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# Development and Validation of Workshop-Based Process Skill Test in Metal Fitting for Improving Students' Skills in Technical Colleges for Work

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**Abstract**
The study focused on the development and validation of workshop-based process skill tests for assessing students in metal fitting trade in technical colleges. The study adopted the instrumentation design and was carried out in Nasarawa state. The population for the study was 25 NTC III students comprising 3 ability groups (8 high, 12 average and 5 low abilities). A 92 draft copy of workshop-based process skill items were validated and utilized to developed the WBPST. The test was used in assessing students in government technical college Mada Station. The data generated were analyzed using Cronbach Alpha, Kendell coefficient of concordance and Scheffe Test. The reliability of the test revealed coefficient of 0.76. It was found out that there were differences in the mean scores of the 3 ability groups (high, average and low). The inter-rater reliability coefficient of the WBPST was 0.57. It was therefore recommended that examination bodies (NABTEB and WAEC) should integrate the workshop-based process skill test items in their examination process for certification of NTC students.
**Keywords:** Development, Validation, Metal fitting, Process assessment, Technical College, Skill improvement

## Introduction

Metal fitting is one of the job areas in mechanical engineering craft in technical colleges, in which students are examined by the National Business and Technical Examination Board (NABTEB) for the award of National Technical Certificate (NTC).The main objective of metal fitting module is to produce competent craftmen who would be able to produce spare parts to specifications and carry out daily maintenance of tools and equipment. The National Board for Technical Education (NBTE) (2003) emphasized that the metal fitting module when successfully completed can be used for employment purposes. Ombugus (2013) explained that fitting means preparing mating parts to touch or join each other in such a way that one will turn inside another, one will slide upon another, or the parts will hold tightly together so that they cannot move upon each other. Metal fitting is a module of study involving skills to produce, repair, maintain and assemble metallic components together. Sawing, shearing, filing, bending, soldering, thread-cutting, heat treatment and assembling are tasks necessary to make part fit.

The metal fitting objective is meant to achieve adequate development in skills which can make the recipient employable. To achieve this goal at the NTC level, learners need to be well assessed. Jimoh (2010) observed that product evaluation used by NABTEB only help to determine students' achievement of metal fitting objectives in cognitive and affective domains. Ogbu (2011) pointed out that there are negligible observable results in achievement of psychomotor objectives. Williams (2012) stated that metal fitting practical examination conducted by NABTEB and teachers are mere products rating and not process rating of students. Similarly, Jain (2010) noted that the assessment of manipulative activities as acquired by the students in the production processes need to be ascertained through workshop-based process skill test (WBPST). In Crowder (2010), workshop-based process skill test connote the presentation of step-by-step practical activities to be responded to by the learners in a typical workshop setting. Workshop-based process skill test is then an instrument for determining the extent to which students can demonstrate the practical competencies in metal fitting using process rating
scale while the examiner is observing the students perform the operations involved. For effective assessment, the workshop based process skill test items should be valid and reliable.

Validity, according to Effiong, (2012), is the property that ensures that the instrument measure what it is suppose to measure. In other words, the validity of workshop based process skill test is the extent to which the students intended practical competencies outlined in the NTC curriculum are covered by the test items.

In Okeme (2013), reliability of a measuring instrument is the ability of the instrument to measure consistently the phenomenon it is designed to measure. It is the consistency with which an instrument measure whatever it

measures. The use of valid and reliable workshop based process skill test for assessing NTC students in metal fitting will ensure that students are taught the proper way of performing tasks according to their ability levels. Ability level according to Adeyemo (2010) means characteristic mode of functioning that enable an individual show in, intellectual activities in a highly consistent and persuasive way. Ability level of a student in technical college is then personality characteristic that influence that student's school performance. Adeyemo (2010) identified three ability levels in relation to teaching-learning situation, viz: High, average and low.

In technical colleges in Nasarawa state, NABTEB is accorded the responsibility of assessing the performance of students in metal fitting trade. The examining body has been using product evaluation technique in the form of marking scheme checklist. This is done at the expense of judging the production process of students through WBPST. Experience in technical collages shows hat 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 teacher's intervention. On the examination day, one examiner is sent to each college to rate 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. Sometimes, the finished products submitted are bought from the market. 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 evaluation without students process skill development. Most metal fitting graduates lack skills and yet have good grades in their results. Zhang and Lam (2013) explained that the objectives of metal fitting cannot be achieved with product evaluation. Evidence in the field revealed that graduates of metal fitting trade in cannot practice on their own or get sustainable employment. The students skills cannot be guarantee with the present NABTEB mode of assessment, hence the need to try out an alternative method.

**Purpose of the study**

The major purpose of the study was to develop and validate workshop-based process skills test items in metal fitting for assessing students' skills at NTC level in Nasarawa state.

Specifically, the study sought to:

1. Develop workshop-based process skill test items in metal fitting at NTC level
2. Determine the validity of the developed workshop based process skill test in metal fitting at NTC level
3. Establish the reliability of the developed workshop based process skill test in metal fitting at NTC level
4. Determine the ability levels of students in metal grinding at NTC level

**Research Questions**

The study sought answers to the following research questions:

1. What are the workshop-based process skill test items for assessing students' skills in Metal fitting at NTC level?
2. What is the validity of the developed workshop-based process skills test for assessing students' skills in metal fitting at NTC level?
3. What is the reliability of the developed work based process skill test for assessing students' skills in metal fitting at NTC level
4. What are the ability groups of students in metal fitting at NTC level?

**Hypothesis**

$H_o$: There is no significant difference in the mean ratings of students on the workshop-based process skill test in metal fitting based on their ability levels (High, average, and low).

**Methodology**

**Design of the study**

The study utilized the instrumentation research design.

**Area of the study**

This study was carried out in Nasrasawa state, Nigeria and covered the four technical colleges in the state.

**Population for the study**

The population for the study was 25 NTC lll students in government technical college, Mada Station. No sampling was carried out because the population was manageable.

**Instrument Development**

The workshop based process skill test that consisted of 12 tasks and 89 process skill items was developed as the instrument for the study. The following processes were involved:

1. Isolation of performance objectives from the metal grinding curriculum.
2. Identification of the tasks in the metal grinding curriculum.

3. Identification of parameters that were used to develop the workshop based process skill test.
4. Preparation of table of specification.
5. Construction of workshop based process skill test items. The tasks and skill items developed are shown in Table 2.

**Validation of Instruments**

To determine important process skills for inclusion into the final test instrument, the following validations were carried out - Factor analysis, using 0.40 as factor loading at 10% over lapping variance (Ashley et al (2007). In the result, 5 skill items with factor loading less than 0.40 were discarded while 87 with factor loading of 0.40 and above were selected for the study.

A table of specifications was developed based on the curriculum content giving due consideration to the six levels of Simpson's (1972) model of psychomotor domain. This helped in ensuring that the 87 process skills were adequately distributed across the level of the domain. The table of specification, the draft workshop-based process skill tests and the curriculum in mechanical engineering craft at NTC level were validated by 3 experts from the department of Vocational Teacher Education (VTE) and 2 in measurement and evaluation from the department of Science Education, University of Nigeria, Nsukka. The experts assessed the test for proper wording, consistency and representativeness. Their corrections and suggestions were utilized in improving the test.

**Reliability of Instrument**

The internal consistency of the metal fitting process skills were determined using the Cronbach alpha method to analyze test scores of the 25 students who were used for the field testing of the tests. The results revealed reliability coefficients of 0.83 for fitting operations. Based on the suggestions of Bukar (2006), every fifth out of the 25 students was systematically selected and rated by five teachers. Their rating scores were analysed using Kendall coefficient of concordance (Tau). The results revealed that the Kendall correlation coefficients between rater 1 and 2 is 0.71, 2 and 3 is 0.81, 3 and 4 is 0.60 and 4 and 5 is 0.80. Each of these scores represent the degree of relationship or association between the ratings of the 4 paired raters on level of performance among the 25 students of mechanical engineering craft. Sensiter (1969) in Olaitan (2003) stated that tests with reliability coefficients of 0.70 and above are considered sufficiently reliable to be of practical use. This means that the WBPST in metal fitting is reliable.

**Data Collection and Analysis**

The workshop-based process skill test was try tested on 25 NTC lll students in government technical college,Mada Station.Data were collected during students practical activities. Cronbach alpha method was utilized to establish the internal consistency of the questionnaire items. The results revealed reliability coefficient of 0.82. The findings were used to develop WBPST for the study. The developed WBPST was built on a five-point scale namely: very low (VL); Low (L); Moderately High (MH); High (H) and Very High (VH). These levels of responses were weighted as 1, 2, 3, 4 and 5 respectively. The workshop-based process skill test was administered on the students of metal fitting using raters to determine the extent of skills they possessed. Factorial analysis was used in answering research question 1. Simpson (1972) psychomotor domain levels and experts' comments were utilized to answer research question 2. Research question 3 was answered using Cronbach alph coefficient. Research question 4 was answered through a 9 skill items test while ANOVA was employed to test the hypothesis at 0.05 level of probability.

**Results**

The results of the study are presented according to headings that correspond to the research questions and the hypothesis tested as indicated in tables 1-5

***Workshop-based process skill test items for assessing students' skills in Metal Fitting at NTC level***

For selecting the tasks and process skill items important for inclusion in the workshop-based process skill test, 0.40 as factor loading was used. Any skill item with factor loading of 0.40 and above was important and any skill item with factor loading less than 0.40 was not important. Ten tasks with their 87 corresponding process skill items were found suitable for inclusion in the WBPST,(see table 1).

 

**Summary of Factor Analysis Results**

| S/No | Skill item | Factor loading | Remark | S/No | Skill item | Factor loading | Remark |
|---|---|---|---|---|---|---|---|
| 1 | ITEM FO1 | .586 | Important | 49 | ITEM FO49 | .466 | ” |
| 2 | ITEM FO2 | .735 | ” | 50 | ITEM FO50 | .076 | ” |
| 3 | ITEM FO3 | .747 | ” | 51 | ITEM FO51 | .508 | ” |
| 4 | ITEM FO4 | .886 | ” | 52 | ITEM FO52 | .599 | ” |
| 5 | ITEM FO5 | .792 | ” | 53 | ITEM FO53 | .517 | ” |
| 6 | ITEM FO6 | .661 | ” | 54 | ITEM FO54 | .789 | ” |
| 7 | ITEM FO7 | .642 | ” | 55 | ITEM FO55 | .661 | ” |
| 8 | ITEM FO8 | .456 | ” | 56 | ITEM FO56 | .521 | ” |
| 9 | ITEM FO9 | .751 | ” | 57 | ITEM FO57 | .698 | ” |
| 10 | ITEM FO10 | .646 | ” | 58 | ITEM FO58 | .716 | ” |
| 11 | ITEM FO11 | .625 | ” | 59 | ITEM FO59 | .675 | ” |
| 12 | ITEM FO12 | .788 | ” | 60 | ITEM FO60 | .764 | ” |
| 13 | ITEM FO13 | .514 | ” | 61 | ITEM FO61 | .768 | ” |
| 14 | ITEM FO14 | .642 | ” | 62 | ITEM FO62 | .515 | ” |
| 15 | ITEM FO15 | .456 | ” | 63 | ITEM FO63 | .580 | ” |
| 16 | ITEM FO16 | .751 | ” | 64 | ITEM FO64 | .620* | Not important |
| 17 | ITEM FO17 | .646 | ” | 65 | ITEM FO65 | .489 | Important |
| 18 | ITEM FO18 | .625 | ” | 66 | ITEM FO66 | .710 | ” |
| 19 | ITEM FO19 | .788 | ” | 67 | ITEM FO67 | .632 | ” |
| 20 | ITEM FO20 | .514 | ” | 68 | ITEM FO68 | .542 | ” |
| 21 | ITEM FO21 | .655 | ” | 69 | ITEM FO69 | .341 | ” |
| 22 | ITEM FO22 | .443 | ” | 70 | ITEM FO70 | .756 | ” |
| 23 | ITEM FO23 | .536 | ” | 71 | ITEM FO71 | .703 | ” |
| 24 | ITEM FO24 | .413 | ” | 72 | ITEM FO72 | 549 | ” |
| 25 | ITEM FO25 | .543 | ” | 73 | ITEM FO73 | .451* | Not important |
| 26 | ITEM FO26 | .722 | ” | 74 | ITEM FO74 | .488 | Important |
| 27 | ITEM FO27 | .693 | ” | 75 | ITEM FO75 | .642 | ” |
| 28 | ITEM FO28 | .588 | ” | 76 | ITEM FO76 | .776 | ” |
| 29 | ITEM FO29 | .544 | ” | 77 | ITEM FO77 | .609 | ” |
| 30 | ITEM FO30 | .547 | ” | 78 | ITEM FO78 | .816 | ” |
| 31 | ITEM FO31 | .496 | ” | 79 | ITEM FO79 | .027 | ” |
| 32 | ITEM FO32 | .523 | ” | 80 | ITEM FO80 | .421 | ” |
| 33 | ITEM FO33 | .497 | ” | 81 | ITEM FO81 | .687 | ” |
| 34 | ITEM FO34 | .551 | ” | 82 | ITEM FO82 | .519 | ” |
| 35 | ITEM FO35 | .663* | Not important | 83 | ITEM FO83 | .695* | Not important |
| 36 | ITEM FO36 | .625 | Important | 84 | ITEM FO84 | .436 | Important |
| 37 | ITEM FO37 | .841 | ” | 85 | ITEM FO85 | .212 | ” |
| 38 | ITEM FO38 | .240 | ” | 86 | ITEM FO86 | .841 | ” |
| 39 | ITEM FO39 | .467 | ” | 87 | ITEM FO87 | .551 | ” |
| 40 | ITEM FO40 | .458 | ” | 88 | ITEM FO88 | .665 | ” |
| 41 | ITEM FO41 | .742 | ” | 89 | ITEM FO89 | .518 | ” |
| 42 | ITEM FO42 | .774 | ” | 90 | ITEM FO90 | .486 | ” |
| 43 | ITEM FO43 | .675 | ” | 91 | ITEM FO91 | .561 | ” |
| 44 | ITEM FO44 | .485* | Not important | 92 | ITEM FO92 | .772 | ” |
| 45 | ITEM FO45 | .654 | Important | | | | |
| 46 | ITEM FO46 | .734 | ” | | | | |
| 47 | ITEM FO47 | .631 | ” | | | | |
| 48 | ITEM FO48 | .532 | ” | | | | |

**Validity of the developed workshop-based process skill test for assessing students' Skills in Metal fitting at NTC level**

Validity of an instrument according to Ombugus (2013) is the degree to which a test measures what it is designed to measure. An instrument with high validity will measure accurately the particular qualities it is suppose to measure. The validity of workshop based process skill test is then the extent to which the students intended practical competencies outlined in the curriculum are covered by the test. The table of specification constructed based on the Simpson's (1972) levels of psychomotor domain revealed that out of 87 skill items, 5.5% comprising 6 skill items were assessing the perception level; 5.5% comprising 6 skill items were assessing the set level; 20% comprising 23 skill items were assessing the guided response level; 20% comprising 23 skill items were assessing the mechanism level; 20% comprising 23 skill items were assessing the complex overt response level and 5.5% comprising 6 skill items were assessing the adaptation level. The origination level of Simpson's domain 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 instrument. This signified a balance in the spread of distribution of test item across the 6 levels which is in the agreement with the assertion by Okeme (2011) that the fairer the degree of distribution of test items the better representation of the behaviour domain and the higher the content validity of the test.

The test items were submitted to 5 experts, 3 from VTE and 2 in measurement and evaluation unit, all from University of Nigeria, Nsukka. The experts reviewed, reworded and re-structured the test items and made satisfactory comments about the entire test. On the whole as shown in table 2, there were 10 tasks with their 87 corresponding process skill items on fitting operation.

**NTC level**

The result of the internal consistency of the workshop-based process skill test items are given in table 3.

**Table 3**

Reliability estimates (Cronbach alpha) for items in fitting operation of WBPST

| S/No | Task | Cronbach alpha | No. of items | Remark |
|---|---|---|---|---|
| 1 | Heat treating a metal product | 0.81 | 5 | Very high |
| 2 | Assembling with metal fasteners | 0.80 | 6 | ” |
| 3 | Construction of a swarf cleaner | 0.75 | 7 | ” |
| 4 | Construction of a tool box | 0.68 | 16 | ” |
| 5 | Construction of an angle guage | 0.72 | 9 | ” |
| 6 | Constructing a pipe wrench | 0.69 | 13 | ” |
| 7 | Making a vice clamp | 0.66 | 7 | ” |
| 8 | Production of fitting plate | 0.77 | 9 | ” |
| 9 | Production of dept gauge | 0.83 | 9 | ” |
| 10 | Making camp saw | 0.86 | 9 | ” |

Table 3 reveals that each of the 10 fitting tasks had a high reliability coefficient ranging from 0.66 to 0.86. Also, the reliability coefficient of the entire test was computed to be 0.75 which indicated that the assessment instrument was a refined test in consonance with the recommendation of Uzoagulu (2011) who stated that acceptable reliability of tests use in education is generally in the range of 0.50-0.95. Therefore given the reliability coefficients of the various fitting tasks would be in the affirmative. Thus, the items in WBPST were reliable and considered for assessing metal fitting students' skills in technical colleges.

**Ability groups of students in metal fitting at NTC level**

**Table 4:**

**The task and its corresponding skill items utilized to determine ability group of students in metal fitting.**

| | **Task: Filing a metal piece flat and square** | 5 | 4 | 3 | 2 | 1 |
|---|---|---|---|---|---|---|
| | **Procedural steps / skill items** | | | | | |
| 1 | Measuring out | | | | | |
| 2 | Marking out | | | | | |
| 3 | Cutting out to specification | | | | | |
| 4 | Choosing an appropriate file | | | | | |
| 5 | Clamping work piece in vice | | | | | |
| 6 | Filing the face side | | | | | |
| 7 | Filing the face edge | | | | | |
| 8 | Filing the second side and edge to required size | | | | | |
| 9 | Polishing with emery cloth | | | | | |

**$Ho_1$:** There is no significant difference in the mean ratings of students on workshop-based process skill test in

 

fitting operation based on their ability levels.

**Table 2**

**Validated tasks and skill items in fitting operation**

| | **Students** | 5 | 4 | 3 | 2 | 1 |
|---|---|---|---|---|---|---|
| | **Task 1: Heat treating a metal product** | | | | | |
| | **Procedural steps / skill items** | | | | | |
| 1 | Selecting appropriate source of heat | | | | | |
| 2 | Putting off heat | | | | | |
| 3 | Cooling in a way that will give the desired results | | | | | |
| 4 | Heating to the required temperature | | | | | |
| 5 | Leaving at this temperature for a certain length of time | | | | | |
| | **Task 2: Assembling with metal fasteners** | | | | | |
| | **Procedural steps / skill items** | | | | | |
| 6 | Checking the fastener for length | | | | | |
| 7 | Inserting fastener in the holes | | | | | |
| 8 | Pressing or tightening the parts together | | | | | |
| 9 | Selecting the fastener | | | | | |
| 10 | Laying out the location of the fastener and drill the given hole on the parts | | | | | |
| 11 | Countersinking if necessary | | | | | |
| | **Task 3: Construction of a Swarf cleaner** | | | | | |
| | **Procedural steps / skill items** | | | | | |
| 12 | Selecting the materials and tools | | | | | |
| 13 | Measuring and marking out | | | | | |
| 14 | Cutting and sharpening scraper blade | | | | | |
| 15 | Brazing | | | | | |
| 16 | Cutting off to length | | | | | |
| 17 | Forging eye end | | | | | |
| 18 | Forging and hot bending scraper end | | | | | |
| | **Task 4: Constructing a tool box** | | | | | |
| | **Procedural steps/skill items** | | | | | |
| 19 | Marking out position of partition plate “C” in box “A” | | | | | |
| 20 | Setting partition plate “C” in box “A” and soldering | | | | | |
| 21 | Selecting the materials | | | | | |
| 22 | Measuring out the given dimensions | | | | | |
| 23 | Marking out lid “B” | | | | | |
| 24 | Cutting out lid “B” to shape | | | | | |
| 25 | Turning runner allowance and stopping flange on lid “B” | | | | | |
| 26 | Fitting lid “B” to box “A” | | | | | |
| 27 | Checking all sizes | | | | | |
| 28 | Marking out box body “A” with pencil from centre lines | | | | | |
| 29 | Cutting out shape | | | | | |
| 30 | Folding runners, two sides and corner laps | | | | | |
| 31 | Bending other two sides. | | | | | |
| 32 | Soldering laps to sides | | | | | |
| 33 | Marking out partition plate “C” | | | | | |
| 34 | Folding flanges | | | | | |
| | **Task 5: Construction of an Angle Gauge** | | | | | |
| | **Procedural steps/skill items** | | | | | |
| 35 | Checking for hand tools* | | | | | |
| 36 | Selecting the material | | | | | |
| 37 | Measuring and marking out the required dimensions | | | | | |
| 38 | Checking angle sizes for accuracy | | | | | |
| 39 | Finishing with emery cloth | | | | | |
| 40 | Cutting to approximate size with hacksaw | | | | | |
| 41 | Filing two long edges square and parallel | | | | | |
| 42 | Squaring one end | | | | | |
| 43 | Marking out male and female vees | | | | | |

 

**Task 6: Constructing a Pipe Wrench**
**Procedural steps/ skill items**

44 Controlling threading tools*
45 Fitting packing piece and drilling in position.
46 Riveting parking piece in position
47 Filing jaw teeth
48 Selecting the materials
49 Measuring the required dimensions
50 Removing burrs
51 Case-hardening jaw teeth
52 Marking out profile of handle
55 Cutting and filing to shape
54 Bending, in round form
54 Drilling reaming and taping pivot hole
56 Filing packing piece wedge shaped to suit handle and4mm" oversize on curved edges

**Task 7: Making a vice clamp**
**Procedural steps / skill items**

57 Selecting the material
58 Measuring the required size
59 Marking out to the sizes given
60 Cutting out the size given
61 Marking off the corners as given
62 Fastening in the vice and bending with a hammer
63 Rounding off the corners with a smooth file

**Task 8: Production of fitting plate**
**Procedural steps/skill items**

64 Listing tools required*
65 Drilling the number of required holes on the pieces
66 Rounding corners of the pieces with given radius
67 Cutting out the given equilateral triangle
68 Lapping A and B coupling
69 Finishing the surface
70 Measuring the required sizes
71 Marking out
72 Cutting the required pieces

**Task 9: Production of depth gauge**
**Procedural steps/skill items**

73 Inspecting angle gauge*
74 Punching the centres where holes are to be drilled
75 Drilling the required holes
76 Threading the holes with the specified tap size
77 Providing the required metal bar
78 Finishing the surface
79 Selecting the appropriate material
80 Measuring out the required size
81 Marking out
82 Cutting the required size

**Task 10: Making camp saw**
**Procedural steps/skill items**

83 Naming tools to be used*
84 Cutting slot on one end of the tubing to a specified length
85 Drilling a given hole on both ends
86 Bending the tubing from one end at a specified angle
87 Providing saw blade and wing nuts
88 Fixing the saw blade
89 Selecting appropriate material (aluminum tubing)
90 Measuring the specified size
91 Marking out
92 Cutting out the required size

In order to test this hypothesis, the mean ratings of the high, average and low ability students on each of the WBPST process skill was analyzed using analysis of variance. In the case of significant difference between the group, the Scheffe multiple comparison test was applied to determine the direction or source of the difference. The summary result of analyzed data for hypothesis 1 is presented in Table 5

**Reliability of the developed workshop-based process skill test for assessing students' skills metal fitting at**
**Table 5**
**Summary of Analysis of Variance on the mean ratings of student on workshop-based process skill test on fitting operation based on their ability levels.**

| | Sum of squares | df | Mean of square | F | Sig. (P-value) |
|---|---|---|---|---|---|
| Between groups | 2.229 | 2 | 1.114 | 1.711 | .204 |
| Within Groups | 14.331 | 22 | .651 | | |
| Total | 16.560 | 24 | | | |

**F-critical = 2.17**

Table 5 revealed the mean ratings of teachers on students performance on skill items in fitting operation. The analysis indicated that there was significant difference in the mean scores of the three groups of students at 0.05 level of significance, d.f 2 and 22 on all the skill items except 26, 32 and 44.

In all the 87 skill items (except items 26, 32 and 44), the P value calculated were significant at 0.20 which is higher than the 0.05 probability level. This means that the null hypothesis of no significant was not rejected. The result indicated that the null hypothesis of no significant difference was accepted in all the WBP ST items but rejected for items 26, 32and 44.

**Findings of the Study**

Major findings of the study include

1. All the 10 tasks and 87 process skill items out of 92 were found suitable for inclusion in the workshop based process skill test with factor loading at 0.40 and above.
2. Content validation of the test by 5 experts revealed that the 10 tasks and their 87 corresponding process skill items were agreed upon as well worded and representative enough for assessing skills in metal fitting at NTC level.
3. The internal consistency of the metal fitting process skill items is 0.71.
4. There were significant differences in the mean scores between high and average ability with low ability students in metal fitting.

**Discussion of the Findings**

The findings that 87 out of 92 items with high factor loading were considered suitable for inclusion in the WBPST are in agreement with the conclusions of Effiong (2012), Williams(2011) and Jimoh(2010). In their separate conclusions, they noted that skill items that satisfied all psychometric properties with high factor loading are suitable for inclusion in psychomotor tests. Item 4 in task 1 had the highest factor loading of 0.886 probably because of the importance of temperature in heat treatment of metals. Ugbalu(2012) observed that temperature reading is a vital skill in metal industries. The author added that metal fitters skillful in reading temperatures produce accurate and better products. Five out of the 92 process skill items had factor loading below 0.40 and so needed exclusion. The 10 tasks in metal fitting had factor loading ranging from 0.411-0.886 portraying the tasks with their corresponding 87 skill items suitable for the test.

The validity of the WBPST was ascertained by teachers and technicians of mechanical engineering craft in technical colleges, experts in industrial technical section of vocational teacher education and

measurement/evaluation unit, University of Nigeria, Nsukka. The experts were given the test to indicate how important the items were for assessing the students' skill performance. As pointed out by Okoro(2012) and Hersbatch(2010) that content validity of psychomotor learning activity could be pursued by submitting the list of skill items drawn up for use to experts for review so as to yield compromise or consensual agreement on the importance of the items and such was the case in this study. After validation,it was found out that the developed process skill test possessed a high content validity when compared with findings reported by Garba(2010) and Amuka(2013) in similar tests developed by them.

The 87 skill items in metal fitting had reliability coefficient of 0.82. This indicated that all the items were reliable in the six levels of Simpson's taxanomy tested. These findings also agree with the findings of Balogun and Mustapha (2014) in a study on Development and validation of psycho-productive test in mechanical engineering craft for assessing students in technical colleges in Bauchi state, Nigeria the test had a high reliability with Cronbach coefficient of 0.68. The findings of the study are also in consonance with Ombugus (2013) in a study on development and validation of workshop-based process skill test in mechanical engineering craft for assessing students in technical colleges in Nasarawa state Nigeria, where it was found out that the test had a high reliability coefficient of 0.82. The findings of the authors above gave credence to the findings of this study.

The study also found out that the calculated p-value for the skill items in metal fitting ranged between 0.411-886. These values were greater than the p-critical value of 0.05 level of significance. This implies that there were significant differences in the mean performance of the three groups of students (high, average and low ability) on the workshop-based process skill test in metal fitting. Hence the null hypothesis of no significant difference was rejected.

**Conclusion**

The developed workshop-based process skill test has provided a readily available process assessment instrument of high quality for the realization of skill development in students of metal fitting trade in technical colleges. If WBPST is implemented there will be assurance of skill acquisition. This will go a long way in enhancing the possibility of employment after graduation. The implementation of the developed and validated workshop-based process skill test for assessing skills of NTC students would no doubt remove the inconsistencies associated with assessment of skills in metal fitting.

**Recommendations**

In view of the findings discussions, the following recommendations were made:

1. The external examination bodies (NABTEB and WAEC) should integrate WBPST items in their examination for certification of the students.
2. Seminars workshops should be organized for teachers on process skill assessment.
3. Evaluators in technical education should use WBPST to study their curricular,structure the contents into relevant tasks and develop similar tests in their respective subject areas.

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