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Fitting Skills Assessment Instrument (FSAI) In Nigeria Certificate in Education for Colleges of Education in North East Nigeria

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Abstract: Fitting Skills Assessment Instrument (FSAI) will improve the assessment of students' skills in colleges of education in north east Nigeria. The study employed instrumentation research design. The population of the study was 735 comprising 27 metalwork teachers and 708 NCE metalwork students in five of the colleges of education that offer NCE metalwork in north east States. A purposive sampling technique was used to select three colleges of education for the study. Eighty seven NCE III metalwork students of the three colleges of education purposively sampled were involved in the trial test of FSAI. The study answered four research questions and tested two null hypotheses. The draft FSAI was face and content validated by seven experts which establish a S-CVI of 0.978 for 83 items along 15 sub-tasks developed from VTE minimum standard for NCE metalwork. The validated FSAI was then trial tested on the eighty seven students and found to be internally consistent with 0.935 reliability coefficient. An average index of 0.776 for ICC was determined to be rater reliability of FSAI. Based on these results, it was recommended among others that teachers in colleges of education should be encouraged by Government to use FSAI to assess NCE student during teaching and at the semester assessment of their student.
Keywords: Skills, Fitting, Assessment Instrument, Development.

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Introduction

Fitting work is one of making skilled cuts to parts, so that they will fit together with the desired degree of fit. Fitting is the way to create precise assemblies of components, Crawford (1995), which are done with tools and equipments such as files, scrappers, saw, chisel, etc. Fitting involves tasks such as marking out, measuring, cutting, welding, riveting etc of metalwork component. These fitting tasks are spread into Nigeria Certificate in Education (NCE) metalwork courses in order to achieve national educational goal of producing skilled manpower for economic and technological development through Vocational and Technical Education (VTE) programmes (Federal Republic of Nigeria [FRN], 2013).

Part of the efforts towards achieving this objective is the establishment of the Nigeria Certificate in Education (NCE) programmes in colleges of education (Yalams, 2001). The National Commission for Colleges of Education (NCCE), [2012] stated that NCE is recognized minimum teaching qualification in Nigeria and the programme is designed to produce quality teachers for the basic education sector. Therefore, its graduate must possess skills required to be imparted to achieve national educational goal. Metalwork tasks in NCE are classified into machining practices and fitting work which, according to NCCE's minimum standard for VTE (2012), are designed to achieve the following objectives among others: to produce technical NCE teachers who will be able to inculcate scientific and technological attitudes and values into the society; to produce qualified technical teachers motivated to start the so much desired revolution of technological development right from the Nigerian schools. Metalwork fitting task operations could be executed with simple hand tools while others may require the use of light or heavy duty machine tools such as drilling machine. These fitting tasks are spread along NCE metalwork courses: sheet metal, fabrication and welding; foundry and forging; advanced fabrication and welding and maintenance and repair of mechanical tools and equipments. These outlined courses are part of the minimum standard that explains what components each course is made up of and each of these components is meant to expose the students in understanding what manufacturing processes involved and the skills required. Hence NCE metalwork objectives are most often achieve by assigning practical tasks and operations to students to perform in the workshop because: it helps students in organizing their experience as they put efforts towards getting solution to their problem and; it provides teachers with a basis for assessing the learners' outcomes, originality and creativity of their students (Davis, 1979 & Ferier, 1973 in Yalams, 2001).

Therefore, when students are engage in practical work to perform a task's operations, some unique method of assessing their skills is required. Skills are constructs, traits or characteristics that are assessed through observation of behavioural patterns. The skills enable the student to apply appropriately what is theoretically learned from the classroom in order to achieve his psychomotor domain of educational objectives (Adamu, 2015). The skills demonstrated by students of a training programme will determine the extent to which behavioural or instructional objectives have been achieved. Hence assessment is an important aspect of education that makes such exercise possible. Therefore, in assessing the extent to which skill has been achieved and for the instrument to be good enough to assess the expected performance of students, the developed assessment instrument must possess and satisfy certain psychometric properties. Psychometric properties of an assessment item involves the mental measuring abilities of the instrument following certain characteristics that is expected to be possessed by the instrument items such as item reliability and validity (Gall, Gall & Borg, 2007).

Validity refers to the degree to which an instrument is measuring what it is supposed to measure. It indicates extent of relationship between a scale and a measure of independent criterion variable (DeVellis, 2003). Validity can be determined at face, content, construct and/or criterion-related based on the applicability or type of the instrument to be developed. For this study face and content validity of FSAI was established using Content Validity Index (CVI) technique. The item-rated CVIs are usually denoted as I-CVI while the scale-level CVI is termed S-CVI. Reliability is defined as the extent to which an assessment instrument yields consistent information about the skills, or abilities being assessed. An assessment instrument is considered reliable if the same results are yielded each time assessment is administered (Alias, 2005). Other properties of the assessment instrument's items that was considered for this study is the measuring abilities of the items to show the extent to which it discriminates among ability groups of students.

Ability is the mental or physical power that enables a person to achieve or accomplish something. Adeyemo (2010) defines ability as characteristic mode of functioning that enables an individual show in intellectual activities in a highly consistent and persuasive way. Ability of a student is then the personality characteristic that influence the students' school performance. Ability groups of student refer to classes of student base on similarities in their academics abilities, talents or previous achievement as opposed to their age or grade level (Tuckman, 1995 & Svinicki, 2008). Students are usually identified to belong to a group based on a review of a variety of performance data such as their grades in a subject, result on an assessment and performance in a class. Adeyemo (2010), Olaitan (2014) and Ombugus (2014) have identified three major groups of students which are high ability groups, average ability group and low ability groups of learners. They also revealed that the performance of low ability students have been found to be lowest while that of high ability students was high. Lleras and Ranges (2009) noted that schools and teachers may engage in assessments types that will consider ability groups as a way to improve overall achievement and reduce disparities among student with differing level of the group and thus avoid giving assessment that is too difficult or easy for most students.

This study significantly provides information to the colleges of education administrators, teachers and students on objective performance and promotion, demotion and placement of students in metalwork technology; credible and sure of the process involved in arriving at the scores of individual student which will invariably help in guidance and counseling in areas where problems are exposed; pointer and the need to adopt FSAI for manipulative or performance assessment that could lead to the achievement of all the objectives of NCE metalwork technology programme at the colleges of education as different from the current practice of assessment. Hence the study provides a valid and reliable instrument for assessing their students' practical skills thereby discouraging teachers from practicing the traditional method of assessment which is product-oriented assessment to embrace process and product method of assessment.

Statement of the Problem

The current method of assessing student skills in NCE metalwork at colleges of education is done through the use of teacher-made assessment instrument that lack item analysis, validity and reliability (Sakiyo, 2009). Despite these, Egunsola, Denga and Pev (2014) confirmed that teacher-made assessment instruments are still used as instruments of assessment for placement, continuous assessment, prediction and educational guidance in Nigeria. Earlier, assessment instruments were developed for NCE metalwork teachers to assess their student but unfortunately, with the advent of the latest edition of NCE minimum standards for metalwork technology in 2012, the instruments were found to be invalid. Hence the need to develop a valid and reliable instrument for assessing NCE metalwork students' skills base on the latest edited NCE minimum standards for metalwork technology.

Purpose of the Study

The main purpose of this study was to develop and validate Fitting Skills Assessment Instrument (MSAI) in NCE for Colleges of Education in Nigeria. The study specifically:

1) Identified the expected psychomotor skills for assessment in practical fitting tasks operations from NCE metalwork technology minimum standard;

2) Determined the validity of FSAI items;

3) Determined the internal consistency of FSAI items;
4) Determined the inter-rater reliability of FSAI.

Research Questions

Research questions were formulated in line with the specific purposes of the study to guide the study.

Hypotheses

The following hypotheses were formulated and tested at 0.05 level of significance:

HO_1: There is no significant difference in the mean ratings of metalwork teachers on the expected psychomotor skills for assessment in NCE metalwork technology in practical fitting.

HO_2: There is no significant difference in the mean scores of students of the three ability groups of high, average and low in north east states on MSAI items in practical fitting.

Methodology

The study employed instrumentation research design, which is appropriate for use when introducing new procedures, technologies or instrument for educational practices (Gay, 1996). Frankael and Wallen (2000) stated that instrumentation research design entails the development of an assessment technique and the condition under which the technique is administered. The study was carried out in north east Nigeria. The States include: Adamawa, Bauchi, Borno, Gombe, Taraba and Yobe States. The study was carried out in all the colleges of education that offer NCE metalwork technology in the study area. The population for the study comprises all the students offering metalwork technology at NCE in the 5 colleges of education in the study area. There are 708 students of NCE metalwork technology in all the colleges in 2017/2018 session in the study area.

The population of the study also includes all the 27 metalwork technology teachers at the colleges of education in the study area. The teachers were involve in identifying the expected skills operations in NCE metalwork for the MSAI and also rating of students performances when trial testing the instrument. A purposive sampling technique was utilized to select 3 schools that is in Azare, Gombe and Potiskum with 21, 37 and 29 students respectively involved in trial test of the MSAI. The choice of the school was base on adequate equipments and tools necessary for carrying out the trial test. All the metalwork technology teachers were involved in the study therefore there was no sampling because the population was manageable. NCE III students were purposively selected for trial testing of MSAI. The final year NCE III students were considered suitable for this study because they had covered almost all the areas of the NCE metalwork technology minimum standard and course specification that was involved in the study.

Data generated from the study was analyzed using SPSS 22 software. Research question 1 was answered using mean and standard deviation. Mean of 2.50 and above were utilized in selecting the identified psychomotor objectives for MSAI items therefore, any identified psychomotor objectives for MSAI items with a mean of 2.50 and above was considered expected to be carried out by NCE metalwork students and one with a mean less than 2.50 was not considered. Content Validity Index (CVI) technique was used to answer research question 2 therefore, an item with validity index of 0.80 and above was considered valid for MSAI. Research question 3 and 4 were answered using Cronbach alpha and Intra-class Correlation Coefficient (ICC) respectively. The reliability coefficient of 0.70 and above was considered reliable.

The Analysis of Variance (ANOVA) was utilized in testing the null hypotheses at 0.05 level of significance. For analysis of data relating to the null hypotheses, if P-value is less than the level of significance (P<0.05), then reject the null hypothesis but if otherwise, do not reject the null hypothesis.

Instrumentation

The instrument MSAI was developed from vocational and technical minimum standard for NCE metalwork technology. The following stages were used in the procedural development of the instrument. These are:

1) Identification of appropriate psychomotor objectives for assessment
2) Transforming identified psychomotor objectives into questions/items or operational task format
3) Developing the table of specifications
4) Developing descriptive rating scale
5) Validating the draft MSAI by 7 experts
6) Trial testing the MSAI
7) Determining the inter-rater reliability and the internal consistency of the MSAI.

Following a detailed review of NCE metalwork minimum standard, 55 metalwork machining tasks operations were identified as psychomotor objectives area for assessment. Based on opinion of practicing metalwork teachers in colleges of education and the critical review of relevant literature, these objectives were transformed into 45 operational items spread along 6 sub-tasks in metalwork machining task. Table of specification based on Simpson model was developed and these 45 items for MSAI were distributed along the 7 stages of Simpson for experts' validation. These items were further arranged and send for validation by 7 experts each 1 of the 7 is from the department of technology education Modibbo Adama University of Technology Yola, department of vocational and technology education Abubakar Tafawa Balewa University Bauchi, departments of technical education in colleges of education in Azare, Bama, Gombe, Hong and Potiskum respectively. A two point scale of relevant and not relevant was written against each item. The data obtained was used to determine the 0.987 S-CVI of MSAI (see Table 1). The experts also face validate MSAI for proper wording, consistency and representativeness. Their corrections and suggestions were utilized in improving the MSAI's items.

The questionnaire ETOMTE was used to collect data for answering research question 1. The instrument was administered personally to 21 teachers by the researchers. This was to ensure 100% return of ETOMTE for the study. Based on the teachers rating, expected psychomotor objectives for assessment were identified for the study. The draft MSAI was also used to collect data by administering it to 7 experts as indicated in stage 5 of the instrumentation, the data obtained was used to determine the CVI of MSAI.

Assembled MSAI was tried on the sampled students by the researcher and the teachers involve in the study. The teachers were given instructions on how to administer the instrument to the student and some orientations as it relates to the rules and guidelines governing the administration of the instrument. The students were given instruction to get them familiar with the instrument procedure. The instrument comprises the instruction, the items/operational task and a scale measure. The data obtained was used in determining the inter-rater reliability and internal consistency of each task's items to form the final MSAI. Based on suggestion by Tuckman (1975), every fifth out of the 87 final year student were symmetrically selected and rated by four teachers making a total number of 17 NCE III students. The data obtain from the trial test of the 17 NCE metalwork technology students were used for determining the inter-rater reliability while the data obtained from the total of 87 NCE III students were used for determining the internal consistency of the MSAI. Teachers mean ratings on a single administration of the MSAI on students skills was used to establish the internal consistency of MSAI items using Cronbach alpha method of reliability. The four teachers' ratings of a student performance were correlated to determine the inter-rater reliability of the observation/rating scale. Their scores was analyzed using ICC to establish the inter-rater reliability coefficient of MSAI. The internal consistency reliability coefficient of MSAI revealed 0.866 and there was significant relationship between four raters' ratings of the process skills of students with ICC average index of 0.776 thus making them to be worthy of being included into the final copy of MSAI.

Results

Research Question 1

What are the expected psychomotor skills for assessment in practical fitting tasks operations?

Table 1. Expected and Valid Fitting Tasks Operations for NCE Metalwork

S/N	Expect fitting sub-tasks and operations	$\bar{X}$	δ	I-CVI	Remark
SUB-TASK 1: MEASURING					
1.	Promptness to starting measurement	1.85	0.72	-	Unexpected
2.	Selection of right material to measure	1.93	0.68	-	Unexpected
3.	Selection of appropriate measuring equipment	3.63	0.49	1	Expected & Valid
4.	Right setting of the measuring equipment	3.52	0.51	1	Expected & Valid
5.	Measuring flat surface	3.74	0.45	1	Expected & Valid
6.	Measuring internal diameter*	3.70	0.47	1	Expected & Valid
7.	Measuring external diameter*	3.70	0.47	1	Expected & Valid
8.	Measuring depth	3.67	0.48	1	Expected & Valid
9.	Measuring openings	3.41	0.69	0.86	Expected & Valid
10.	Measuring angles	3.70	0.46	1	Expected & Valid
11.	Measuring curves	1.85	0.60	-	Unexpected
SUB-TASK 2: MARKING OUT					
12.	Promptness to starting marking out	1.81	0.62	-	Unexpected
13.	Selection of right material to mark out	1.74	0.45	-	Unexpected
14.	Selection of appropriate marking out equipment	3.26	0.53	1	Expected & Valid
15.	Right setting of the marking out equipment	2.81	0.62	1	Expected & Valid
16.	Marking out straight lines	3.70	0.46	0.86	Expected & Valid
17.	Marking out parallel lines	3.30	0.47	1	Expected & Valid
18.	Marking out lines at right angles to an angle	1.30	0.47	-	Unexpected
19.	Marking out angles	3.52	0.51	1	Expected & Valid
20.	Locating center of a round stock	3.56	0.50	1	Expected & Valid
21.	Locating center of a angular stock	3.44	0.51	1	Expected & Valid
SUB-TASK 3: SHEARING					
22.	Promptness to starting metal shear	1.85	0.72	-	Unexpected
23.	Selection of appropriate shearing tool	3.12	0.66	1	Expected & Valid
24.	Aligning marked line with the tool blades	3.52	0.51	0.86	Expected & Valid
25.	Pressing shearer to specification	3.07	0.73	1	Expected & Valid
26.	Finish of shearing work *	2.85	0.66	1	Expected & Valid
SUB-TASK 4: FOLDING/BENDING					
27.	Promptness to starting metal folding/bending	1.67	0.55	-	Unexpected
28.	Selection of appropriate folding/bending tool	3.19	0.74	1	Expected & Valid
29.	Work to the required shape as in the drawing	3.19	0.74	1	Expected & Valid
30.	Finish of folding/bending work*	2.50	0.50	1	Expected & Valid
SUB-TASK 5: TESTING					
31.	Promptness to starting testing	1.93	0.83	-	Unexpected
32.	Selection of appropriate testing equipment	2.93	0.78	1	Expected & Valid

33.	Right setting of testing equipment	3.00	0.73	1	Expected & Valid
34.	Testing holes	3.26	0.81	1	Expected & Valid
35.	Testing diameters Invalid	3.11	0.75	0.71	Expected&
36.	Testing surfaces for flatness	3.44	0.58	1	Expected & Valid
37.	Testing angles for squareness	3.63	0.56	0.86	Expected & Valid
38.	Testing screw threads	3.26	0.81	1	Expected & Valid
SUB-TASK 6: CUTTING					
39.	Promptness to starting cutting	1.93	0.83	-	Unexpected
40.	Identification of marked position to cut	1.56	0.70	-	Unexpected
41.	Selection of appropriate cutting tool	3.19	0.68	1	Expected & Valid
42.	Right setting of the cutting tool	3.33	0.55	1	Expected & Valid
43.	Correct use and manipulation of cutting tool	3.41	0.50	1	Expected & Valid
44.	Positional accuracy of cutting	3.11	0.75	0.86	Expected & Valid
45.	Care of cutting tools during and after cutting	3.04	0.76	1	Expected & Valid
SUB-TASK 7: FILING AND FINSHING					
46.	Promptness to starting filing/finishing	1.85	0.72	-	Unexpected
47.	Selection of appropriate filing/finishing tool	3.56	0.51	1	Expected & Valid
48.	Correct use and manipulation of tool	3.41	0.50	1	Expected & Valid
49.	Smoothness of the filed and finished surface	3.59	0.50	1	Expected & Valid
50.	Care of tools during and after operation	3.41	0.50	1	Expected & Valid
SUB-TASK 8: METAL POLISHING					
51.	Promptness to starting polishing	1.67	0.55	-	Unexpected
52.	Selection of appropriate polishing tool	3.15	0.66	1	Expected & Valid
53.	Right setting of polishing tool	3.52	0.51	1	Expected & Valid
54.	Correct use and manipulation of polishing tool	3.07	0.73	1	Expected & Valid
55.	Care of tools during and after operation	2.85	0.66	1	Expected & Valid
56.	Finish of the polished surface	3.41	0.50	1	Expected & Valid
SUB-TASK 9: RIVETING					
57.	Promptness to starting riveting	1.85	0.72	-	Unexpected
58.	Selection of appropriate riveting tool	2.93	0.78	1	Expected & Valid
59.	Selection of appropriate rivet	3.00	0.73	1	Expected & Valid
60.	Right setting of riveting tool and rivet	3.26	0.81	1	Expected & Valid
61.	Riveting a work *	3.11	0.75	1	Expected & Valid
62.	Finishes of the rivet work	3.63	0.56	0.86	Expected & Valid
SUB-TASK 10: SOLDERING*					
63.	Promptness to starting soldering/weld	1.85	0.71	-	Unexpected
64.	Selection of appropriate type of soldering*	3.15	0.66	1	Expected & Valid
65.	Selection of appropriate soldering tools*	3.52	0.51	1	Expected & Valid
66.	Right setting of soldering tools*	3.07	0.73	1	Expected & Valid
67.	Use and manipulation of soldering tools*	2.85	0.66	1	Expected & Valid
68.	Finishes surface of soldering work*	3.41	0.50	1	Expected & Valid
SUB-TASK 11: WELDING					
69.	Promptness to starting welding	1.85	0.72	-	Unexpected
70.	Selection of appropriate welding tools	3.63	0.49	1	Expected & Valid
71.	Right setting of welding tools	3.52	0.51	1	Expected & Valid
72.	Selection of appropriate welding design (weld)	3.44	0.51	1	Expected & Valid
73.	Correct use and manipulation of welding tools	3.74	0.45	1	Expected & Valid
74.	Finish surface of weld	3.70	0.47	1	Expected & Valid
SUB-TASK 12: FORGING					
75.	Promptness to starting forging	1.85	0.72	-	Unexpected
76.	Selection of appropriate forging tools	3.07	0.68	1	Expected & Valid
77.	Right setting of forging tools	2.67	0.48	0.86	Expected & Valid
78.	Forging a work	1.85	0.71	-	Unexpected
79.	Upsetting a work	3.11	0.75	1	Expected & Valid
80.	Heading a work	3.00	0.68	1	Expected & Valid
81.	Drawing-down a work*	3.11	0.75	1	Expected & Valid

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82.	Off-setting a work	1.81	0.68	-	Unexpected
83.	Twisting a work	3.63	0.49	1	Expected & Valid
84.	Bending a work	3.41	0.50	1	Expected & Valid
85.	Flattening a work*	3.52	0.51	1	Expected & Valid
86.	Finishes surface of a forge	3.56	0.51	1	Expected & Valid
SUB-TASK 13: HEAT TREATMENT					
87.	Promptness to starting metal heat treatment	1.85	0.72	-	Unexpected
88.	Selection of appropriate heat treatment process	3.15	0.66	1	Expected & Valid
89.	Selection of appropriate source of heat	3.52	0.51	1	Expected & Valid
90.	Heating to the required temperature	3.07	0.73	1	Expected & Valid
91.	Putting off heat Invalid	2.85	0.66	0.57	Expected&
92.	Quenching to give the desired result*	3.41	0.50	1	Expected & Valid
SUB-TASK 14: CASTING					
93.	Promptness to starting casting	1.85	0.72	-	Unexpected
94.	Selection of appropriate casting tools*	3.15	0.66	1	Expected & Valid
95.	Making a pattern for casting*	3.52	0.51	1	Expected & Valid
96.	Preparing a sand mould	3.07	0.73	1	Expected & Valid
97.	Melting metal for casting	2.85	0.66	1	Expected & Valid
98.	Pouring the molten metal into the mould	3.41	0.50	1	Expected & Valid
99.	Removing the cast from the mould	3.15	0.66	1	Expected & Valid
100.	Cleaning and finishing the cast	3.52	0.51	1	Expected & Valid
101.	Finish surface of the cast	3.07	0.73	0.86	Expected & Valid
SUB-TASK 15: DIE AND TAPPING*					
102.	Promptness to starting tapping/threading	1.86	0.71	-	Unexpected
103.	Selection of appropriate die/tapping tools*	3.62	0.49	1	Expected & Valid
104.	Right setting of die/tapping tools*	3.40	0.50	1	Expected & Valid
105.	Cutting internal thread with tap	3.48	0.51	1	Expected & Valid
106.	Cutting external thread with die	3.52	0.51	1	Expected & Valid
107.	Finishing die/tapping work*	3.56	0.50	1	Expected & Valid
S-CVI				**0.978**	

In Table 1, teachers rated the expected fitting sub-tasks' operations with mean ($\bar{X}$) ranging from 1.30 to 3.74. The result shows that 24 sub-tasks operations for fitting task were rated below the cut-off point of 2.50, hence they are rated unexpected and not included into the study. The 85 operations rated above 2.50, which are spread along the 15 fitting sub-tasks, are expected and therefore included into the study. The standard deviation (δ) of the teachers rating ranged from 0.45 to 0.83. This implies that the teachers were very close in their ratings.

Research Question 2
What is the validity of FSAI items?

Data in Table 1 provided information for answering research question 2. In Table 1, 7 experts rated 83 items as relevant and have their I-CVIs ranging from 0.86 to 1.00 which is above the critical point of 0.80 while 2 items number 35 and 91 were rated irrelevant with I-CVI of 0.71 and 0.57 respectively. Therefore items 35 and 91 with I-CVIs below the 0.80 were not included into the assembled MSAI.

Table 1 further indicated that 2 sub-task and 18 items with mark (*) were face validated and included into assembled MSAI. Therefore the result in Table 1 shows that FSAI have 15 sub-tasks with 83 relevant items which yielded 0.978 S-CVI.

Research Question 3
What is the internal consistency of FSAI items?

Table 2. Internal Consistency (IC) and Inter-rater Reliability of FSAI

S/n	Sub-tasks	N_{Items}	N_{Raters}	α_{IC}	Inter-Rater$_{Corr.\ Coeff.}$	ICC	P	Remark
1.	Measuring	8	4	0.949	0.718-0.964	0.822	0.380	Reliable
2.	Marking out	7	4	0.957	0.764-0.977	0.825	0.121	Reliable
3.	Shearing	4	4	0.968	0.816-0.985	0.851	0.148	Reliable
4.	Folding/Bending	3	4	0.974	0.866-1.000	0.821	0.070	Reliable
5.	Testing	6	4	0.956	0.777-0.949	0.801	0.062	Reliable
6.	Cutting	5	4	0.863	0.620-0.873	0.604	0.371	Reliable
7.	Filing/Finishing	4	4	0.967	0.861-1.000	0.761	0.074	Reliable
8.	Metal Polishing	5	4	0.970	0.945-1.000	0.706	0.059	Reliable
9.	Riveting	5	4	0.864	0.623-0.764	0.655	0.917	Reliable
10.	Soldering	5	4	0.942	0.784-0.953	0.831	0.917	Reliable
11.	Welding	5	4	0.965	0.868-1.000	0.724	0.065	Reliable
12.	Forging	9	4	0.907	0.681-0.822	0.716	0.574	Reliable
13.	Heat Treatment	4	4	0.909	0.600-0.866	0.769	1.000	Reliable
14.	Casting	8	4	0.889	0.532-0.864	0.784	0.771	Reliable
15.	Die and Tapping	5	4	0.942	0.772-0.958	0.831	0.917	Reliable
MSAI average indices		83	12	0.935		0.767		Reliable

Table 2 shows that all the 15 sub-tasks have their internal consistency reliability (α_{IC}) indices ranging from 0.863 to 0.974 with average index of 0.935, which is above the acceptable line of 0.70 (Nunnally, 1978). Hence FSAI items are internally consistent.

Research Question 4

What is the inter-rater reliability of FSAI?

Table 2 shows that FSAI sub-task have their ICCs from 0.604 to 0.859 with average of 0.767 which is very high correlation between raters. The result also shows paired rater or inter-rater correlation coefficient (Inter-Rater$_{\mathbf{Corr.\ Coeff.}}$) ranging from 0.600 to 1.000. This indicated that all the four raters rating a particular student's performance in each item of FSAI's are found reliable in their ratings. The results further revealed that p-value of raters' rating of a particular student in each sub-tasks' items of FSAI ranged from 0.059 to 1.000. These values are greater than the 0.050 level of significance, thus indicating that data of raters' ratings of a student significantly fit ICC technique.

Hypothesis 1

HO_1: There is no significant difference in the mean ratings of metalwork teachers on the expected psychomotor skills for assessment in NCE metalwork technology in practical fitting.

Table 3. ANOVA of Teachers' Rating of Expected Fitting Psychomotor Skills for Assessment in NCE Metalwork

Source of variation	Sum of square	df	Mean square	F-cal	F-table	P	Remark
Between groups	0.011	4	0.003				
				0.117	2.82	0.975	Accepted
Within groups	0.515	22	0.23				
Total	0.526	26					

$N_{Adamawa}$= 5, N_{Bauchi}= 4, N_{Borno}= 4, N_{Gombe}= 8, N_{Yobe}= 6. P>0.05 (P = 0.975)

Data in Table 3 revealed that the p-value of teachers' rating of expected fitting sub-tasks' operations for NCE metalwork is 0.975. This value is greater than the p-value of 0.05 (level of significance) indicating there is no significant difference in the mean ratings of metalwork teachers on the expected psychomotor skills for assessment in NCE metalwork technology in practical fitting. Therefore, the null hypothesis was accepted.

Hypothesis 2

HO_2: There is no significant difference in the mean scores of students of the three ability groups of high, average and low in north east states on FSAI items in practical fitting.

Table 4. ANOVA of the Mean Scores of Students in High, Average and Low Ability Groups in Practical Fitting

Source of variation	Sum of square	df	Mean square	F-cal	P	Remark
Between groups	36342.316	2	18171.158			
				227.812	0.000	Rejected
Within groups	6700.167	84	79.764			
Total	43042.483	86				

Data in Table 4 revealed that the p-value of mean academic achievement scores students of the three ability groups of high, average and low in north east states on FSAI items was 0.000. This value is less than the p-value of 0.05 (level of significance) indicating that there is significant difference in the mean academic achievement scores students of the three ability groups of high, average and low in north east states on FSAI items in practical fitting.

The null hypothesis is therefore rejected. This further indicates the differences in the mean scores of the students are significant and not as a result of chance. Although the mean academic achievement scores of the students in high, average and low ability groups differ significantly, ANOVA does not indicate where the differences occur. Therefore, a post-hoc test was conducted using Scheffe test. Scheffe test is appropriate where comparisons among means are to be made. SPSS 22 software provides post-hoc test as part of the ANOVA.

Table 5. Mean Scores Multiple Comparisons

State	High	Average	Low	$\bar{X}_{Grand}$	df	$P_{Ability\ Group}$	Remark
Bauchi	79.00^{A}	53.29^{B}	29.57^{C}	53.95	2/18	0.000	Rejected
Gombe	79.67^{A}	50.00^{B}	25.75^{C}	51.76	2/34	0.000	Rejected
Yobe	77.44^{A}	51.64^{B}	29.44^{C}	52.76	2/26	0.000	Rejected
Grand Mean	78.79	51.32	27.89				
df	2/25	2/28	2/25				
P_{States}	0.883	0.711	0.538				
Remark	Accepted	Accepted	Accepted				

F-Scheffe $_{(P>0.05)}$: States = 0.711; Ability Groups = 0.000.

NOTE: Mean scores followed by the same letter (A, B, or C) are not significantly different

The result of post-hoc in Table 5 indicates that mean scores of students in high, average and low ability groups recorded significant difference in Bauchi, Gombe and Yobe States with p-values of 0.000 respectively. The result further revealed that mean academic achievement scores of students in high ability group that are in Bauchi, Gombe and Yobe States recorded not significantly different with p-value of 0.883. Those of the average and low ability groups were 0.771 and 0.538 respectively. These values were greater than the level of significant, hence no significant difference within each ability group in Bauchi, Gombe and Yobe States.

Discussion

The finding related to research question 1, in Table 1, revealed that 85 out of 107 psychomotor skills operations are identified as metalwork fitting task operations which are distributed into 15 sub-tasks. This finding is related to the findings of Okwelle and Okoye (2012) regarding the fact that practicing teachers were involved in identifying from the curriculum items for the instrument to be developed for assessing students' skills. The face and content of FSAI is valid for assessing NCE metalwork students' skills with S-CVI of 0.978 which is very high.

This information is reveal in Table 1 for answering research question 2. Seven experts rated 83 out 85 items as relevant with I-CVIs ranging from 0.86 to 1 and face validated 2 sub-task and 18 items for FSAI. Therefore these items were established from detailed and comprehensive table of specification on how each item is distributed along Simpson model of psychomotor domain of educational objectives and experts' comments. This was to signify the adequacy of sampling of the content areas in the minimum standard which the FSAI items were designed to assess (Ombugus, 2014). This agrees with Engel and Schutt (2013) that the establishment of a content valid assessment instrument is typically achieved by a rational analysis of the instrument by experts that are familiar with the construct of interest using a method of quantifying content validity of each item for multi-item scales as FSAI. The finding of this study related to research question 2 is in accordance with Lynn (1986), Polit and Beck (2004) and Sangoseni et'al (2015) that a significant level for inclusion of an item into an instrument to be I-CVI of ≥ 0.80.

The findings related to research question 3 reveals in Table 2 that 15 sub-tasks have their internal consistency reliability indices ranging from 0.863 to 0.974 with average index of 0.935, which is above the acceptable line of 0.70 (Nunnally, 1978). This indicated that all the 83 items were internally consistent and reliable in the seven levels of Simpson's model of psychomotor. This finding is in agreement with the findings of Fatunsin (1996), Yalams (2001), Zhang and Lam (2008), Olaitan (2014) and Adamu (2015) where in their parallel studies they found reliability coefficients of 0.94, 0.83, 0.75, 0.96 and 0.92 respectively. The findings of the authors above gave credence to the findings of this study.

The findings in research question 4 indicated a very high correlation between (paired) raters from 0.604 to 0.859 with average ICC of 0.767. The result also shows paired rater or inter-rater correlation coefficient ranging from 0.600 to 1.000. These results signify that paired raters' correlation is very high. This indicated that all the four raters rating a particular student's skills in each item of MSAI's are found reliable in their ratings. This finding is related to the findings of Yalams (2001) and Olaitan (2014) where kendall coefficient of concordance and Pearson product moment correlation respectively where use in their studies to determine the correlation coefficient between raters.

After the inter-rater reliability procedures in this study, it was found out that the developed MSAI possessed a high inter-rater reliability when compared with findings reported by Yalams (2001) and Olaitan (2014) in similar instruments developed by them. Therefore this findings have minimize errors such as personal bias, halo effect, logical error, generosity error and central tendency error mostly encountered in rating students' skills (Gronlund, 1981).

The findings in Tables 3 related to hypotheses 1 reveals that there was no significant differences in the mean ratings of metalwork teachers in colleges of education on the expected psychomotor skills for assessment in NCE metalwork technology in practical fitting. Hence the null hypotheses of no significant were accepted. This finding is consistent with Adamu (2015) regarding the facts that teachers were involved in developing items for the instrument developed.

Table 4 provided information on hypothesis 2, which reveal that there was significant difference in the mean scores of the students of the three ability groups of high, average and low on FSAI items in practical fitting throughout the states. Hence the null hypotheses of no significant different was rejected. The study further determined significant difference in each ability group in Bauchi, Gombe and Yobe States and it was revealed that there was no significant difference in the mean scores of the students of each ability group on FSAI items in practical fitting in Bauchi, Gombe and Yobe States. Hence the null hypothesis of no significant was accepted. Scheffe multiple comparison test was carried out in order to find the direction of the difference. The test revealed that the difference was significant between the high, average and low ability groups. The implication of the result of Scheffe test is that the FSAI in fitting tasks operations were able to distinguish between high, average and low ability groups in terms of their performance which is a measure of the validity of FSAI.

Conclusion

The major findings of this study serves as a basis for drawing conclusion that FSAI is a valid and reliable assessment instrument that could be used in assessing NCE metalwork students' skills performance in machining tasks in colleges of education (technical) in Nigeria. It is expected that metalwork teachers in colleges of education (technical) may now be able to use an objective, comprehensive and systematic instrument to effectively assess students' performance in machining tasks. Furthermore, it is believed that students' performance in machining tasks will be improved.

Recommendations

Based on the findings from the study, the following recommendations are suggested:
1) The instrument MSAI should be published to enable beneficiary access to it.
2) The NCCE body should provide assessment medium and integrate MSAI into their minimum standard for certification of the students.
3) The metalwork teachers in colleges of education should be encouraged by Government to use MSAI to assess NCE student during teaching and at the semester assessment of their student.
4) The developed MSAI should be subjected to further try outs by the metalwork teachers in order to serve as a means of further assuring its efficacy, practical usefulness and eventual adoption for the assessment of skills acquisition in NCE metalwork level.

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