

WORKSHOP-BASED PSYCHOMOTOR TEST DEVELOPMENT AND VALIDATION IN METAL FITTING FOR ASSESSING STUDENTS PROCESS SKILLS IN TECHNICAL COLLEGES

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Abstract

The focus of this study was to compete globally on performance evaluation Methods in technical and vocational education and training, the need for new methods to improve skill acquisition and performance is inevitable. This study was therefore, centred on developing a process skill multiple choice test for full achievement of Metal Fitting objectives at National Technical Certificate (NTC) level. The researcher identified eight (8) tasks and generated fifty five (55) corresponding process skill items used as multiple choice test items for the study. The study discussed the extent of the present rating method used by National Business and Technical Examination Board NABTEB affects students' skill acquisition or development. One research question was formulated for the study. A 55-process skill items questionnaire was sent to elicit information from 36 teachers and 14 technicians teaching Metal Fitting in technical colleges. Mean scores and standard deviations were used for data analysis. The finding of the study unveiled that eight (8) tasks with their 55 corresponding skill items were essential in process assessment by the teachers of Metal Fitting for effective performance of students in technical colleges. The findings also disclosed that all the 55 skill items were valid for inclusion in the test instrument, with the 6 levels of the domain (Perception level, Set level, Guided response level, Mechanism level, Complex overt response level and Adaptation level) were adequately covered in the assessment method. The research there by recommended that the process skill rating scale test items should be used by the teachers in metal fitting at the NTC level to assess the student during teaching and at the terminal assessment of their student. And the examination bodies in charge of conducting and organizing examinations for the technical colleges (NABTEB) should integrate the process skill test items in their examination for certification of student in metal fitting at NTC level.

Keyword: Workshop-Based, Psychomotor Test, Development, Validation, Metal Fitting.

Introduction

Metal fitting is one of the job areas in mechanical Engineering craft in technical colleges, in which students are examined by the National Business and Technical Examination Board (NABTEB) for the award of National Technical Certificate (NTC). The National Board for Technical Education (NBTE, 2018) stated that fitting means preparing mating parts to touch or join each other in such a way that one will turn inside another, one will slide upon another, or the parts will hold tightly together so that they cannot move upon each other. Fitting Operations therefore, among others involves skills to produce, repair, maintain and assemble engineering components together. Sawing, shearing, filing, bending, soldering, thread-cutting, Heat treatment and assembling are tasks necessary to make parts fit. The National Board for Technical Education (2018) emphasized that the metal fitting module when successfully completed can be used for employment purpose. The NBTE (2018) further specified the following as objectives of Metal Fitting: shape metals to size by methods of shearing, sawing and filing; operate off- hand angle grinders to sharpen cutting tools; lap a given component to high degree of surface finish and select and use hand tools for carrying out a variety of bench fitting and assemble tasks. These objectives are stated in mechanical Engineering Craft (metal fitting) curriculum.

Odu, (2001) observed that the assessment instrument used by NABTEB only help determine students' achievement of Metal Fitting objectives in cognitive and affective domains. There are negligible observable results for the achievement of objectives in the area of psychomotor domain. Ombugus (2014) stated that Metal Fitting practical examination conducted by NABTEB and teachers are mere rating products and not skill manipulation. The only way to ensure that metal fitting objectives are being fully achieved is to assess the technical college students through workshop-based psychomotor

test with process skill multiple choice items. The extent to which objectives of metal fitting operation are achieved demand development of valid instrument for assessment.

Assessment in the view of Nwachukwu (2008) is the process of collecting evidence and making judgment on whether competence has been achieved. That is, assessment refers to a process of determining the functionality and performance of students in Metal Fitting manipulative skills. Williams (2009) noted that individual manipulative skills need assessment with appropriate test. A test in the opinion of Ndaman (2018) is a means for measuring the achievement of student or procedures developed for measuring the rate of progress in students. A validity test is then a validity of workshop-based psychomotor test in Bukar (2006) is the extent to which the students intended practical competencies outlined in the curriculum are covered by the test. A valid test is then a means of assessing student's performance by presenting to them process skill items in form of multiple choice questions in fitting operation, using Simpson's taxonomy of psychomotor domain (2013). Simpson (2013) classified the taxonomy into seven stages (perception, set, guided response, mechanism, complex overt Response, Adaptation and Origination) through which learners' skill acquisition can be assessed.

Igbo (1997) cited in Alhassan (2016) pointed out that psychomotor tests with process skill multiple choice items is appropriate procedure for finding out the extent which vocational and technical education has attain its stated objectives. Therefore, measuring the process skills in Metal Fitting might be more rewarding through a workshop-based psychomotor test (WBPT). Workshop-based psychomotor test connote the presentation of series of multiple choice questions on practical activities to be responded to by the learners in a workshop. Workshop-based psychomotor test is then an instrument for determining the extent to which students can demonstrate the practical competencies of Metal Fitting Operation using process skill items.

In technical colleges in kwara State, NABTEB is accorded the responsibility of assessing the performance of students in mechanical Engineering craft (Metal Fitting). The examining body has been using product evaluation technique in form of rating scale. This is done at the expense of judging the process skills of students through workshop based psychomotor test 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 send to each college to merely rate the finished work with no consideration of the processes involved in the production.

The product rating method has limitations. Students can get assistance from outside to produce products submitted for final assessment. Students can purchase products presented for assessment from the market rating method cannot be done through internet. This is a weakness considering the 21st century pressure to compete globally on performance evaluation methods in Technical Vocational Education and Training (TVET). The product assessment practice is also considered subjective and prone to abuse by raters (Mkpa, 2009).

The practice by examining body has given room to product assessment without student's process skill development for instance the objectives of Metal fitting in technical colleges cannot be achieved and therefore students the students skills cannot be guaranteed with the present NABTEB mode of assessment, hence the need to try out alternative method. Therefore, the provision of a valid and reliable process skill assessment instrument that may contain details of the skills to be carried out in performing given tasks would provide an alternative solution to the skills assessment problem at the NTC level. This was the concern of this study.

Purpose of the Study

Specifically, the researcher proposes to:

1. Develop workshop-based psychomotor test process skill items in Metal Fitting Operation at NTC level.
2. determine validity of the developed process skill rating scale test for assessing skills of NTC students in metal fitting

Research Questions

The research questions are as follows

1. What are the workshop-based psychomotor test process skill items in performing tasks in metal fitting operations at NTC level?
2. What is the validity of the developed process skill rating scale test for assessing skills of NTC students in metal fitting.

Research Methodology

The study utilized the instrumentation research design. Nworgu (2006), stated that an instrumentation research deals with the process of developing an instrument for assessing performance of students or obtaining data for making decisions. The instrumentation design is suitable for this study because the focus of the study was on developing and validating workshop-based psychomotor test for assessing students’ skills in metal fitting operations at the NTC level. The study was carried out Kwara State which is North Central States of Nigeria. Kwara state has six technical colleges namely: Government Technical college Patigi, Government Technical college Ilorin, Government Technical college Erin-ile, Government Technical college Esie-iludun and Government Technical college Amodu Osungbolu.

The population of this study was 142 respondents. This was made up of 36 teachers and 14 technicians teaching mechanical Engineering craft (Metal Fitting) at the NTC level and 92 TC III Students in the five technical colleges in the study area. The 36 teachers and 14 technicians helped in identifying important skill items for the inclusion in the workshop-based psychomotor test. Based on suggestion by Tuckman (1975), every fifth out of the 120 final year student was symmetrically selected and rated, making up ninety-two(92)TC III students were used for the tryout of the workshop-based psychomotor test.

Two types of instrument were used for data collection for the study. They are: the structured questionnaire consisting of 8 tasks with their 55 corresponding skill items. The workshop-based psychomotor test consist of 68 multiple choice questions with process skill items in Metal Fitting Operation. Face, content and criterion-referenced types of validity were involved in the study. Three experts from the Federal University of Technology, Minna were involved in the face and content validation of the table of specifications and the draft workshop-based psychomotor test. Two of the validates came from the department of Industrial and Technology education (ITE) and one in Measurement and Evaluation from Science Education Department. The criterion referenced validity of the test was determined by comparing the scores of the students to the predetermined cut scores of at least 1/3 of all the items in the level of Simpson’s psychomotor model. The means of the responses of the metal fitting teachers and technicians was used to answer research question 1. Weighted mean and values were assigned to different skill items of the questionnaire and corresponding Mean Scores were interpreted using real limit of numbers based on essentiality. Any skill item with a Mean value less than 2.50 was regarded as not essential and those with mean value 2.50 and above as essentials. To answer Research Question 2, the content validity was determined using Simpson’s (2013) taxonomy of psychomotor objectives in generating the test items. Also comments of experts in vocational Teacher Education and measurement and evaluation were utilized to determine the face validity of the test items.

Result

The result of the study is presented according to the research question that guided the study as indicated in Table 1 (Task 1 through 8).

Research Question One

What are the process skill items in metal Fitting operations for use in developing psychomotor test for students at NTC level?

Table 1: Mean rating of the teachers and techniques on process skill items for performing tasks in metal fitting operation.

S/N	Process skill items	\bar{x}	SD	Remark
	Process Skill items in sawing a metal bar	3.69	0.72	E
1.	Taking measurement	3.62	0.88	E
2.	Marking out	3.56	0.86	E
3.	Clamping work in vice	3.52	0.76	E

4.	Tightening hack saw blade	3.96	0.82	E
5.	Cutting to required size	3.80	0.92	E
	Process skill items in shearing a metal plate	3.70	0.74	E
6.	Measuring out	3.98	0.87	E
7.	Marking out	3.60	0.83	E
8.	Fixing work between blades	3.52	0.94	E
9.	Aligning Marked line with the cutting blades	3.60	0.89	E
10.	Pressing shearer handle down ward to shear off the work	3.80	0.74	E
	Process skill item in Filling a metal piece flat and square	3.68	0.76	E
11.	Measuring out	3.60	0.75	E
12.	Marking out	3.80	0.79	E
13.	Cutting out to specification	3.60	0.97	E
14.	Choosing an appropriate file	3.60	0.78	E
15.	Clamping work piece in vice	3.85	0.90	E
16.	Filing the face side	3.60	0.80	E
17.	Filing the face edge	3.64	0.87	E
18.	Filing the second and edge to required size	3.87	0.87	E
19.	Polishing with emery cloth	3.50	0.76	E
	Process skill items in Bending a metal rod	3.62	0.88	E
20.	Selecting the material and tools	3.62	0.79	E
21.	Checking a full size drawing of the part to be bent	3.64	0.81	E
22.	Measuring and marking out.	3.52	0.67	E
23.	Deciding which is to be made first if more than one bend is required.	3.62	0.68	E
24.	Fastening the work piece vertically in the vice, with bend line at the top of the jaws	3.80	0.79	E
25.	Bending the work piece by striking it with hammer near the bend line	3.60	0.88	E
26.	Squaring off the bend by holding the work piece in a vice with the edge parallel to the top of the vice jaw	3.54	0.87	E
27.	Making an obtuse bend, using a monkey wrench as a blending tool	3.60	0.87	E
	Process skill items in Soldering two metal parts together	3.62	0.77	E
28.	Selecting the parts and tools	3.51	0.90	E
29.	Cleaning surfaces to be joined	3.51	0.81	E
30.	providing correct joint gap	3.80	0.80	E
31.	Selecting correct soldering device and flux	3.62	0.73	E
32.	Applying appropriate amount of heat	3.72	0.74	E
33.	Removing of Surplus solder	3.54	0.73	E
	Process skill items in Threading a metal bolt	3.68	0.87	E
34.	Selecting the material.	3.80	0.99	E
35.	Measuring and Marking out	3.60	0.88	E
36.	Cutting out the work piece	3.66	0.88	E
37.	Grinding a chamfer on the end of the work piece	3.80	0.83	E
38.	Fastening the die in a die stock	3.54	0.91	E
39.	Adjusting the guide on the die stock for a free fit	3.74	0.93	E
40.	Clamping the work piece in the vice and placing die on chamfered end of the piece	3.54	0.77	E
41.	Holding one hand over the centre of the work piece and applying pressure to get the first threads started	3.60	0.75	E
42.	Applying cutting oil and turn the die stock clockwise.	3.64	0.89	E
43.	Turning the diestock back frequently to break the chips	3.61	0.82	E
44.	Backing off the die when the desired length of thread is cut	3.94	0.80	E
	Process skill item in Heat treating a metal product	3.62	0.93	E
45.	Selecting appropriate source of heat	3.76	0.87	E
46.	Heating to the required temperature	3.63	0.96	E
47.	Leaving at this temperature for a certain length of time	3.60	0.65	E

48.	Putting off heat	3.60	0.74	E
49.	Cooling in a way that will give the desired results	3.51	0.93	E
	Process skill items in Assembling with metal fasteners	3.65	0.89	E
50.	Selecting the fastener	3.80	0.88	E
51.	Laying out the location of the fastener and drill the given hole on the parts	3.52	0.99	E
52.	Countersinking if necessary	3.52	0.97	E
53.	Checking the fastener for length	3.80	0.97	E
54.	Inserting fasteners in the holes	3.52	0.84	E
55.	Pressing or tightening the parts together	3.73	0.89	E

E = Essential, SD = Standard Deviation

The data in Table 1 revealed that the 8 tasks in Metal Fitting had their \bar{X} values ranged from 3.62 – 3.70 and were greater than 2.50. This indicated that the tasks were essential to teachers and technicians of Metal Fitting for process skill assessment of students in technical colleges. The standard deviation of the tasks ranged from 0.72 – 0.93 and are positive. This indicated that the respondents were not very far from the mean or one another in their responses. This helped to add value to the mean.

The 8 tasks had 55 corresponding skill items whose mean value ranged from 3.50 – 3.98 (see Table 1). The mean for each item was greater than 2.50, indicating that all the 55 items were essential to teachers and technicians of Metal Fitting for process skill assessment of students at NTC level. The standard deviations of the 55 corresponding skill items ranged from 0.65 to 0.99 (see Table 1), indicating that the respondents were not very far from the mean or one another in their responses.

Research Questions Two

What is the validity of the developed process skill rating scale test for assessing skills of NTC students in metal fitting?

To answer this question, the content items in Table was evaluated using Simpson's (2013) model, The specifications based on the Simpson's (2013) model of psychomotor domain revealed that out of the 55 skills, 10.9 percent comprising 6 skill items were assessing the Perception level; 12.7 percent comprising 7 skill items were assessing the Set level; 14.7 percent comprising 8 skill items were assessing the Guided response level; 21.8 percent comprising 12 skill items were assessing the Mechanism level; 12.7 percent comprising 7 skill items were assessing the Complex overt response level and 9.1percent comprising 5 skill items were assessing the Adaptation level. The Origination level of Simpson's Model was not involved in the study because it was not in the NTC curriculum. These results showed that 6 levels of the domain were adequately covered in the assessment method. This means that all the 55 skill items were valid for inclusion in the test instrument.

The test items were submitted to experts in Vocational teacher education and Measurement and Evaluation who reviewed the appropriateness of the face validity of the items in measuring students' process skills. Teachers of metal fitting work at the technical college also reviewed the appropriateness of the content validity of the items in measuring students' process skills. These sets of validators reviewed, reworded and re-structured the test items and made satisfactory comments about the entire tests. On the whole there were 55 tasks with 5, 5, 9, 8, 6, 11, 5, 6 corresponding process skills item into sawing a metal bar, shearing a metal plate, filling a metal piece flat and square, bending a metal rod, soldering two metal parts together, threading a metal bolt, heat treating a metal product and assembling with metal fasteners respectively.

Findings of the Study

The following were the major findings of the study

1. Eight tasks with their 55 corresponding skill items were essential in process assessment by the teachers of Metal Fitting for effective performance of students in technical colleges.
2. All the 55 skill items were valid for inclusion in the test instrument, with the 6 levels of the domain (Perception level, Set level, Guided response level, Mechanism level, Complex overt response level and Adaptation level) were adequately covered in the assessment method.

Discussion of Findings

The findings of this study relating to the research question revealed that all the 55 process skill items were essential for inclusion in the workshop-based psychomotor test. This signifies a consensus of opinion among the teachers and technicians teaching Metal Fitting at NTC level. This agreement was indication that both the tasks and skill items were assessing what they were designed to assess, which is the objective of Metal Fitting at the NTC level.

Also, the findings were in agreement with the views expressed by Igbo (1997) cited in Alhassan (2016) in and Bukar (2006) pointed that a consensus in opinion among experts and examiners is an indication that the test is technically valid in terms of content areas.

The findings of the study have implications for NABTEB and teachers of Metal fitting: if the workshop-based psychomotor test is implemented, there will be skill improvement. This will provide competency and self-employment for the students in Metal Fitting in Kwara State, thereby creating job for the youths.

Conclusion

Based on the results of the data analysis relating to the validity of the workshop-based psychomotor test in Metal Fitting, it was concluded that the tasks and their corresponding skills are valid for assessing process skills of students at NTC level in the course.

Recommendations

Based on the findings from the study, the following recommendations are suggested:

1. The process skill rating scale test items should be used by the teachers in metal fitting at the NTC level to assess the student during teaching and at the terminal assessment of their student.
2. The examination bodies in charge of conducting and organizing examinations for the technical colleges (NABTEB) should integrate the process skill test items in their examination for certification of student in metal fitting at NTC level.
3. The developed process skill rating scale and the process skill test items items in metal fitting can be adopted by the West African Examination Council (WAEC) and National Examination Council (NECO) as a means of assessing metal fitting technology which happens to be one of the newly introduced 32 trade programmes for Nigerian secondary schools.

References

- Alhassan A. (2016). The Impacts of Career-Technical Education on School Market Success. *Industrial Education Review*, 23, 381-402.
- Bukar, B. (2006). Development of an Instrument for Evaluating Practical Project in Electronics. (Unpublished M.Ed Thesis). University of Nigeria, Nsukka.
- Igbo, C. A. (1997). Development and Validation of Psycho productive skill Test for Assessing Senior Secondary School Students in Clothing and Textiles. (Unpublished Ph.D. Thesis). University of Nigeria, Nsukka.
- Mkpa, N. D. (2009). Teaching Methods and Strategies in Curriculum Theory and Practice. *Curriculum Organization of Nigeria*, 2(1), 31-180.
- National Board for Technical Education NBTE (2018). National technical Certificate and Advance National technical Certificate Programmes Curriculum and Module Specifications in Mechanical Engineering Craft. Kadunna:National Board for Technical Education. Retrieved on September 25, 2019 from <http://www.unesco.unesco.org/images/001613/161378e.pdf>.
- Ndaman, J. (2018). *Research methods an Integrated Approach*. Ilorin: ABIC Books and Equip Ltd.
- Nwachukwu, C. E., (2008). Vocational Teacher Education Programme design and development. Retrieved on 21st May, 2011 from <http://www.nigeriabestforum.com/biog/?p=38404>.

- Nworgu, B. G., (2006). *Educational Research, Basic Issues and Methodology (22nd ed.)*. Nsukka: University of Nigeria ,Nsukka.
- Odu, O. K. (2001). Development and Validation of an instrument for assessing students Psycho-performance in Block laying and concreting. (Unpublished Ph.D Thesis). University of Nigeria, Nsukka.
- Okeme, I., (2011). Development and Validation of Psycho-productive Skills Multiple Choice items for Students in Agricultural Science in Secondary Schools. (Unpublished PH.D Thesis). Department of Vocational Teacher Education, University of Nigeria, Nsukka.
- Okoro, O. M. (1999). *Principles and Methods in Vocational and Technical Education*. Nsukka: University Trust Publishers.
- Ombugus, D. A. (2014).Development and Validation of Workshop-based Process Skill Tests in Mechanical Engineering Craft for Assessing Students in Technical Colleges in NasarawaState, Nigeria.Unpublished Ph.D Thesis. Department of Vocational Teacher Education.University of Nigeria, Nsukka.
- Simpson, E. (2013). *The classification of Educational Objectives in the Psychomotor Domain*. Washington, DC: Gryphon House.
- Tuckman, B. (1995). *Measuring Educational Outcomes: Fundamentals of Testing*. USA; Harcourt Brace Jovcanano.
- Williams, P. S. (2009). Skill Acquisition: A Tool for Youth Development and Empowement, Nigerian Association of Teachers of Technology (NATT) 22nd Annaul National Conference. 184 – 188.