Journal of Education and Practice
ISSN 2222-1735 (Paper) ISSN 2222-288X (Online)
Vol.5, No.25, 2014

Development and Validation of Workshop Based Process Skill Test in Metal Grinding for Assessing Students in Technical Colleges for work

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Abstract
The study focused on the development and validation of Workshop-Based Process Skill Tests (WBPST) for assessing students in metal grinding trade in technical colleges. The study adopted the instrumentation design and was carried out in Nasarawa State. The population for the study was 25 NTC III students comprising of 3 ability groups (8 high, 12 average and 5 low abilities). A 74 draft copy of workshop-based process skill items were generated, validated and utilized to develop WBPST. The developed test was used in assessing the students in governmental technical college Assakio. The data collected were analyzed using Cronbach Alpha, Kendall coefficient of concordance and Scheffe test. The reliability of the WBPST revealed coefficient of of 0.76. It was found out that there were differences in the mean scores of 3 ability groups (high, average and low). The inter-rater reliability coefficient of the WBPST was 0.57. It was therefore recommended that examination bodies (NABTEB and WAEC) should integrate the workshop –based process skill test items in their examination process for certification of NTC students.
Keywords: Development, Validation, Process assessment, Students, Metal grinding, Technical college.

Introduction

Metal grinding is one of the job areas in mechanical engineering craft programme in technical colleges in Nigeria. Students undergoing the programme are examined by the National Business and Technical Examination Board (NABTED) for the award of National Technical Certificate (NTC). Technical college specifically is designed to prepare individual to acquire manipulative skill, basic scientific knowledge and attitude required of a craftsman and technician at sub-professional level. The objectives of Metal grinding module for NTC students are specified as the following in the curriculum of [(1)]: demonstrate under supervision, the procedure for wheel turning, dressing and balancing; demonstrate the principle of operation of permanent and electro-magnetic chucks; operate off -hand grinder to sharpen cutting tools and operate a surface grinding machine to produce components with parallel, square and angular sides. The [(1)] emphasized that the metal grinding module when successfully completed can be used for employment proposes. Grinding is defined as a machining process which remove metal from work piece either with a revolving abrasive (grinding wheel) a moving abrasive belt, a disc or some other form[(2)]. To grind means to abrade; to wear away by friction or to sharpen. Metal grinding is therefore a module of study involving operations in reshaping, snagging the rough spots from castings, sharpening, polishing, wheel mounting, wheel dressing and fitting to produce and repair valuable metal articles.

The psychomotor aspects of metal grinding objective are meant to achieve adequate development in skills which can make the recipient employable. To achieve this goal at the NTC level, learners need to be well assessed. At present the assessment instrument used by NABTEB only helps to determine students' achievement of metal grinding objectives in cognitive domain. There are negligible observable results in achievement of psychomotor objectives [(3)].Metal grinding practical examination conducted by NABTEB and teachers are mere product rating and not skill manipulation rating of students[(4)]. Similarly, the assessment of manipulative activities as acquired by the students in the production processes need to be ascertained through workshop-based process skill test[(5)]. Workshop-based process skill test connote the presentation of step-by-step practical activities to be responded to by the learners in a typical workshop setting[(6)]. In this study, workshop-based process skill test is an instrument for determining the extent to which students can demonstrate the practical competencies in metal grinding using rating scale while the examiner is observing the student perform the operations involved. For effective assessment, the workshop-based process skill test should be valid and reliable. Validity of a measuring instrument is the property that ensures that the instrument measures what it is suppose to measure[(7)]. In other words, the validity of workshop based process skill test is the extent to which the student intended practical competencies outlined in the NTC curriculum are covered by the test items.

A valid instrument should also be reliable. Reliability of a measuring instrument is the ability of the instrument to measure consistently the phenomenon it is designed to measure. It is the consistency with which an instrument measure whatever it measures. The use of valid and reliable WBPST for assessing NTC Students in metal grinding will ensure that students are taught the proper way of performing tasks according to their ability

level.

Ability levels means characteristics mode of functioning that enable an individual show in, intellectual activities in a highly consistent and persuasive way[8]. Ability level of a student in technical college is the personality characteristic that influence that student school performance. The author identified three ability levels in relation to teaching –learning situation, viz: High, Average and low.

In technical colleges in Nasarawa State, NABTEB is accorded Metal grinding is one of the job areas in mechanical engineering craftprogramme in technical collegesin Nigeria. Students undergoing the programme are examined by the National Business and Technical Examination Board (NABTEB) for the award of National Technical Certificate (NTC). The National Board for Technical Education (NBTE) (2003) curriculum specified the objectives of metal grinding module for NTC students and emphasized that when the module is successfully completed can be used for employment proposes. Okoro (2012) defined grinding as a machining process which remove metal from work piece either with a revolving abrasive (grinding wheel), a moving abrasive belt, a disc or some other form. To grind means to abrade; to wear away by friction or to sharpen. Metal grinding is a module of study involving operations such as reshaping cutting tools, snagging the rough spots from castings; polishing, wheel mounting, and grinding to produce and repair valuable metal articles.

Theobjectives of metal grinding in NBTE (2003) is meant to achieve adequate development in skills which can make the recipient employable. To achieve this goal at the NTC level, learners need to be well assessed. Hersbatch (2010) observed that the product evaluation used by NABTEB only helps to determine students' achievement of metal grinding objectives in cognitive domain. Ogbu (2011) noted that there are negligible observable results in achievement of psychomotor objectives. Williams (2012) stated that metal grinding practical examination conducted by NABTEB and teachers are mere product rating and not process rating of students. Similarly, Bukar (2012) explained that the assessment of manipulative activities as acquired by the students in the production processes need to be ascertained through workshop-based process skill test. In Zhang and Lam (2013), workshop-based process skill test connote the presentation of step-by-step practical activities to be responded to by the learners in a typical workshop setting. In this study, workshop-based process skill test is an instrument for determining the extent to which students can demonstrate the practical competencies in metal grinding using process rating scale while the examiner is observing the student perform the operations involved. For effective assessment, the workshop-based process skill test should be valid and reliable.

Validity of a measuring instrument in Garba (2010)is the property that ensures that the instrument measures what it is suppose to measure. The validity of workshop based process skill test is then the extent to which the student intended practical competencies outlined in the NTC curriculum are covered by the test items.A valid test should also be reliable.

Reliability in Kiade (2013) is the ability of an instrument to measure consistently the phenomenon it is designed to measure. It is the consistency with which an instrument measure whatever it measures. The use of valid and reliable WBPST for assessing NTC Students in metal grinding will ensure that students are taught the proper way of performing tasks according to their ability level

Ability levels in Manion and Morrison (2011) means characteristics mode of functioning that enable an individual show in, intellectual activities in a highly consistent and persuasive way. Ability level of a student in technical college is the personality characteristic that influence that student performance. The author identified three ability groups in relation to teaching and learning situation,viz: High, Average and Low. According to authors the first 33% of the students with highest scores in a test are in high ability group,while the least 33% in the test are in low ability group. The middle 34% of the students belong to average ability group. A student can only perform according to his/her ability level which can be enhanced and better determined with valid and reliable instruments in technical colleges.

In technical colleges in Nasarawa state, NABTEB is accorded the responsibility of assessing the performance of students in metal grinding trade. The examining body has been using product evaluation technique in the form of marking scheme checklist. This is done at the expense of judging the production process of students through WBPST. Experience in technical colleges show that NABTEB sends her practical examination question papers to schools two weeks ahead of examination date. Students are left on their own to produce products in the workshop without their teachers' intervention. On the examination day, one examiner is sent to each college to rate finished products and marks are awarded based on mere looking and checking the end results of students' activities. Students can get assistance from outside to produce products presented for final assessment.This assessment practice is considered subjective and prone to abuse by both students and the raters. The practice of the examining body, has given room to product evaluation without students process skill development. Most metal grinding graduates lack skills and yet have good grades in their results. Ombugus(2013) observed that the objectives of metal grinding cannot be achieved with product evaluation. Evidence in the field revealed that graduates of metal grinding trade cannot practice on their own or get sustainable employment. The students' skills cannot be guarantee with the present NABTEB mode of assessment, hence the need to try out an

alternative method.

Purpose of the study

The major purpose of the was to develop and validate workshop-based process skill test items in metal grinding for assessing students in technical colleges in Nasarawa state for work. Specifically the study sought to:

1. Develop workshop based process skill test items in metal grinding at NTC III level
2. Determine the validity of the developed WBPST in metal grinding at the NTC III level
3. Establish the reliability of the developed WBPST in metal grinding at NTCIII level
4. Determine the ability groups of students in metal grinding at NTC III level.

Research Questions.

The study sought answers to the following research questions

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

Hypothesis.

H_0: There is no significant difference in the mean ratings of students on the workshop-based process skill test in metal grinding based on their ability levels (High, Average and Low). **Methodology.**

Design of the study

The study is a developmental and instrumental research which was aimed at developing a validated workshop-based process skill test for assessing students in practical areas of metal grinding at the NTC level.

Area of the study

This study was carried out in Nasarawa state and covered the four technical colleges in the state.

Population for the study

The population for the study was 25 NTC III students in government technical college Assakio. There was no sampling because the population was manageable.

Instrument Development

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

1. Isolation of performance objectives from the metal grinding curriculum.
2. Identification of the tasks in the metal grinding curriculum.
3. Identification of parametersthat were used to develop the workshop based process skill test.
4. Preparation of table of specification.
5. Construction of workshop based process skill test items. The tasks and skill items developed are shown in Table 1.

Validation of Instrument.

To determine important process skills for inclusion into the final test instrument, the following validations were carried out – Factor analysis using 0.40 as factor loading at 10% over lapping variance (Ashley, Boyale and Haile, 2010). In the results, 89 skill items with factor loading of 0.40 and above were selected for the study. A table of specification was developed based on the curriculum content given due consideration to the six levels of Simpson's(1972) level of psychomotor domain. This helped in ensuring that the 89 process skill items were adequately distributed across the levels of the domain.

The table of specification,the draft workshop-based process skill test and the curriculum of mechanical engineering craft at NTC level were validated by 3 experts in the department of Vocational Teacher Education (VTE) and 2 in Measurement and Evaluation unit, department of Science Education, all in University of Nigeria, Nsukka. The experts reviewed the appropriateness of the face validity of items in measuring students' process skills. Their corrections and suggestions were utilized in improving the test.

Reliability of Instrument.

The internal consistency of the metal grinding process skills items were determined using Cronbach alpha method to analyze test scores of the 25 NTC III students who were used for the field testing of the test. The result revealed reliability coefficient of 0.71. Based on the suggestion of Balogun and Mustapha (2014), every fifth out of the 25 students were systematically selected and rated by five teachers. Their rating scores were analyzed using Kendall coefficient of Concordance (Tau). The results revealed that the Kendall correlation coefficient between raters l and 2 is 0.71; 2 and 3 is 0.81; 3 and 4 is 0.60 and 4 and 5 is 0.80. Each of these scores represents the degree of relationship or association between the ratings of the 4 paired raters on level of performance among the 25 students of metal grinding trade. Sensiter (1996) in Okeme (2011) stated that tests

with reliability coefficient of 0.70 and above are considered sufficiently reliable to be of practical use. This means that the WBPST in metal grinding is reliable.

Data Collection and Analysis

The workshop-based process skill test was try-tested in government technical college, Assakio. Data were collected during students practical activities. Cronbach alpha method was utilized to establish the internal consistency of the questionnaire items. The result revealed reliability coefficient of 0.71.

The findings were used to develop WBPST for the study. The developed WBPST was built on a five-point scale namely: Very Low (VL); Low (L); Moderately High (MH); High (H) and Very High (VH). These levels of responses were weighted as 1, 2, 3, 4, and 5 respectively. The workshop-based process skill test was administered on the students of metal grinding using raters to determine the extent of skills they possessed. Factorial analysis was used in answering research question 1. Simpson (1972) psychomotor domain levels and experts' comments were utilized to answer research question 2. Research question 3 was answered using Cronbach alpha coefficient. Research question 4 was answered through an 8 skill items test while ANOVA was employed to test the hypothesis at 0.05 level of probability.

Results

The results of the study are presented according to headings that correspond to the research questions and the hypothesis tested:

Workshop-based process skill test items for assessing students' skills in metal grinding at NTC level

For selecting the tasks and process skills items important for inclusion in the workshop-based process skill test, 0.40 as factor loading was used. Any skill item with factor loading less than 0.40 was not important. Twelve tasks with their 89 corresponding process skill items were found suitable for inclusion in the workshop-based process skill test.

Table 1 Summary of factor Analysis Results

S/N	Skill Item	Factor loading	Remark
1	Testing wheel for damage/crack	.687	Important
2	Selecting washers or blotters	.806	"
3	Checking lead bush for burrs and fit	.643	"
4	Pushing wheel on spindle	.472	"
5	Tightening flange nut	.806	"
6	Test-running wheel without load	.744	"
7	Test-running with load *	.341	Not Important
8	Cleaning work-piece	.512	Important
9	Wiping magnetic chuck with clean cloth	.759	"
10	Greasing magnetic chuck *	.285	Not Important
11	Centering work piece on the chuck	.560	Important
12	Adjusting the table reverse dogs	.633	"
13	Turning on the coolant valve	.486	"
14	Adjusting the rate of table feed	.686	"
15	Turning on the power	.449	"
16	Hand feeding the table in until work piece is under grinding wheel	.693	"
17	Adjusting grinding wheel down until it is near the work piece	.679	"
18	Turning on the power table feed	.433	"
19	Turning the cross-feed out one fourth the width of the grinding	.542	"
20	Wheel Grinding the entire work piece surface	.696	"
21	Checking the condition of the tool	.605	"
22	Hand-running the grinding wheel	**.529**	**Important**
23	Removing burrs or dirt from work piece	.434	"
24	Turning on power	.773	"
25	Holding the tool and pressing against wheel at correct angle	.722	"
26	Dipping the tool in water regularly	.582	"
27	Grinding to required angle	.605	"
28	Checking the condition of the wheel	.743	"
29	Rising with oil *	.285	NotImportant

30	Selecting wheel dresser	.636	Important
31	Wearing safety goggles	.892	"
32	Turning on power	.647	"
33	Holding dresser on tool rest	.734	"
34	Feeding the dresser across the wheel until it is true	.778	"
35	Checking the condition of the machine	.427	"
36	Taking measurement *	.331	Not Important
37	Cleaning oil, chips and other dirts	.598	Important
38	Toping oil level	.631	"
39	Greasing mating parts	.648	"
40	Adjusting slides	.835	"
41	Cutting a strip of abrasive cloth from a roll or sheet	.696	"
42	Wrapping it round a stick or file	.670	"
43	Applying a few drops of oil to the metal surface	.717	"
44	Rubbing the cloth back and as if you were sanding. Do not rock the tool, keep it flat.	.458	"
45	Removing all scratches to make abrasive grains float in oil on the surface	.757	"
46	Reversing the cloth, exposing the back. Rubbing back and forth to get a high polish.	.572	"
47	Checking the condition of the punch	.614	"
48	Test running the grinding wheel with hand	.688	"
49	Turning on power	.555	"
50	Holding punch to the wheel at the correct angle	.863	"
51	Pressing the punch against the grinding wheel	.654	"
52	Swinging the punch from side to side by pivoting it over the tool rest	.421	"
53	Ensuring correct angle of the punch	.849	"
54	Dipping the punch in water regularly	.769	"
55	Checking the correct point angle of the punch	.633	"
56	Checking the condition of the screw driver	.611	Important
57	Test running the grinding wheel with hand	.471	"
58	Filing either side of the point to remove dirts	.486	"
59	Turning power of the grinding machine	.509	"
60	Grinding each side of the point a little a time	.691	"
61	Grinding the tip square	.516	"
62	Dipping the tool in water often to keep it cool	.797	"
63	Selecting the chisel *	.293	NotImportant
64	Checking the condition of the chisel	.491	Important
65	Hand running the grinding wheel	.663	"
66	Removing burrs from cutting edge with file	.508	"
67	Switching on the grinding machine	.422	"
68	Controlling chisel movement	.821	"
69	Holding one side of cutting edge against the face of the wheel and moving it back and forth in an arc	.697	"
70	Grinding the second side to form a sharp edge	.694	"
71	Cooling the chisel at interval of grinding	.426	"
72	Checking the condition of the twist drill	.496	"
73	Switching on the grinding machine	.599	"
74	Grasping the drill near the point in your right hand, with your left hand holding the shank	.824	"
75	Holding the lip of the drill at an angle of 59 degree to the grinding wheel	.864	"
76	Turning the drill in a clockwise direction, at the same swinging the shank down in an arc of 12-15 degrees	.699	"
77	Grinding a little off each cutting edge	.773	"
78	Dipping the drill coolant at intervals	.604	"
79	Checking with a drill-grinding gauge for current cutting edges length and angles	.457	"
80	Listing out materials for polishing	.497	"
81	Selecting the type of article to be polished	.411	Important
82	Attaching a clean, soft cloth wheel to the head of the polishing machine	.518	"
83	Selecting a stick of greaseless polishing compound	.623	"
84	Turning on the machine	.639	"
85	Holding the abrasive stick against the turning wheel until the face is coated	.890	"
86	Holding the work piece firmly in your hands,	.642	"
87	Moving it back and forth across the wheel until the scratches have been removed	.792	"
88	Selecting the type of article	.788	"
89	Stating the conditions of the metal article	.747	"
90	Fixing the abrasive belt around two or three pulleys	.511	"
91	Turning on power	.643	"

92	Holding the work against the belt in the areas between the pulleys	.483	"
93	Moving the work piece back and forth	.570	"
94	Applying even pressure for a good polish	.441	"

ll. Validity of the developed workshop-based process skill tests for assessing students' skills in metal grinding at NTC level

The validity of an instrument in Odu (2012) is the degree to which a test measures what it is designed to measure. An instrument with high validity will measure accurately the particular qualities it is supposed to measure. The validity of WBPST is then, the extent to which the students intended practical competencies outlined in the curriculum are covered by the test. In this study, the table of specification constructed based on Simpson (1972) levels of psychomotor domain showed that 6 levels were adequately covered and satisfactory comments were made by experts on the test. On the whole as shown in Table 1, there were 12 tasks with their 89 corresponding process skill items in metal grinding.

111. Reliability of the developed workshop-based process skill tests for assessing students' skills in metal grinding at NTC level

The result of the internal consistency of the workshop-based process skill test items are given in Table 2 below.

Table 2

Reliability estimate (Cronbach alpha) for items in metal grinding operation of WBPST

S/N	Task	Cronbach alpha	No. of items	Remark
1	Mounting wheel in machine spindle	0.66	6	Very high
2	Grinding metal object with surface grinder	0.74	12	"
3	Sharpening a cutting tool with a grinding wheel	0.76	7	"
4	Dressing and truing grinding wheel	0.65	6	"
5	Maintaining grinding machine	0.76	6	"
6	Hand polishing of a metal article	0.82	6	"
7	Sharpening centre punch on the bench grinder	0.81	8	"
8	Sharpening a screw driver on bench grinder	0.74		"
9	Sharpening cold chisel on pedestal grinder	0.63	7	"
10	Sharpening a twist drill on pedestal grinder	0.71	8	"
11	Polishing metal article with compound wheel	0.74	6	"
12	Polishing a metal article with coated abrasive	0.74	6	"

Table 2 revealed that each of the 12 grinding tasks had a high reliability coefficient ranging from 0.63 to 0.82. Also the reliability coefficient of the entire test was computed to be 0.71 which indicated that the assessment instrument was a refined test in consonance with the recommendation of Miller (2011) who stated that acceptable reliability of test use in education is generally in the range of 0.50 – 0.95. Therefore given the reliability coefficients of the various grinding tasks would be in the affirmative. Thus, the items in WBPST were reliable and considered for assessing metal grinding students' skills in technical colleges.

IV. Ability groups of students in metal grinding at NTC level

Table 3

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

	Task: Sharpening a twist drill on pedestal grinder	**5**	**4**	**3**	**2**	**1**
	Procedural steps /skill items					
1.	Checking the condition of the twist drill					
2.	Switching on the grinding machine					
3.	Grasping the drill near the point in your right hand with your lift hand holding the shank					
4.	Holding the lip of the drill at an angle of 59 degree to the grinding wheel					
5.	Turning the drill in a clockwise direction at the same time swinging the shank down in an arc of 12 – 15 degrees					
6.	Grinding a little of each cutting edge					
7	Dipping the drill in coolant at intervals					
8.	Checking with a drill-grinding gauge for correct cutting edges, length and angles					

The result of Table 3 was computed and revealed the following: 8 students under high ability, 5 and 12 students under low and average abilities respectively.

H_0: There is no significant difference in the mean rating of students on workshopbased process skill test in grinding operation based on their ability levels.To test this hypothesis, the mean ratings of the high, average and low ability students on each of the WBPST process skill was analyzed using F-ratio statistic. In the case of significant difference between the groups, the Scheffe multiple comparison test was applied to determine the direction or source of the difference. The summary result of analyzed data for the hypothesis is presented in table 4.

Table 4

Summary of Analysis of variance on the mean ratings of students on workshop-based process skill test on grinding operation based on their ability levels.

	Sum of Squares	**DF**	**Mean of Squares**	**F**	**Sig. (P-Value)**
Between groups	1.4502	2	0.70744	1.05098	0.4982
Within groups	15.43938	22	0.70176		
Total	16.8544	24			

P– Critical = 0.05

Table 4 revealed the mean ratings of teachers on students' performance on skill items in metal grinding. The analysis indicated that there was significant difference in the mean scores of the three groups of students at 0.05 level of significance, df 2 and 22 in all the skill items except 051 and 052. In all the 89 skill items (except items 051 and 052), the P – value calculated were significant at 0.20 which is greater than 0.05 probability level. This means that the null hypothesis of no significant difference was accepted in all the WBPST items but rejected for items 051 and 052.

Findings of the Study.

Major findings of the study include:

1. Twelve tasks with their 89 corresponding process skill items were found suitable for inclusion in the WBPST with factor loading at 0.40 and above.
2. The result of content validations revealed that 6 levels of the Simpson's psychomotor domain were adequately covered in the process skill test.
3. The internal consistency of the metal grinding process skill test items is 0.71.
4. Three ability groups of students (high, average and low) were identified in metal grinding.
5. There were significant differences in the mean scores between high and average ability with low ability students in metal grinding.

Discussion of the Findings.

The findings that 89 items with high factor loading were found suitable for inclusion in the workshop-based process skill test was supported by the conclusions ofBalogun and Mustapha (2014), Bukar (2012) and Ugbalu(2012). In their various studies ,the authors concluded that test items that have high factor loading and satisfy other psychometric properties are important for selection. In this study, item 31 in task 4 had the highest factor loading of 0.892 probably because of the importance of safety in metal working. Garba(2011) and Kaide(2013) observed that safety is a vital skill in metal industries. The authors added that metal grinders skillful in safety precautions produce accurate and better articles. Five out of 94 process skill items had factor loading below 0.40 and so needed exclusion. Eighty-nine process skill items had factor loading ranging from 0.411 to 0.892 portraying them with their corresponding 12 tasks as suitable and were used to develop the WBPST.

The content validity of the workshop-based process skill test was ascertained by critical analysis of each item by specialists in industrial technical section of vocational and teacher education, and measurement and evaluation unit, University of Nigeria, Nsukka. As pointed out by Okeme(2011) andOmbugus(2013) that the content validity of psychomotor learning activities could be pursued by submitting the list of skill items drawn up for use to experts for review so as to yield compromise or consensual agreement on the importance of the items and such was the case in this study. The draft test was further content validated for representativeness by building a detailed and comprehensive table of specification based on six levels of Simpson's(1972) model of psychomotor domain. This result was in agreement with the assertion by Odu(2010), Ogbu(2011) and Williams (2012) that the fairer the degree of distribution of test items ,the better representation of the behavioral domain and the higher the content validity of the test.

Eight-nineskill items in metal grinding had reliability coefficient of 0.71. This indicated that all the items were reliable in the six levels of Simpson's taxonomy tested. These results are in agreement with the findings of Cohen, Manion and Morrison (2011) in a study on development and validation of metalwork process evaluation scheme, whereit was found out that the instrument had good reliability with Cronbach alpha coefficient of 0.83. The findings also agree with the findings of Zhang and Lam(2013) in a study on development and validation of Racquet Ball Skills Test for Adult Beginners in Cleveland where the test had a high reliability of Cronbach coefficient of 0.68. The findings of this study on reliability is in consonance with the findings of Jimoh(2010) in a study on development and validation of objective test items in physics for class nine in Rawalpindi city, Pakistan, where it was found out thatthe test had a reliability coefficient of 0.75.

The study also found out that of the 25 students used in the study,8 fell under high abilitygroup representing the first 33% of the students with the highest scores; 5 students under low ability representing 33% of students with the least scores and 12 students in average ability representing 34% of the students with middle scores. This finding is in confirmity with the findings of Miller(2011) in a study on development and standardization of performance-based tests in agricultural science in secondary schools in Ondo state with a sample population of 675 students, where it was found out that 201,314 and 160 students fell under high, average and low abilities in that order.

The study further found out that there were significant differences in the mean performances of the three groups of students (high, average and low) on the workshop-based process skill test in metal grinding. Hence,the null hypothesis of no significant difference was rejected. This finding of the study is in agreement with the findings of Bukar (2012) in his study on development of an Instrument for evaluating practical projects in electronics in Kaduna polytechnic, Nigeria. The study found out that there were significant differences in the mean scores of high and low abilities but no significant difference in the mean scores of high and average abilities. The findings of the above authors gave credence to the findings of this study.

Conclusion

The developed workshop-based process skill test has provided a readily available process assessment instrument of high quality for the realization of skill development in students of metal grinding in technical colleges. Test developers,NABTEB, teachers and students would benefit from the study in terms of test preparations, certification processes, teaching and learning of metal grinding at the NTC level. The implementation of the developed test would no doubt remove the inconsistencies associated with assessment of skills in metal grinding. If the WBPST is implemented, there will be assurance of skill acquisition which would enhance the possibility of employment after graduation.

Recommendations

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

- The external examination bodies(NABTEB and WAEC) should integrate WBPST items in their examination for certification of the students.
- Seminars and workshops should be organized for teachers on process skill assessment.
- Evaluators in technical education should use WBPST to study their curricular, structure their

contents into relevant tasks and develop similar tests in their respective subject areas.

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