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DEVELOPING AN INSTRUMENT FOR ASSESSING STUDENTS' PSYCHOMOTOR SKILLS IN DRILLING AND REAMING OPERATIONS IN MECHANICAL ENGINEERING CRAFT TRADE IN TECHNICAL COLLEGES IN GOMBE STATE

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Abstract: *The main purpose of the study was to develop an instrument for assessing students' performance in lathe machining operations at technical college level. Two research questions were posed to guide the study. Instrumentation research design was adopted for the study and the instrument used for data collection was a structured questionnaire developed by the researcher. Three psychomotor objectives identified by the research, were transformed to items for the draft of Machining Process Skill Test Instrument (MAPTI). Draft of the MAPTI was face and content validated by three (3) experts. The data generated were analysed using mean, standard deviation, and Analysis of Variance (ANOVA). The Content Validity Index (CVI) and the reliability index (RI) were 0.70 and 0.83respectively. The results of the data analysed relating to psychomotor objectives for assessment revealed 50 operations along 3 tasks were consider appropriate for the draft MAPTI. it was recommend that among others Teachers of mechanical engineering craft trade should use the instrument (MAPTI) in measuring the strength and weaknesses of their students in practical lessons and also during teacher made test and that teachers should use the MAPTI using applicable operations as per level covered content area, and adjust grading to suit purpose.*
Keywords: *Development, Testing, Instrument, Mechanical Engineering and Craft Trade*

Introduction

The Federal Republic of Nigeria (FRN, 2013) believe that, technical education is the catalyst for change in any nation that embraces its practices. That is to say Technical education is a useful instrument that brings about improved economy. Different institutions were established to offer technical education at different levels. These include: Technical Colleges, Polytechnics, Colleges of Education (Technical), Vocational training Centers among others. The National Policy on Education of the Federal Republic of Nigeria, (FRN, 2013), has placed a premium on Technical Education in view of its role in technological and industrial development of Nigerians, it described technical education as that aspect of education which leads to the acquisition of practical and applied skills as well as basic scientific knowledge. The FRN therefore stated the following as some of the aims of technical education in Nigeria.

i. Providing trained manpower in applied science, technology and commerce, particularly at sub-professional grades;
ii. Providing people who can apply scientific knowledge to the improvement and solution of environmental problems for the use and convenience of man;
iii. Giving training and impact the necessary skills leading to the production of craftsmen, technicians and other skilled personnel who was enterprising and self-reliant; and
iv. Enabling young men and women to have an intelligent understanding of the increasing complexity of technology.

Technical education is provided in skill training institutions which were designed largely to prepare craftsmen, artisans, and other skilled personnel who should be enterprising and self-reliant. The need for human resource training and development is indispensable for any nation aspiring to achieve greatness and technological development, the central focus to human resource training and development is the role of these skill training institutions and one of these institutions is the Technical College.

Based on the objectives of Technical Colleges, the National Technical Certificate (NTC)programmes were designed to include a multi-dimensional and multi-disciplinary curriculum, which contains various trades in which learners acquire various technical skills. One of such trades is Mechanical

Engineering Craft Practice (MECP). As stipulated in the National Board for Technical Education (NBTE, 2007) curriculum and module specification for Technical Colleges, the NTC curriculum in MECP is designed in modules which include: Metal Lathe Machining operations.

The lathe machine operation is the most basic and multi-functional of all metalworking machine tools operations, because the same skills required for performing basic lathe operations apply to the operation of other machine tools (such as drilling machine and milling machine) most of which are modifications or adaptations of the lathe. Therefore, a basic understanding of the metalworking lathe and its operation is fundamental to the development of a broad knowledge of machine shop theory and practice. The lathe, also commonly called the father of the entire machine tools family (Ibhadode (2014), uses a single point cutting tool which removes metal as it travels past along or across the revolving work piece. All the mentioned practical operations require skills which students of MECP are expected to acquire while they undergo the training. Students are also expected to use the skills acquired to make practical projects which can be used in assessing their skills or proficiency.

These practical projects in MECP at NTC mechanical craft level, involve use of various tasks on machine tools such as grinding, turning, milling, and shaping, among others. While, some of these operations could be carried out with simple hand tools, others may require the use of light or heavy duty machines such as the lathe, shaping, milling machines and surface grinders. Metal machining is a basic shape forming process performed by the removal of material from stock, and by this process, a material is brought to the required shape and size; and it is the surest method out of all the many basic production methods, of obtaining the best dimensional control and surface finish (Ibhadode, 2014).

Unfortunately, industries have alleged that Technical Colleges teach skills that are too far from those they require and that the complaint of the employers in the industries is that the graduates of those colleges are only theorist and not perform the skills for which they are trained. Also researchers like Mohammed,(2006) Aminu, (2015), and Garba (2019),are of the opinion that, in the contemporary Nigeria, the low quality of technical college graduates has been a major source of concern by most employers who expressed their dissatisfaction on the low level of technical skills possessed by these technical college graduates. Furthermore Jadas, Aminu and Garba revealed that most students tend to give the workshop attendants to carry out the practical projects for them and some of them even go to the extent of buying finished products in the market. Since assessment of individual's achievement leads to evaluation of knowledge and skills, it should be seen as an integral part of teaching and learning process. This calls for the development of an instrument that will provide a more reliable measurement of practical skills

Development is the production or generation of a new or improved assessment package for educational purposes. Mehrens and Lehman (1991) asserted that assessment instrument development is a systematic design and construction, building up or preparing assessment instrument for the purpose of assessing students ability in practical in academic content areas. Mehrens and Lehman further stated that It involve identifying objectives of the course or programme, outlining the content to be covered, preparing table of specifications and writing items, item analysis and selection for inclusion into the instrument and trial-testing the instrument on representative sample of students to determine the reliability coefficient of the instrument.

Statement of the Problem

Examinations in Technical colleges in Gombe, Bauchi and Yobe States, like in other states in Nigeria, are conducted by the National Business and Technical Examination Board (NABTEB), where the board is saddled with the responsibility of assessing the performance of students in mechanical engineering craft practice trade and other trades. The examining body has been using product evaluation technique that was Marking Scheme Checklist. This is done at the expense of judging the production process of students through workshop based process skills.

The structure of NABTEB Marking Scheme Checklist seems to favour the cognitive domain and do not sufficiently address the psychomotor aspect as observed by Aminu (2015). The practice of the

examining body has given room to end-product evaluation without assessing students' process skill development, hence the objective of assessing performance of students in Mechanical Engineering Craft is not being fully achieved. In situations where mechanical engineering craft students are expected to possess high quality practical skill proficiency especially in machining operations. Based on their ability levels, the assessment method employed must be comprehensive, systematic and unified. It does appear however, that lack of standard test exists among vocational and technical education teachers with regards to assessing their students in performing workshop-based tasks Ombugus, 2013).

In line with that literature has revealed, the current researchers that observed the present assessment practices does not enable students of mechanical engineering craft acquire practical process skills necessary for carrying out given task and it is envisage that the turn over effect is that, the products will continue to be unable to employ themselves and will not be employed by employers of labour and so the number of the unemployed will continue to increase. The multiplier effect will be that economic development for the individual and the nation will be slowed down if this problem is left unattended. Therefore, a study to halt this problem becomes necessary. This study is therefore designed to develop and validate workshop based process skill test instrument that will help to complement the present product assessment method used by teachers and examination bodies in order to enable students develop interest in employable practical skills in mechanical engineering craft trade and probably practice them after graduation and that's enable the product become employable by employers of labour and or employ them self to earn a living.

Purpose of the Study

The purpose of this study is to;

1. Determine a Drilling operational Tasks required on Lathe machine to achieve the psychomotor objectives of Lathe machining operations
2. Determine a Reaming operational Tasks required on Lathe machine for the achievement of psychomotor objectives of lathe machining operations
3. Determine the content validity of Machining Process Performance Test items.
4. Determine the reliability of Machining Process Performance Test items.

Research Questions

The following research question were used to guide the study

1. What are the appropriate Drilling skill tasks to be included in workshop based Performance Test instrument for assessing machining skills of Mechanical Engineering Craft Practice Trade students at NTC III level toward achieving the psychomotor objective of the curriculum.
2. What are the appropriate Reaming skill tasks to be included in workshop based Performance Test instrument for assessing machining skills of Mechanical Engineering Craft Practice Trade students at NTC III level toward achieving the psychomotor objective of the curriculum.

Methodology

The study adopted the instrumentation research design. According to Wallen & Frankael (2013), instrumentation research design entails the development of an assessment technique and the condition under which the technique is administered. Also, Nworgu (2006) stated that instrumentation design involves the following steps: Developing a test blue print (table of specification); writing test items; trial testing; item analysis; test assembly; final testing; Norming and printing. The instrumentation design is therefore consider to be suitable for this study because the focus of the study was on developing and validating workshop-based process skill test instrument for assessing students' skills in mechanical Engineering craft at National Technical Certificate level.

The study was carried out in North-Eastern geopolitical region of Nigeria. The region is Gombe States. The study was carried out in 8 Technical Colleges that offer National Technical Certificate (NTC) in mechanical craft trade in the study area.The population for the study comprise of 10 Technical teachers and 24 NTC III Mechanical Craft Trade students sampling census technique was employed because the population of the study was manageable.

A questionnaire titled "Appropriate Tasks Machining Operation" (ATMO),developed from NBTE Syllabus, was used in order to address psychomotor objectives in the NBTE curriculum for assessment by the teachers. A four point response opinion scale of Highly Appropriate (HA), Appropriate (A), slightly- Appropriate (SA) and Not-Appropriate (HNA). Their corresponding numerical values are 4,3,2, and 1 respectively. The respondent were requested to indicate the level at which each identified psychomotor skill tasks is appropriate or not to be performed by mechanical craft trade students. These appropriate tasks and operations rated by the teachers was transformed into items for Machining Process Performance Test (MAPTI).

Following a detailed review of NBTE Syllabus, the following three machining tasks operations were identified as psychomotor objectives area for the assessment. Namely, task 1.Drilling on the metal lathe machine. 2. Reaming on metal lathe machine and task. Based on opinions of practicing teachers and the critical review of relevant literature, the two tasks were transformed into 49 operational items.

The decision rule for testing the research questions and null hypotheses was that all items with mean score below 2.5 was not be included as part of the instrument only those items that have the mean scores of 2.5 and above were included in the instrument, with regards the null hypotheses. Analysis of Variance (ANOVA) was used to testing the null hypotheses at 0.05 level of significance. The decision rule was that if the p-value is greater than 0.05 the null hypothesis was to be rejected, but when the p-value was less than 0.05, the hypothesis was to be accepted.

Results and Analysis

Research Question 1: What are the appropriate Drilling skill tasks to be included in workshop based Performance Test instrument for assessing machining skills of Mechanical Engineering Craft Practice Trade students at NTC III level toward achieving the psychomotor objective of the curriculum.

Table 1: Mean and Standard Deviation of appropriate lathe machine tasks to be included in workshop based Performance Test instrument

	TASK 1: Drilling on the Metal Lathe Machine	**X**	**SD**	**Remark**
1	Appropriate use of vernier calliper	3.46	0.95	Appropriate
2	Appropriate use of micrometre screw gauge	3.11	0.91	Appropriate
3	Right setting of the cutting tool	2.46	0.95	S/Appropriate
4	Mounting of work piece on the vice	2.05	1.23	S/Appropriate
5	Marking out centre on a round bar	3.23	1.14	Appropriate
	LATHE SET-UP			
6	Mounting appropriate cutting tool to the tool post	2.88	1.07	Appropriate
7	Mounting work piece on lathe chuck (3 or 4-jaw)	3.15	1.08	Appropriate
8	Setting of lathe for a given operation	2.85	1.32	Appropriate
	DRILLING OPERATION			
9	Select the proper drill size.	3.19	1.20	Appropriate
10	Tightly clamp the tailstock assembly to thebed of the lathe,	3.00	1.23	Appropriate
11	Clamp the work piece accurately in the lathe chuck.	3.12	1.14	Appropriate
12	Bring the tailstock assembly up until the point of the twist drill clears the work piece.	3.12	1.21	Appropriate
13	Select the appropriate speed for the operation.	3.23	1.18	Appropriate
14	Start the lathe machine	3.15	1.22	Appropriate
15	Centre drill with a combination Centre drill	3.15	1.08	Appropriate
16	Turn the tailstock hand wheel to feed the drill slowly into the work piece	3.27	1.12	Appropriate

17	If the hole is quite deep,feed the twist drill in and out several times to clear out the chips.	3.46	0.90	Appropriate
18	Finally,remove the twist drill from the tailstock spindle.	3.27	0.92	Appropriate
19	Use reamer to square and smooth the hole.	3.15	1.08	Appropriate

Task 1 Drilling on lathe machine presented items 2 and 3 with the mean rating of 2.46 and 2.05 indicating the task items are slightly appropriate while items 1,3, to 19 with mean rating of 3.46 and 2.85 indicating high mean that are appropriate for inclusion in the development of instrument for assessing psychomotor domain of Mechanical engineering craft trade practice in Technical colleges in Gombe State Nigeria.

Research Question 2: What are the appropriate Reaming skill tasks to be included in workshop based Performance Test instrument for assessing machining skills of Mechanical Engineering Craft Practice Trade students at NTC III level toward achieving the psychomotor objective of the curriculum.

Table 1: Mean and Standard Deviation of appropriate lathe machine tasks to be includedin workshop based Performance Test instrument

	TASK 2:**Reaming on Lathe Machine**	X	SD	Remark
1	Appropriate use of vernier caliper	3.38	0.90	Appropriate
2	Appropriate use of micrometre screw Gauge	3.23	0.90	Appropriate
3	Mounting of workpiece on the vice	2.88	1.14	Appropriate
4	Marking out lines on a round bar	3.27	1.10	Appropriate
5	Marking out centre on a round bar	3.23	0.91	Appropriate
	LATHE SET-UP			
6	Mounting appropriate cutting tool to the tool post	3.35	1.02	Appropriate
7	Right setting of the cutting tool	3.00	0.98	Appropriate
8	Mounting workpiece on lathe chuck (3 or 4 jaw)	3.96	1.02	Appropriate
9	Setting of lathe for a given operation	3.35	0.98	Appropriate
	REAMING OPERATION			
10	Mount the work piece in the appropriate holding Device	3.54	0.95	Appropriate
11	Face the work piece to square and length	3.50	0.95	Appropriate
12	Drill the work piece to be ream	3.42	0.95	Appropriate
13	Remove the drill and mount a reamer in the drill chuck or tailstock spindle.	3.19	1.13	Appropriate
14	Mount the reamer in the tailstock spindle			
15	Move tailstock and reamer close to the work piece			
16	Check that tailstock Centre is in line.			
17	Start lathe at about half the cutting speed used for drilling			
18	Remove the bur from the edge of the reamed hole with a scraper.			
19	Withdraw out the reamer from the hole to clear chips until the correct depth and required smoothness is reached.			

Tasks 2 presented items on Reaming work in a metal lathe with item between 1,7 and 18with mean rating between 2.88 and 3.00,this shows that the tasks are appropriate while item

2,3,4,5,6,8 and 19 recorded mean rating of 3.15 and 3.96 this shows that the tasks are highly appropriate for inclusion in the development of instrument for assessing psychomotor domain of Mechanical engineering craft trade practice in government science and technical colleges in Gombe State Nigeria.

Finding of the study

The following finding emerged from the research questions.

All the items are appropriate for inclusion in the developed instrument for assessing MECTP students' psychomotor skills in technical colleges in Gombe state, Nigeria

Discussion of Findings

Finding related to research question are in Table 1 revealed that All the items are appropriate for inclusion in the developed instrument for assessing MECTP students' psychomotor skills in technical colleges in Gombe state, Nigeria This finding is related to the findings of Mohammed, (2006) Aminu, (2015), and Garba (2019), regarding the fact that teachers were involved in identifying from the curriculum items for the instrument to be developed for assessing students' skills. This is because teachers are conversant with the content areas of the NBTE curriculum Mechanical engineering craft trade, since they use it every day for teaching and learning.

Practical tasks are widely used as a method of developing skills in vocational and technical education. With the present need for assessing performance of students in mechanical engineering craft, it is pertinent that teachers be increasingly knowledgeable about various methods of assessments that can guarantee objectivity especially in practical activities or skills.

It has been reported that, in almost all technical/vocational institutions, teachers, NABTEB, NECO and WAEC often neglect the evaluation of the procedures/steps taken by students to carry out practical projects in favour of the completed products. In other words often times, grading of students' practical projects are not done based on process of producing such projects, but that teachers often award marks by rating the finished product alone. Where students are assessed in practical works based only on the completed products rather than the processes, the result is bound to be biased and unreliable. Misleading data or information about students' performances does not only adversely affect the students, but also tends to mere the image of both the teachers and the entire school system.

Based on the findings of the study, the developed instrument when tested enable students' practical skills to be improved. The implication of this findings is that the newly developed instrument is better than the current teacher made practical test procedure.

Conclusion

The major findings of this study serve as a basis for drawing conclusion that MAPTI is a valid and reliable assessment instrument that could be used in assessing Mechanical engineering craft trade practice trade in Technical Colleges in north east Nigeria. MAPTI will also improve assessment procedure of MECTP teachers in Technical Colleges to effectively assess students' performance in lathe machining tasks.

Recommendations

Based on the findings of this study, the following recommendations are made:-

1. Teachers of mechanical engineering craft trade should adopt the use of MAPTI in assessing their students' performance at technical college.
2. Examination bodies like; WAEC, NABTEB, NECO should adopt and influence its examiners to always use MAPTI when conducting their practical examinations on lathe machine operations at technical college level. This will make the results obtained to be valid and reliable as a unified way of assessment is used.

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