



## Development of a Test Instrument for Assessing Students' Process Machining Skills in Mechanical Engineering Craft Trade in Gombe States Technical Colleges

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### ABSTRACT

The study aimed at development and validation of workshop-based process test instrument for assessing students' skills in mechanical engineering craft trade in technical colleges. The 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. The 3 psychomotor objectives identified by the teachers were transformed to items for the draft Machining Process Skill Test Instrument (MAPTI). The draft MAPTI was face and content validated by three (3) experts. The data generated were analyzed using mean, standard deviation, Content Validity Index (CVI) 0.70, Cronbach's Alpha (0.83), and Analysis of Variance (ANOVA) tested at 0.05 level of significance. The results of the data analyzed relating to psychomotor objectives for assessment revealed 21 operations items along 2 tasks were identified for the final draft of instrument (MAPTI). It was recommended 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, teachers should use the MAPTI using applicable operations as per level covered content area, and adjust grading to suit purpose.

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### INTRODUCTION

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 some of the following aims of technical education:

- 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

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- iv. Enabling young men and women to have an intelligent understanding of the increasing complexity of technology.

Technical education is practiced in institutions which were designed largely to prepare craftsmen, artisans, and other skilled personnel who was 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 institutions and one of these institutions is the Technical College.

Based on the objectives of Technical Colleges, the National Technical Certificate 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 trade is the 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 of all metalworking machine tools operations, because the same skills required for performing basic lathe operations apply to the operation of other machine tools, most of which are modifications or adaptations of the lathe. Therefore, a basic understanding of the metal 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 tool family (Ibhadode (2014), uses a single point cutting tool which removes metal as it travels past the revolving work piece. All the mentioned practical operations require skills which students of MECP are expected to acquire skills while they undergo the programme. Students are also expected to use the acquired skills to make practical projects which can be used in assessing such skills.

Subsequently, these practical projects in MECP at NTC mechanical craft level, involve

use of various tasks on machine tools such as Drilling and Turning among others. 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 basic production methods, of obtaining the best dimensional control and surface finish (Ibhadode, 2014).

In support of the above assertion, industries have alleged that Technical Colleges teach skills which are far too remote 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 Aminu, (2015), Garba (2019) and Mbaya, (2022) are in 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.

Development is the production of a new or improved assessment package for educational purposes. Bakoji (2016), asserted that assessment instrument development is a systematic design and construction, building up or preparing assessment instrument for the purpose of assessing students in academic content areas. 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 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 and other trades. The examining body has been using product evaluation technique in form of Marking Scheme Checklist. This is done at the expense of judging

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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 fully achieved. In situations where mechanical engineering craft students are expected to possess high quality 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 (Ombugas, 2013).

The present assessment practices does not enable students of mechanical engineering craft acquire practical process skills necessary for carrying out given task. The turn over effect was that, the products will continue to be unable to employ themselves, will not be employed by employers of labour, to the effect that the unemployed were coming too many. To mitigate these negative effects, 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 developed interest in practical skill and more employable skills in mechanical engineering craft trade and probably practice them after graduation to be employed by employers of labour and employed them self to earn a living.

### Purpose of the Study

The purpose of this study sort to;

1. Determine turning parallel diameter work between centres and operational task required to achieve the psychomotor objectives.

2. Determine Drilling on the metal lathe machine and operational task required to achieve the psychomotor objectives.
3. Determine the content validity of Machining Process Performance Test items.
4. Determine the reliability of Machining Process Performance Test items.

### Research Questions

The research questions was used to guide the study

1. What are the appropriate turning between center and operational items to be included in workshop based Performance Test instrument for assessing machining skills of Mechanical Engineering Craft Practice Trade students at NTC III level?
2. What are the appropriate drilling and operational items to be included in workshop based Performance Test instrument for assessing machining skills of Mechanical Engineering Craft Practice Trade students at NTC III level?
3. What is the content validity of Machining Process Test instrument (MAPTI) items?
4. What is the reliability of Machining Process Test instrument (MAPIT) items?

### Hypothesis

The following null hypotheses which guided the study are formulated and was tested at 0.05 level of significance.

**HO<sub>2</sub>:** There is no significant difference among the mean ratings of MECTP teachers of Gombe states on the appropriate lathe machine tasks skills to be included in workshop based performance test instrument for assessing machining skills of mechanical engineering craft trade practice trade students at NTC III level.

### METHODOLOGY

The study adopted the instrumentation research design. Metu (2017) stated that the instrumentation research is the study which is aimed at developing and certifying the efficacy of an instrument for measurement of a given behavior or construct. The instrumentation design is therefore found to be

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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.

This study was carried out in Gombe State. 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 comprises of all 34, Technical teachers (10), and NTC III Mechanical Craft Trade students (24). A census sampling technique was utilized where all the teachers teaching mechanical engineering craft trade practice within the area of the study were used for the study. A questionnaire titled Appropriate Tasks Machining Operation (ATMO) developed from NBTE Syllabus was used in order to identify psychomotor objectives for assessment by the teachers. A four point scale of Highly Appropriate (HA), Appropriate (A), Slightly-Appropriate (SA) and Not-Appropriate (HNA) was written against each of the identified psychomotor

objectives with corresponding assigned values of 4, 3, 2, and 1 respectively. Mechanical craft trade teachers was requested to indicate the level at which each identified psychomotor objective is appropriate or not to be perform by mechanical craft trade students. These appropriate tasks and operations rated by the teachers was transform to items for Machining Process Performance Test (MAPTI). The Analysis of Variance (ANOVA) was used to testing the null hypotheses at 0.05 level of significance.

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

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

<b>TASK 1: Turning Parallel Diameter Work Between Metal Lathe Centres</b>	$\bar{X}$	SD	Rem
<b>Measuring Skill</b>			
Appropriate use of vernier caliper	2.50	1.33	App
Appropriate use of micrometre screw gauge	2.04	1.24	N App
Right setting of the cutting tool	2.15	0.97	N App
Mounting of workpiece on the vice	2.42	1.30	N App
Marking out lines on a round bar	3.19	0.98	App
Marking out centre on a round bar	3.35	0.94	App
<b>Lathe Set-Up</b>			
Mounting appropriate cutting tool to the tool post	2.50	1.33	App
Mounting workpiece on lathe chuck (3 or 4- jaw)	2.04	1.25	N App
Setting of lathe for a given operation	2.15	0.97	N App
Mounting work between centers	2.42	1.30	N App
<b>Parallel Turning Between Centres Operation</b>			
Face and Locate Centre and Centre drill (both ends in turn)	3.73	1.08	App
Put lathe dog on work piece and mount between Centres (if required )	3.19	1.06	App
Using dial indicator and test bar, check and adjust Centre alignment.	3.08	1.13	App

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Determine the appropriate cutting speed and set	3.15	1.12	App
With the desired depth of cut almost reached, finish turn work piece to the required length	3.15	1.08	App
Check the work piece for size with a precious measuring instrument	3.38	0.85	App

Key; AP- Appropriate, NAP – Not Appropriate

Task 1: The parallel turning between Centre operation with item between 1 and 16 recorded the mean between 2.04 and 2.42 indicating that 2, 3, 4, 8 and 9 Tasks item are not appropriate for inclusion in the development of instrument for assessing psychomotor domain of Mechanical engineering craft trade practice. In

addition item 1, 5, 6, 7.10 and 11- 16 with mean rating of 2.50 to 3.73 indicating the task item are 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.

**Table 2:** Mean and Standard Deviation of appropriate Drilling on lathe machine tasks to be included in workshop based Performance Test instrument

<b>TASK 2 : DRILLING ON THE METAL LATHE MACHINE</b>	$\bar{X}$	SD	Rem
<b>Measuring skills</b>			
Appropriate use of vernier caliper	3.46	0.95	App
Appropriate use of micrometre screw gauge	3.11	0.91	App
Right setting of the cutting tool	2.46	0.95	N App
Mounting of workpiece on the vice	2.05	1.23	N App
Marking out centre on a round bar	3.23	1.14	App
<b>Lathe Set-Up</b>			
Mounting appropriate cutting tool to the tool post	2.88	1.07	App
Mounting workpiece on lathe chuck (3 or 4- jaw)	3.15	1.08	App
Setting of lathe for a given operation	2.85	1.32	App
<b>Drilling Operation</b>			
Select the proper drill size.	3.19	1.20	App
Tightly clamp the tailstock assembly to the bed of the lathe,	3.00	1.23	App
Clamp the work piece accurately in the lathe chuck.	3.12	1.14	App
Bring the tailstock assembly up until the point of the twist drill clears the work piece.	3.12	1.21	App
Select the appropriate speed for the operation.	3.23	1.18	App
Start the lathe machine	3.15	1.22	App
Centre drill with a combination Centre drill	3.15	1.08	App
Turn the tailstock hand wheel to feed the drill slowly into the work piece	3.27	1.12	App
Release the tailstock assembly and pull it back from the work piece.	3.23	1.18	App
If the hole is quite deep, feed the twist drill in and out several times to clear out the chips.	3.46	0.90	App
Finally, remove the twist drill from the tailstock spindle.	3.27	0.92	App
Use reamer to square and smooth the hole.	3.15	1.08	App

Key; AP- Appropriate, NAP – Not Appropriate

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Task 2: Drilling on lathe machine presented items 3 and 4 with the mean rating of 2.46 and 2.05 indicating the task items are not appropriate while items 1, 2, 4 - 20 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 government science and technical colleges in Gombe State.

**Hypothesis One**

There is no significant difference among the mean ratings of MECTP teachers of Gombe states on the appropriate lathe machine tasks skills to be included in workshop based performance test instrument for assessing machining skills of mechanical engineering craft trade practice trade students at NTC III level

The result for answering hypothesis two is presented in table 8.

**Table 3:** Analysis of Variance (ANOVA) of MECTP Teachers based on the appropriate psychomotor skills Developed for Assessing Lathe Machining Operation Process skills in GSTCs in Gombe states, GSTCs, Nigeria

	Sum of Squares	Df	Mean Square	F	P	Remark
Between Groups	4249.874	2	2124.937	6.167	.004	Rejected
Within Groups	21706.247	63	344.544			
Total	25956.121	65				

The Analysis of Variance (ANOVA) presented in Table 3 revealed that  $F(2, 65) = 6.167$ ,  $P = 0.004$  computed at 0.05 level of significance. Since the computed probability value is less than the level of significance; hence the null hypothesis was rejected.

**FINDINGS OF THE STUDY**

The following are the findings based on the research questions and hypotheses:

1. Psychomotor skill task were considered appropriate for inclusion in the developed instrument for assessing MECTP students' psychomotor skills in technical colleges in Gombe State.
2. All the items are appropriate for inclusion in the developed instrument for assessing MECTP students' psychomotor skills in technical colleges in Gombe State.
3. The items are valid for inclusion in the developed instrument for assessing MECTP students' psychomotor skills in technical colleges in Gombe State.
4. All the items are reliable for inclusion in the developed instrument for assessing MECTP students' psychomotor skills in technical colleges in Gombe State.
5. There was significant difference among the mean rating of MECTP Teachers on the

developed instrument for assessing lathe machining process skills in GSTCs in Gombe State.

**DISCUSSION OF FINDINGS**

Finding related to research question are in Table 1 and 2 revealed that All the items are appropriate for inclusion in the developed instrument for assessing MECTP students' psychomotor skills in technical colleges in Bauchi Gombe and Yobe state, Nigeria This finding is related to the findings of Mbaya, (2022), Adamu (2015), and Aminu (2015), 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

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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 Gombe State. MAPTI will also improve assessment procedure of MECTP teachers in Technical Colleges to effectively assess students' performance in lathe machining tasks. In so doing, the teachers will be able to show proof of the scores and grades that they award. Furthermore, the researcher concludes that the developed instrument was successful because it could be used perfectly for the purpose for which it was developed after testing which is for assessing students' practical skills in mechanical engineering craft trade practice in technical colleges.

## 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. School proprietors should organize in house training for mechanical engineering craft trade practice trade on how to use the new testing instrument.
3. 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.
4. Curriculum planners should include the use of MAPTI in the curriculum for technical colleges.
5. Future researchers should consider modifying the new test instrument to suit future needs.

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