (WAEC) and National Examination Council (NECO) as a means of assessing automobile technology which happens to be one of the newly introduced 32 trade programmes for Nigerian secondary schools.
3. The WBPSA items should be used by the teachers in general metalwork at the NTC level to assess the students during teaching and at the terminal assessment of their students.
4. The developed process skill assessment items in general metalwork should be subjected to further try outs by the teachers in order to serve as a means of further assuring its efficacy, practical usefulness and eventual adoption for the assessment of practical skill acquisition in general metalwork at the NTC level.
5. All general metalwork workshops should be adequately equipped and obsolete tools, equipment and machines should be replaced with modern ones.

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