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Welding skills assessment instrument for Nigeria certificate in education in colleges of education in Nigeria

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Abstract

This study developed and validated Welding Skills Assessment Instrument (WSAI) that will improve the assessment of students' skills in colleges of education in Nigeria. The study employed instrumentation research design. The population of the study was 735 comprising 27 teachers and 708 NCE students in 5 of the Colleges of Education that offer welding and fabrication in north east States. A purposive sampling technique was used to select 3 Colleges of Education for the study. 87 NCE III metalwork students of the 3 Colleges of Education were purposively sample and involved in the trial test of WSAI. The study answered four research questions and tested 2 null hypotheses. The draft WSAI was face and content validated by 7 experts which establish a S-CVI of 0.98 for welding tasks with 84 items along 10 tasks developed from VTE minimum standard for NCE technical. The validated WSAI was then trial tested on the 87 students and WSAI was found to be internally consistent with 0.86 reliability coefficient. An average index of 0.82 for ICC was determined to be rater reliability of WSAI. Based on these results, it was recommended among others that teachers in colleges of education should be encouraged by Government to use WSAI to assess NCE student during teaching and at the semester assessment of their student.

Keywords: skills, welding, assessment instrument

Introduction

The National Commission for Colleges of Education (NCCE), [2012] [1] stated that Nigeria Certificate in Education (NCE) is a programme for producing teachers with minimum teaching qualification for the basic education sector in Nigeria. Therefore, NCE graduates must possess skills required to be imparted 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) [2]. Welding processes is one of the skills courses offered in NCE Technical Education programme with the objectives of producing teachers who will be able to inculcate scientific and technological attitudes and values into the society; to produce qualified teachers motivated to start the so much desired revolution of technological development right from the Nigerian schools; to prepare technical teachers so as to qualify them for a post-NCE degree programme in technical education. Welding is the joining of metals through coalescence by the use of either heat or pressure or both. It is a fabrication or sculptural process that joins metals or thermoplastics by using high heat to melt the parts together and allowing them to cool causing fusion. Welding tasks in NCE involve activities such as measuring, marking out, cutting, forging, oxy-acetylene welding, arc welding etc. Operations in these tasks could be executed with simple hand tools while others may require the use of welding machine such as milling machine, lathe machine, drilling machine etc. These tasks and their operations are spread along NCE courses: sheet metalwork fabrication and welding and advance fabrication and welding. 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 welding processes involved and the skills required. Hence NCE objectives are most often achieve by assigning tasks and operations to students to perform in the workshop. These tasks and operations plays a very important role in teaching and learning because; it helps students in organizing their experience as they put efforts towards getting solution to technical problems and; it provides teachers with a basis for assessing the students' creativity and skills (Davis Ferier in Yalams, 2001) [3]. The skills demonstrated by students will determine the extent to which behavioural objectives have been achieved. Assessment is an important aspect of education that makes such exercise possible.

Therefore, in assessing the extent to which psychomotor skills of students in welding operations have been achieved, it is expected that Welding Skills Assessment Instrument (WSAI) must possess and satisfy certain psychometric properties such as item reliability and validity (Gall, Gall & Borg, 2007) [4]. Validity and reliability are quality indicators of a good assessment instruments. 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) [5]. 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) [6]. Reliability in an assessment is important because assessments provide information about student achievement and progress. 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 and physical power that enables a person to achieve or accomplish something. Adeyemo (2010) [7] 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 or previous achievement as opposed to their age or grade level (Tuckman, 1995 & Svinicki, 2008) [8, 9]. 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) [7], Olaitan (2014) [10] and Ombugus (2014) [11] 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) [12] 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.

The current method of assessing student welding skills in NCE at colleges of education is done through the use of teacher-made assessment instrument that lack validity and reliability (Sakiyo, 2009 and Egunsola, Denga & Pev, 2014) [13, 14]. Earlier, assessment instruments were developed for NCE teachers to assess their student but unfortunately, with the advent of the latest edition of NCE minimum standards in 2012, the instruments were found to be inappropriate. Hence the need to develop a valid and reliable instrument for assessing welding skills base on the latest edition of NCE minimum standards.

Purpose of the Study

The study developed and validated Welding Skills Assessment Instrument (WSAI) in NCE for Colleges of Education in Nigeria. The study specifically:

1. Identified the expected psychomotor skills for assessment in welding operations from NCE minimum standard;
2. Determined the validity of WSAI items;
3. Determined the internal consistency of WSAI items;
4. Determined the inter-rater reliability of WSAI.

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 teachers on the expected psychomotor welding skills for assessment in NCE.

HO_2: There is no significant difference in the mean scores of students of the three ability groups of high, average and low on WSAI items.

Methodology

The study employed instrumentation research design, which is appropriate for use when introducing new procedures, technologies or instrument for educational practices (Gay, 1996) [15]. The study was carried out in North East States of Nigeria which include Adamawa, Bauchi, Borno, Gombe, Taraba and Yobe States. The population for the study includes 27 metalwork technology teachers and 708 students of NCE metalwork that offer welding and fabrication course in the five Colleges of Education (Technical) in 2017/2018 session in the study area. A purposive sampling technique was utilized to select three schools that is in Azare, Gombe and Potiskum with 21, 37 and 29 NCE III students respectively involved in trial test of the WSAI. The choice of the school was base on adequate equipments and tools necessary for carrying out the trial test and the choice of the final year NCE III students was base on the fact that they have covered almost all the areas of the welding and fabrication course in the minimum standard. The teachers were involve in identifying the expected welding skills operations in NCE for the WSAI and also rating of students performances when trial testing the instrument. All the metalwork technology teachers were involved in the study therefore there was no sampling because the population was manageable.

The instrument WSAI was developed from VTE minimum standard for NCE technical. The following stages were adhered in the procedural development of the instrument. These are:

1. Identification of appropriate psychomotor objectives for assessment
2. Transforming identified psychomotor objectives into items or operational task format
3. Developing the table of specifications using Simpson model
4. Developing descriptive rating scale
5. Validating the draft WSAI by 7 experts
6. Trial testing the WSAI
7. Determining the inter-rater reliability and the internal consistency of the WSAI using ICC and Cronbach alpha respectively
8. Final assemble of WSAI

Based on the teachers rating, 75 expected welding psychomotor objectives for assessment were identified from the minimum standard. Based on suggestion of Tuckman (1995) [8], every fifth out of the 87 final year student were symmetrically selected during the trial test of WSAI and rated by four teachers making a total number of 17 students. The data obtain from the trial test of the 17 students were used for determining the inter-rater reliability while the data obtained from the total of 87 students were used for determining the internal consistency of the WSAI. Data generated was analyzed using mean, standard deviation, Content Validity Index (CVI) technique, Cronbach alpha, Intra-class Correlation Coefficient (ICC) and Analysis of Variance (ANOVA). Mean cut-off point of 2.50 and above were utilized in selecting the identified psychomotor objectives for WSAI items. Any item with CVI of 0.80 and above was considered valid for WSAI (Lynn, 1986 and Sangoseni, Hellman, & Hill, 2015) [16, 17]. The reliability coefficient of 0.70 and above was considered (Nunnally, 1978) [18]. For analysis of data relating to the null hypotheses at 0.05 level of significance, 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.

Results

Research Question 1

What are the expected psychomotor skills for assessment in welding operations in NCE?

Table 1: Teachers Mean Ratings of Expected Machining Tasks Operations for Metalwork

S. No.	Expect fitting sub-tasks and operations	$\bar{X}$	δ	I-CVI	Remark
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
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
Task 3: Cutting					
22.	Promptness to starting cutting	1.93	0.83	-	Unexpected
23.	Identification of marked position to cut	1.56	0.70	-	Unexpected
24.	Selection of appropriate cutting tool	3.19	0.68	1	Expected & Valid
25.	Right setting of the cutting tool	3.33	0.55	1	Expected & Valid
26.	Correct use and manipulation of cutting tool	3.41	0.50	1	Expected & Valid
27.	Positional accuracy of cutting	3.11	0.75	0.86	Expected & Valid
28.	Care of cutting tools during and after cutting	3.04	0.76	1	Expected & Valid
Task 4: Setting-Off Oxy-Acetylene Gas Welding Equipment					
29.	Promptness to starting setting-off equipment	1.91	0.92	-	Unexpected
30.	Identification of gas cylinder	2.56	0.89	0.86	Expected & Valid
31.	Assembling of gas cylinders on trolley	2.87	0.77	1	Expected & Valid
32.	Fixing of pressure gauge on gas cylinder	3.56	0.51	1	Expected & Valid
33.	Fixing of gas hoses on gas cylinders	3.49	0.66	1	Expected & Valid
34.	Fixing of gas hoses on welding blow pipe	3.32	0.78	1	Expected & Valid
35.	Fixing of selected welding nozzle	3.21	0.71	1	Expected & Valid
36.	Observing safety precautions	2.98	0.87	0.86	Expected & Valid
Task 5: Oxy-Acetylene Cutting					
37.	Promptness to starting gas welding cutting	1.67	0.61	-	Unexpected
38.	Setting of gas discharge rate on cylinder gauges	3.21	0.54	1	Expected & Valid
39.	Setting of work pressure rate on cylinders	3.04	0.67	1	Expected & Valid
40.	Selection of nozzle size on given metal thickness	2.97	0.55	1	Expected & Valid
41.	Using spark lighter to light-on cutting touch	2.76	0.72	1	Expected & Valid
42.	Setting flame for pre-heating purpose on cutting	3.12	0.87	1	Expected & Valid
43.	Pre-heating operation before cutting	3.21	0.69	1	Expected & Valid
44.	Correct speed of cutting	3.54	0.62	1	Expected & Valid
45.	Observing safety precautions	3.15	0.57	1	Expected & Valid
Task 6: Oxy-Acetylene Welding					
46.	Promptness to start welding	1.93	0.98	-	Unexpected
47.	Using hand file to bevel out edge of stock	2.50	0.98	0.86	Expected & Valid
48.	Setting of gas discharge rate on cylinder gauges	3.12	0.76	1	Expected & Valid
49.	Setting of working pressure rate on cylinders	3.15	0.71	0.86	Expected & Valid
50.	Selection of nozzle size on given metal thickness	3.33	0.87	1	Expected & Valid
51.	Lighting on welding torch	2.89	0.65	0.86	Expected & Valid
52.	Setting correct welding flame	3.00	0.70	1	Expected & Valid
53.	Tacking of parent metal	3.07	0.73	1	Expected & Valid

54.	Determining penetration gap	2.79	0.67	0.86	Expected & Valid
55.	Angle of blow pipe held during welding	3.55	0.61	1	Expected & Valid
56.	Angle of filler rod held during welding	3.45	0.54	1	Expected & Valid
57.	Welding speed used during welding	3.67	0.63	1	Expected & Valid
58.	Manipulation of filler rod and welding torch	3.59	0.61	1	Expected & Valid
59.	Observing safety precautions	3.35	0.52	1	Expected & Valid
Task 7: Arc Welding					
60.	Promptness to start welding	1.99	0.52	-	Unexpected
61.	Using hand file to bevel out edge of stock	2.51	0.98	0.57	Invalid
62.	Allowing flange thickness of beveled stock for root penetration	3.19	0.68	1	Expected & Valid
63.	Setting of correct welding current	3.11	0.72	1	Expected & Valid
64.	Selecting correct electrode size	3.26	0.81	1	Expected & Valid
65.	Tacking of parent metals	3.19	0.69	1	Expected & Valid
66.	Striking and maintaining the arc	3.12	0.76	1	Expected & Valid
67.	Holding electrode at correct angle during welding	3.42	0.89	1	Expected & Valid
68.	Maintaining correct arc length	2.98	0.88	1	Expected & Valid
69.	Maintaining correct welding speed	3.17	0.61	1	Expected & Valid
70.	Manipulation of electrode during welding	3.10	0.56	1	Expected & Valid
71.	Observing safety precautions	3.04	0.76	1	Expected & Valid
Task 8: Riveting					
72.	Promptness to starting riveting	1.85	0.72	-	Unexpected
73.	Selection of appropriate riveting tool	2.93	0.78	1	Expected & Valid
74.	Selection of appropriate rivet	3.00	0.73	1	Expected & Valid
75.	Drilling correct hole size	3.21	0.81	1	Expected & Valid
76.	Right setting of riveting tool and plate to rivet	3.26	0.81	1	Expected & Valid
77.	Riveting a work*	3.11	0.75	1	Expected & Valid
78.	Finishes of the rivet work	3.63	0.56	0.86	Expected & Valid
Task 9: Hard And Soft Soldering					
79.	Promptness to starting soldering	1.85	0.71	-	Unexpected
80.	Selection of appropriate type of soldering*	3.15	0.66	1	Expected & Valid
81.	Selection of appropriate soldering tools*	3.52	0.51	1	Expected & Valid
82.	Right setting of soldering tools*	3.07	0.73	1	Expected & Valid
83.	Edge preparation and cleaning of metals to be soldered	3.33	0.55	1	Expected & Valid
84.	Lighting the blow lamp/welding torch and setting flame	3.11	0.75	1	Expected & Valid
85.	Preheating of parent metals	3.19	0.68	1	Expected & Valid
86.	Applying flux	3.41	0.50	1	Expected & Valid
87.	Applying rod/solder	3.56	0.51	1	Expected & Valid
88.	Use and manipulation of soldering tools*	2.85	0.66	1	Expected & Valid
89.	Finishes surface of soldering work*	3.41	0.50	1	Expected & Valid
Task 10: Forging					
90.	Promptness to starting forging	1.85	0.72	-	Unexpected
91.	Selection of appropriate forging tools	3.07	0.68	1	Expected & Valid
92.	Right setting of forging tools	2.67	0.48	0.86	Expected & Valid
93.	Forging a work	1.85	0.71	-	Unexpected
94.	Upsetting a work	3.11	0.75	1	Expected & Valid
95.	Heading a work	3.00	0.68	1	Expected & Valid
96.	Drawing-down a work*	3.11	0.75	1	Expected & Valid
97.	Off-setting a work	1.81	0.68	-	Unexpected
98.	Twisting a work	3.63	0.49	1	Expected & Valid
99.	Bending a work	3.41	0.50	1	Expected & Valid
100.	Flattening a work*	3.52	0.51	1	Expected & Valid
101.	Holding hot metal for beating	2.79	0.64	1	Expected & Valid
102.	Finishes surface of a forge	3.56	0.51	1	Expected & Valid
	S-CVI				0.98

In Table 1, teachers rated the expected welding tasks' operations with mean ($\overline{X}$) ranging from 1.30 to 3.74. The result shows that 7 welding tasks operations 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 10 welding tasks, are expected and therefore included into the study. The standard deviation (δ) of the teachers rating ranged from 0.48 to 0.98. This implies that the teachers were very close in their rating.

Research Question 2

What is the validity of WSAI items?

Data in Table 1 provided information for answering research question 2. In Table 1, 7 experts rated 84 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 1 items number 61 was rated irrelevant with I-CVI of 0.57. Therefore item 61 with I-CVI below the 0.80 was not included into the assembled MSAI. Table 1 further indicated that 10 items with mark (*) were face validated and included into assembled WSAI. Therefore the result in Table 1 shows that WSAI have 10 tasks with 84 relevant items which yielded 0.98 S-CVI.

Research Question 3

What is the internal consistency of WSAI items?

Table 2: Internal Consistency (IC) and Inter-rater Reliability of WSAI

S/n Tasks	N_{Items}	N_{Raters}	α_{IC}	Inter-Rater	ICC	Remark
Measuring	8	4	0.78	0.63-0.90	0.75	reliable
Marking out	7	4	0.90	0.64-0.93	0.81	reliable
Cutting	5	4	0.88	0.61-0.96	0.77	reliable
Setting-off gas welding equipment	7	4	0.89	0.72-0.84	0.88	reliable
Oxy- Acetylene Cutting	8	4	0.83	0.61-0.88	0.67	reliable
Oxy-Acetylene Welding	13	4	0.90	0.77-0.91	0.90	reliable
Arc Welding	10	4	0.87	0.70-0.89	0.87	reliable
Riveting	6	4	0.87	0.81-0.92	0.87	reliable
Soldering	10	4	0.89	0.63-0.87	0.78	reliable
Forging	10	4	0.83	0.68-0.91	0.88	reliable
WSAI average indices	84	12	0.86	0.82		reliable

Table 2 shows that all the 10 Tasks have their internal consistency reliability (α_{IC}) indices ranging from 0.78 to 0.90 with average index of 0.86, which is above the acceptable line of 0.70.

Research Question 4

What is the inter-rater reliability of WSAI?

Table 2 shows that WSAI tasks have their ICCs from 0.75 to 0.90 with average of 0.82 which is very high correlation between raters. The result also shows paired rater or inter-rater correlation coefficient ranging from 0.61 to 0.96. This indicated that all the four raters rating a particular student's performance in each item of WSAI are found reliable in their ratings.

Hypothesis 1

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

Table 3: ANOVA of Teachers' Rating of Expected Psychomotor Welding Skills for Assessment

Source of variation	Sum of square	df	Mean square	F-cal	F-table	P	Remark
Between groups	0.051	4	0.013				
				0.097	2.82	0.982	Accepted
Within groups	2.902	22	0.132				
Total	2.953	26					

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

Table 3 revealed that the p-value of teachers' rating of expected psychomotor welding skills for assessment in NCE is 0.982. 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 teachers on the expected psychomotor welding skills for assessment in NCE. Therefore, the null hypothesis was accepted.

Hypothesis 2

HO_2: There is no significant difference in the mean performance scores of students of the three ability groups of high, average and low on WSAI items.

Table 4: ANOVA of the Mean Performance Scores of Students of the Three Ability Groups of High, Average and Low on WSAI Items

Source of variation	Sum of square	df	Mean square	F-cal	P	Remark
Between groups	35572.279	2	17786.140			
				191.676	0.000	Accepted
Within groups	7794.571	84	92.793			
Total	43366.851	86				

Table 4 revealed that the p-values of mean scores students of the three ability groups of high, average and low on WSAI items was 0.000. This value is less than the p-value of 0.05 indicating that there is significant difference in the mean scores of students of the three ability groups of high, average and low on WSAI items. 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 performance 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 provides post-hoc test as part of the ANOVA.

Table 5: Multiple Comparisons of the Mean Performance Scores

State	High	Average	Low	$\bar{X}_{Grand}$	df	$P_{Ability\ Group}$	Remark
Bauchi	78.57^{A}	58.00^{B}	28.86^{C}	55.14	2/18	0.000	Rejected
Gombe	78.00^{A}	53.69^{B}	26.08^{C}	52.62	2/34	0.000	Rejected
Yobe	75.11^{A}	54.64^{B}	25.56^{C}	52.28	2/26	0.000	Rejected
Grand Mean	77.21	55.00	26.93				
df	2/25	2/28	2/25				
P_{States}	0.799	0.483	0.846				
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 performance 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 performance scores of students in high ability group that are in Bauchi, Gombe and Yobe States recorded not significantly different with p-value of 0.799. Those of the average and low ability groups were 0.483 and 0.846 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 main contribution of this study is the successful development of a valid and reliable instrument to assess students' welding skills. The finding in research question 1 revealed that 85 out of 102 psychomotor welding skills operations are identified which are distributed into 10 tasks. These 85 psychomotor welding skills operations, identified by the teachers are expected to be carried out by NCE technical students. This finding is related to the findings of Okwelle and Okeke (2012) [19] regarding the fact that practicing teachers were involved in identifying from the curriculum items for the instrument to be developed for assessing students' skills.

Table 1 also revealed finding in research question 2 that WSAI is face and content valid for assessing NCE students' welding skills with S-CVI of 0.98 which is very high. Seven experts rated 85 out 102 items as relevant with I-CVIs ranging from 0.86 to 1. 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. This agrees with Gachino and Galignton (1976)[20] and Engel and Schutt (2013) [21] 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 WSAI. The larger the number of experts involved in assessing the appropriateness of the instrument items the higher the validity index of the instrument. Similarly, this was the case in this study.

The findings related to research question 3 revealed in Table 2 that 10 welding tasks have their internal consistency reliability indices ranging from 0.78 to 0.90 with average index of 0.86, which is above the acceptable line of 0.70 (Nunnally, 1978) [18]. This indicated that all the 84 items were internally consistent and reliable in the seven levels of Simpson's model of psychomotor domain. This finding is in agreement with the findings of Fatunsin (1996) [22], Yalams (2001) [3], Zhang and Lam (2008) [23], Olaitan (2014) [10] and Adamu (2015) [24] 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 raters from 0.75 to 0.90 with average of ICC 0.82. These results signify that raters' correlation is very high. This finding is related to the findings of Yalams (2001) [3] and Olaitan (2014) [10] where kendall coefficient of concordance and Pearson product moment correlation respectively where used 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 WSAI possessed a high inter-rater reliability when compared with findings reported by Yalams and Olaitan 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) [25].

The findings in Tables 3 related to hypotheses 1 revealed that the calculated p-value for mean ratings of teachers on the expected psychomotor welding skills for assessment in NCE is 0.982. This value was found to be greater than the p-critical value of 0.05 (level of significance) with 4 and 22 degrees of freedom. This implied that there were no significant differences in the mean ratings of metalwork teachers in colleges of education on the expected psychomotor welding skills for assessment in NCE. Hence the null hypothesis was accepted. This finding is consistent with Adamu (2015) [24] regarding the facts that teachers were involved in identifying items for the instrument developed.

Tables 4 provided information on hypothesis 2, which revealed that the calculated p-value for mean performance scores of the students of the three ability groups of high, average and low on WSAI items is 0.000. This value was found to be less than the p-critical value of 0.05 (level of significance) at 2/84 degree of freedom. This result implied that there was significant difference in the mean performance scores of the students of the three ability groups of high, average and low on WSAI items throughout the states. Hence the null hypothesis was rejected. Scheffe multiple comparison test of mean performance scores was carried out in order to find the direction of the difference. The test revealed in Table 5 that the difference was significant between the high, average and low ability groups. The implication of the result of

Scheffe test is that the WSAI items were able to distinguish between high, average and low ability students in terms of their performance which is a measure of the validity of WSAI. The study further determined significant difference in each ability group in Bauchi, Gombe and Yobe States. The findings revealed that the calculated p-value for mean scores of the students in each ability group on WSAI items in Bauchi, Gombe and Yobe are 0.799, 0.483 and 0.846 for high, average and low ability groups. These values were found to be greater than the p-critical value of 0.05 (level of significance) with 2/25, 2/28 and 2/25 degree of freedom for high, average and low ability group respectively. These results implied that there were no significant differences in the mean scores of the students of each ability group on WSAI items in Bauchi, Gombe and Yobe States. Hence the null hypotheses of no significant were accepted.

Conclusion
The major findings of this study serves as a basis for drawing conclusion that WSAI is a valid and reliable assessment instrument that could be used in assessing welding skills at NCE in Colleges of Education in Nigeria. Therefore, Colleges of Education teachers will now be able to use comprehensive and systematic instrument to effectively assess students' performance in welding tasks.

Recommendations
Based on the findings from the study, the following recommendations are suggested:
1. Teachers in Colleges of Education should adopt psychomotor welding skills for teaching and assessment.
2. The NCCE body should provide assessment medium and integrate WSAI into their minimum standard for certification of the students.
3. Colleges of Education teachers should be encouraged by Government to use WSAI to assess NCE student during teaching and at the semester assessment of their student.
4. The developed WSAI 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 skills acquisition at NCE level.

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