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Machining skills assessment instrument (MSAI) in Nigeria certificate in education for colleges of education in Nigeria

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Abstract
This study developed and validated Machining Skills Assessment Instrument (MSAI) 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 metalwork teachers and 708 NCE metalwork students in 5 the colleges of education that offer NCE metalwork 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 MSAI. The study answered four research questions and tested 2null hypotheses. The draft MSAI was face and content validated by 7 experts which establish a S-CVI of 0.987 for machining tasks with 45 items along 6 sub-tasks developed from VTE minimum standard for NCE metalwork. The validated MSAI was then trial tested on the 87 students and MSAI was found to be internally consistent with 0.866 reliability coefficient. An average index of 0.776 for ICC was determined to be rater reliability of MSAI. Based on these results, it was recommended among others that 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.

Keywords: Skills, Machining, Assessment Instrument

Introduction

Machining is the process of removing unwanted materials from a work-piece in the form of chips in order to change the size, shape, and surface of the material. Machining involve tasks carried out on lathe, drilling machine, milling machine, grinding machine etc. It is one of the tasks involve in Vocational and Technical Education (VTE) programmes offered in Nigerian's school system with one cardinal objective of producing skilled manpower required for the nation's economic and technological development[1]. Part of the efforts towards achieving this objective is the establishment of the Nigeria Certificate in Education (NCE) programmes in colleges of education [2]. The programme is designed to produce teachers with minimum teaching qualification for teaching at the primary and junior secondary school levels. The [3] stated that NCE is recognized minimum teaching qualification in Nigeria and the programme is designed to produce quality teachers for the basic education sector. Technical education is part of the three year programme run under the NCE structure which includes metalwork technology as one of the five areas of specialization.

Metal work tasks in NCE are classified into fitting work and machine shop practices 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's machining tasks in NCE involve practical activities such as marking out, measuring, cutting, drilling, grinding, threading etc. Operations in these tasks could be executed with simple hand tools while others may require the use of light or heavy duty machine tools such as milling machine, lathe machine, drilling machine etc. These machining tasks are spread along NCE metalwork courses: machine shop practice 1 & 2 and maintenance and repair of mechanical tools and equipment's. 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. These practical task and operations plays a very important role in teaching and learning machining 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 [2].

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 or traits inferred from multiple evidences and used to explain observable behavior patterns. They are characteristics that are assessed through observation of behavioral 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. [4]Defined practical skills as organized and coordinated forms of physically observable activities exhibited in the process of carrying out tasks in VTE and other related field. The skills demonstrated by students of a training programme will determine the extent to which behavioral or instructional objectives have been achieved. The quality measured also determines the extent to which proposed objectives of the programme are being attained. Assessment is an important aspect of education that makes such exercise possible.

Therefore, in assessing the extent to which skills has been achieved or attained in the psychomotor skills of student, and for the instrument to be good enough to assess the expected performance of students, it is expected that 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 peculiarities or characteristics that helps to distinguish it or expected to be possessed by the instrument items such as item reliability and validity[5]. 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 [6]. 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 [7]. 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 or physical power that enables a person to achieve or accomplish something. [8] 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 [9] & [10]. 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. [8], [11, 12] 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. [13]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 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[14]. Despite these, [15] 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 Machining 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 machining tasks operations from NCE metalwork technology minimum standard for VTE;
2. Determined the validity of MSAI items;
3. Determined the internal consistency of MSAI items;
4. Determined the inter-rater reliability of MSAI.

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 machining.

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 machining.

Methodology

The study employed instrumentation research design, which is appropriate for use when introducing new procedures, technologies or instrument for educational practices [16]. [17]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 NCEin 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. 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 .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 .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 0.987S-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 21teachers 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 7experts 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 [9], 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 kills 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 machining tasks operations from NCE metalwork technology minimum standard?

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

Tasks items	δ	$\bar{X}$	I-CVI	Remark
SUB-TASK 1: DRILLING				
1. Promptness to starting drilling operation	1.81	0.74	-	Unexpected
2. Selection of appropriate drilling machine	3.52	0.51	1	Expected& Valid
3. Selection of appropriate drill bit*	3.56	0.50	1	Expected& Valid
4. Clamping work in vice/tool in chuck	3.26	0.81	1	Expected& Valid
5. Drilling a hole	3.11	0.75	1	Expected& Valid
6. Boring a hole	3.52	0.51	1	Expected& Valid
7. Reaming a hole	3.51	0.58	1	Expected& Valid
8. Counter boring a hole	3.26	0.81	1	Expected& Valid
9. Counter sinking a hole	3.52	0.74	1	Expected& Valid
10. Finishes of the drilling operation	3.56	0.51	0.71	Expectd&Invalid
SUB-TASK 2: GRINDING				
11. Promptness to starting grinding operation	1.81	0.68	-	Unexpected
12. Selection of appropriate grinding machine	3.63	0.49	0.86	Expected& Valid
13. Selecting appropriate grinding wheel*	3.41	0.50	1	Expected& Valid
14. Mounting grinding wheel*	3.48	0.51	1	Expected& Valid
15. Grinding a work	2.5	0.51	1	Expected &Valid
16. Sharpening cutting tool	3.52	0.51	1	Expected& Valid
17. Coolant application	1.89	0.64	-	Unexpected
18. Finishing grinding	3.11	0.75	1	Expected& Valid
SUB-TASK 3: SHAPING				
19. Promptness to starting shaping operation	1.85	0.72	-	Unexpected
20. Selection of appropriate shaping tool	3.56	0.51	0.86	Expected& Valid
21. Setting for appropriate swivel	3.26	0.81	1	Expected& Valid
22. Machining horizontal surface	3.37	0.49	1	Expected& Valid
23. Machining vertical surface	3.52	0.51	1	Expected& Valid
24.Machining angular shape	3.52	0.58	1	Expected& Valid
SUB-TASK 4: LATHE OPERATIONS				
25. Promptness to starting lathe operation	1.67	0.48	-	Unexpected
26. Mounting appropriate tool to the post	3.52	0.51	1	Expected& Valid
27. Mounting/setting work on lathe chuck	3.56	0.51	1	Expected& Valid
28. Right setting of lathe for a given operation	3.26	0.81	1	Expected& Valid
29. Mounting work between centers	3.11	0.75	1	Expected& Valid
30. Drilling on lathe	3.52	0.51	1	Expected& Valid
31. Parallel turning	3.52	0.58	1	Expected& Valid
32. Taper turning	3.26	0.81	1	Expected& Valid
33. Eccentric turning	3.52	0.51	1	Expected& Valid
34. Thread cutting	3.56	0.51	1	Expected& Valid
35. Recognize computer numerical control codes3.48		0.50	1	Expected& Valid
36. Apply each CNC command appropriately	3.52	0.51	1	Expected& Valid
37. Use the CNC codes to write programmes	3.56	0.51	1	Expected& Valid
SUB-TASK 5: MILLING				
38. Promptness to starting milling operation	1.85	0.72	-	Unexpected
39. Selection of appropriate milling cutter	3.11	0.75	1	Expected& Valid
40. Setting up indexing head for milling	3.52	0.51	1	Expected& Valid
41. Mounting horizontal milling cutter on arbor	3.52	0.57	1	Expected& Valid
42. Mounting vertical milling cutter on collate	3.26	0.81	1	Expected& Valid
43. Milling a flat surface*	3.51	0.51	1	Expected& Valid
44. Milling an angular surface*	3.26	0.81	1	Expected& Valid
45. Milling hexagonal shape	3.52	0.51	1	Expected& Valid
46. Cutting a key way	3.52	0.50	1	Expected& Valid
47. Drilling on milling machine	1.63	0.56	-	Unexpected
48. Recognize the CNC codes	1.85	0.72	-	Unexpected
49. Apply each CNC command appropriately	1.63	0.57	-	Unexpected
50. Use the CNC codes to write programmes	1.86	0.71	-	Unexpected
SUB-TASK 6: MAINTENANCE TASK				
51. Checking condition of the machine/tool	3.52	0.58	1	Expected& Valid
52. Selecting appropriate maintenance type	3.25	0.82	1	Expected& Valid
53. Cleaning oil, chips, etc	3.52	0.50	1	Expected& Valid
54. Toping oil level	3.51	0.61	1	Expected& Valid
55. Greasing mating parts	3.56	0.51	1	Expected& Valid
56. Adjusting slides	3.26	0.81	1	Expected& ValidS-CVI
		0.987		Valid

In Table 1, teachers rated the expected machining sub-tasks' operations with mean ($\bar{X}$) ranging from 1.63 to 3.63. The result shows that 10 sub-tasks operations for machining task were rated below the cut-off point of 2.50, hence they are rated unexpected and not included into the study. The 46 operations rated above 2.50, which are spread along the 6 machining sub-tasks, are expected and therefore included into the study. The standard deviation (δ) of the teachers rating ranged from 0.48 to 0.82. This implies that the teachers were very close in their rating.

Research Question 2

What is the validity of MSAI items?

Data in Table 1 provided information for answering research question 2. In table 1, 7 experts rated 45 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 10 was rated irrelevant with I-CVI of 0.71. Therefore item 10 with I-CVIs below the 0.80 was not included into the assembled MSAI. Table 1 further indicated that 5 items with mark (*) were face validated and included into assembled MSAI. Therefore the result in Table 1 shows that MSAI have 6 sub-tasks with 45relevant items which yielded 0.987 S-CVI.

Research Question 3

What is the internal consistency of MSAI items?

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

Sub-tasks	N_{Items}	N_{Raters}	α_{IC}	Inter-Rater	ICC	P_{Raters}	Remark
Drilling	8	4	0.780	0.631-0.902	0.746	0.937	Reliable
Grinding	6	4	0.900	0.643-0.928	0.807	0.913	Reliable
Shaping	5	4	0.881	0.612-0.963	0.767	0.930	Reliable
Lathe Operations	12	4	0.896	0.718-0.835	0.735	0.088	Reliable
Milling	8	4	0.835	0.608-0.884	0.786	0.253	Reliable
Maintenance Task	6	4	0.901	0.766-0.903	0.859	0.900	Reliable
MSAI average indices	128	12	0.866			0.783	Reliable

Table 2 shows that all the 6 sub-tasks have their internal consistency reliability (α_{IC}) indices ranging from 0.780 to 0.901 with average index of 0.866, which is above the acceptable line of 0.70 (Nunnally, 1978).

Research Question 4

What is theinter-rater reliability of MSAI?

Table 2 shows that MSAI sub-task have their ICCs from 0.735 to 0.859 with average of 0.776 which is very high correlation between raters. The result also shows paired rater or inter-rater correlation coefficient ranging from 0.608 to 0.928.This indicated that all the four raters rating a particular student's performance in each item of MSAI's are found reliable in their ratings. The results further revealed that p-value of teachers' rating of a particular student in each sub-tasks' items of MSAI ranged from 0.088 to 0.937. 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 machining.

Table 3: ANOVA of Teachers' Rating of Expected Machining Sub-tasks Operations for NCE Metalwork

Source of variation square	Sum of	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

Data in Table 3 revealed that the p-value of teachers' rating of expected machining sub-tasks' operations for NCE metalwork 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 metalwork teachers on the expected psychomotor skills for assessment in NCE metalwork technology in practical machining. 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 MSAI items in practical machining.

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

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
$\bar{X}_{Grand}$	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				

NOTE: F-Scheffe$_{(P>0.05)}$: States = 0.701; Ability Groups = 0.000.

Data in Table 4 revealed that the p-values of students' mean performance scores in machining task based on their ability groups in Bauchi, Gombe and Yobe States was 0.000 all through. These values were less than the p-value of 0.05 (level of significance) indicating that there is significant difference in the mean performance scores of the students of the three ability groups of high, average and low on MSAI items in practical machining. Post-hoc analysis using Scheffe test was carried out to determine the direction of difference of the mean performance scores of the three groups. The result of post-hoc indicated that mean performance scores followed by the same letter are not significantly different.

Data further revealed that the p-values of Bauchi, Gombe and Yobe States students' mean performance scores in machining task of each ability group of high, average and low were 0.799, 0.483 and 0.486 respectively. These values were greater than the p-value of 0.05 (level of significance) indicating that there is no significant difference in the mean performance scores of the students of each ability groups in practical machining. Therefore the results in Table 4 revealed that no significant difference in each ability group in Bauchi, Gombe and Yobe but there is significant difference in the mean scores of student in the three ability groups.

Discussion

The main contribution of this study is the successful development of a valid and reliable instrument to assess students' machining skills. The finding related to research question 1, in Table 1, revealed that 46 out of 56psychomotor skills operations are identified as metalwork machining task operations which are distributed into 6 sub-tasks. These 46 psychomotor skills operations, identified by metalwork teachers are expected to be carried out by NCE metalwork students. This finding is related to the findings of [4] and [18] 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 MSAI is valid for assessing NCE metalwork students' skills with S-CVI of 0.987 which is very high. This information is reveal in Table 1 for answering research question 2. Seven experts rated 45 out 46 items as relevant with I-CVIs ranging from 0.86 to 1 and face validated 5 items along 6 sub-tasks for MSAI. 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 MSAIitems were designed to assess [12]. This agrees with [19, 20] 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 MSAI. They suggested that larger number of experts should be involved in assessing the appropriateness of the instrument items. Similarly, this was the case in this study. The finding of this study related to research question 2 is in accordance with [21, 22, 23] that a significant level for inclusion of an item into an instrument to be an I-CVI of ≥ 0.80.

The findings related to research question 3 reveals in Table 2 that 6 sub-tasks have their internal consistency reliability indices ranging from 0.780 to 0.901 with average index of 0.866, which is above the acceptable line of 0.70 [24]. This indicated that all the 45 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 [25, 2, 26, 11, 27] 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 0.608 to 0.928with average ICC 0.776. 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 [2] and [11] 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 hat the developed MSAI possessed a high inter-rater reliability when compared with findings reported by [2, 11] 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 [28].

The findings in Tables 3 related to hypotheses 1 reveals that the calculated p-value for mean ratings of metalwork teachers on the expected psychomotor skills for assessment in NCE metalwork technology in practical machining is 0.982. This value was found to be greater than the p-critical value of 0.05 (level of significance) with 4 and 22degrees 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 skills for assessment in NCE metalwork technology in practical machining. Hence the null hypotheses of no significant were accepted. This finding is consistent with [27] regarding the facts that teachers were involved in developing items for the instrument developed.

Tables 4 provided information on hypothesis 2, which reveal that the calculated p-value for mean scores of the students of the three ability groups of high, average and low on MSAI items in practical machining in Bauchi, Gombe and Yobe are 0.000 all through. These values were found to be less than the p-critical value of 0.05 (level of significance) with 2/18, 2/34 and 2/26degrees of freedom respectively. These results implied that there were significant differences in the mean scores of the students of the three ability groups of high, average and low on MSAI items in practical machining throughout the states. Hence the null hypotheses of no significant different were rejected. 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 MSAI in machining 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 MSAI.

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 MSAI items in Bauchi, Gombe and Yobe are 0.799, 0.483 and 0.846for high, average and low ability groups for machining tasks. 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 MSAI items in practical machining 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 MSAI 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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