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COMPUTER NUMERICAL CONTROL MACHINING CONTENTS FOR INCLUSION IN METALWORK TECHNOLOGY EDUCATION CURRICULUM OF UNIVERSITIES

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Abstract
This research work is on Computer Numerical Control Machining Contents for Inclusion in Metalwork Technology Education Curriculum of Universities. Two research question and Two hypotheses guided the study. The design adopted was a survey research design. The population of the study consists of 19 metalwork technology lecturers and 60 industrial personnel that are familiar with CNC machine. The instrument for data collection was a structured questionnaire having 4 point rating scale. The data was analyzed using mean, and standard deviation, while t-test was used in testing the hypotheses. The result showed that metalwork technology students required operational skills in CNC lathe and shaping machine among others. It was recommended that, the National Universities Commission (NUC) should lay more emphasis on curriculum review as when due to update the contents of the curriculum of courses like metalwork technology in order to address the technological advancement across all technology education courses in the universities in Nigeria among others.

INTRODUCTION
The changes in manufacturing technology in the 21st century has brought about deviation from the old traditional machining process towards the new non-traditional machining process which is more suitable for precision machining of hard and brittle materials. Jain (2010) revealed that extremely hard and brittle materials are difficult to machine by traditional machining processes such as turning, drilling, shaping and milling. Non-traditional machining processes, also called advanced manufacturing processes, are employed where traditional machining processes are not feasible, satisfactory or economical

The CNC is a computerized technology in which the functions and motions of a machine tools are controlled by means of a prepared program containing coded

alphanumeric programme data (Oberg,*et al* 2004).The CNC machining processes have been developed to meet extra required machining conditions. When the CNC process is employed properly, it offers many advantages over traditional machining processes such as: providing high accuracy and surface finish; prolong tool life; ability to machine very hard fragile materials difficult to clamp for traditional machining; when the work piece is too flexible or slender; when the shape of the part is too complex; and other extra required machining conditions based on customer demand(Oberg,*et al* 2004)

Technical Education is a type of education whose major objective is to prepare individuals for employment in chosen occupations by equipping them with the vocational skills, knowledge and attitude necessary for employment in specific occupations. It equips individuals with the requisite technical skills for survival in the world of work. To Lawal (2010) Technical Education is the type of education that prepares learners who could apply relevant practical skill to make positive changes within their society and afford a self dependent life. Educational scholars and researchers have several times attested that this form of education provides self employment; enhance productivity and self reliance (Ozioma, 2011).

Metalwork Technology Education programme focuses on producing technical teachers in Metalwork Technology occupational area who will teach some basic technology education courses, pre vocational courses as well as related metalwork courses in technical institutions that will lead to the production of graduates with relevant teaching skills for employment as technical teachers in institutions as well as for instructors in metalwork industries and training centres.Metalwork industries refer to industries that focus on the transformation of raw materials into goods for the satisfaction of human needs

The major aim of Metalwork Technology Education programme is to train and produce competent teachers for the production of competent graduates of Metalwork Technology Education that can teach CNC machining operations effectively. The graduate of this programme is trained on how to teach Basic Technology (Introductory Technology) at the junior secondary school level as well as other vocational and pre-vocational subjects at secondary school level

In line with the goals of technology education, Ravert (2006) revealed that the basic function of the metalwork technicians among others is to set up the work and operate the machine tool to carry out various machining operations. They are also responsible for welding various materials to specification. The technical operations carried out by technicians in manufacturing industries includes machining, welding, metal removal, shaping, cutting, boring, grinding, shearing

as well as other forms of metal deformation processes (Ravert,2006). A machine tool according to Crawford (2010) is a machine for metal removal operations or for shaping or machining metal or wood, plastic, and ceramic materials, usually by cutting, boring, grinding, shearing, or other forms of deformation. A person who specializes in machining is called a machinist while a building, or company where machining is done is called a machine shop. Machining can be an isolated business or can form a section in manufacturing industries that deals with metal products

The presence of CNC metal working machines in manufacturing industries have greatly changed the machining skills demanded by modern machining industrial operations. It is the deficiency in the CNC machining skills needed to operate and maintain CNC machines in the metalwork technology education curriculum that calls for the need to conduct this research work with the hope of identifying the new computer numerical control machining contents for inclusion in metalwork technology education curriculum of Universities in North Central, Nigeria.

PURPOSE OF THE STUDY

The main purpose of the study is to determine new:

1. Content in CNC lathe machine operation necessary for inclusion in metalwork technology education curriculum in universities in North Central Nigeria.
2. Content in CNC shaping machine operation necessary for inclusion in metalwork technology education curriculum in universities in North Central Nigeria.

Research Questions

The following research questions were formulated to guide the study:

1. What are the new content in CNC lathe machine operation necessary for inclusion in metalwork technology education curriculum in universities in North Central Nigeria?
2. What are the new content in CNC shaping machine operation necessary for inclusion in metalwork technology education curriculum in universities in North Central Nigeria?

Research Hypotheses

HO_1: There is no significant difference between the mean responses of Metalwork Technology Lecturers and CNC machine operators on the new content in CNC

lathe machine operation necessary for inclusion in metalwork technology education curriculum in universities in North Central Nigeria.

HO_2: There is no significant difference between the mean responsesof Metalwork Technology Lecturersand CNC machine operators on the new content in CNC shaping machine operation necessary for inclusion in metalwork technology education curriculum in universities in North Central Nigeria.

Methodology

The design employed for this research work is descriptive survey research design. This design collects data from a group of people or items are studied by collecting and analyzing data from target group (uzoagulu, 2011). This study covers Universities where technical education is being studied and industries where they are familiar with CNC machne in North Central geopolitical zone, Nigeria. The sample population consists of 19 metalwork technology lecturers and 60 CNC machine operators. The instrument for data collection was a structured questionnaire. This is to ensure adequate collection of data. The data collected were analyzed using mean, standard deviation, and t-test; 4 point rating scale was developed using Strongly Agreed, Agreed, Disagreed, and Strongly Disagreed.

Results

Research Question 1

What are the new contents in CNC lathe machine operation necessary for inclusion in metalwork technology education curriculum in universities in North Central Nigeria?

Table 1: Mean and standard deviation of respondents on the new content in CNC lathe machine operation necessary for inclusion in metalwork technology education curriculum in universities in North Central Nigeria

S/No	*New content in CNC lathe machine operation necessary for inclusion in metalwork technology education curriculum in Nigerian universities in North Central Nigeria*	$\bar{X}_{MWL}$	SD_{MWL}	$\bar{X}_{CMO}$	SD_{CMO}	$\bar{X}_{A}$	SD_{A}	*REMARK*
1.	Skills in performing landing gear operation.	3.32	0.58	2.75	0.65	3.04	0.62	Agreed
2.	Carrying out shoulder turning operation using CNC lathe machine	3.37	0.50	3.27	0.58	3.32	0.54	Agreed
3.	Performing crank shaft turning on CNC lathe machine	3.11	0.46	3.18	0.39	3.15	0.43	Agreed

4.	Carrying out knurling operation using CNC lathe machine	3.53	0.90	2.52	0.50	3.03	0.70	Agreed
5.	Performing eccentric turning operation using CNC lathe machine	2.68	0.48	2.70	0.81	2.69	0.65	Agreed
6.	Skills in carrying out control arm spacer using CNC lathe machine	3.53	0.90	3.12	0.49	3.33	0.70	Agreed
7.	Performing recessing operation using CNC lathe machine	3.00	0.47	3.27	0.45	3.14	0.46	Agreed
8.	Ability to produce 6 or 12 spockaluminium rim using CNC lathe machine	3.11	0.32	3.02	0.13	3.07	0.23	Agreed
9.	Competency in contour turning operation using CNC lathe machine	2.74	0.93	3.68	0.47	3.21	0.70	Agreed
10.	Ability to cut key ways on CNC machines	3.37	0.50	3.08	0.33	3.23	0.42	Agreed
11.	Skills in performing coupler turning using CNC lathe machine	3.53	0.51	3.55	0.50	3.54	0.51	Strongly Agreed
12.	Skills in setting up workpiece on the CNC lathe machine	3.05	0.40	3.12	0.76	3.09	0.58	Agreed
13.	Competency in translating instructions into computer commands so the lathe machine can perform the correct function	3.16	0.37	3.32	0.47	3.24	0.42	Agreed
14.	Ability to translate product specifications and work instructions into a machine-readable format.	3.21	0.42	3.00	0.80	3.11	0.61	Agreed
15.	Skills in inserting tools into their corresponding slots	3.16	0.50	3.03	0.82	3.09	0.66	Agreed
16.	Skills in installing a machining software programme into the CNC lathe according to product requirements	3.68	0.48	2.87	0.85	3.28	0.67	Agreed
	TOTAL	**3.22**	**0.55**	**3.09**	**0.56**	**3.16**	**0.56**	**Agreed**

N_{MWL}, $\bar{X}_{MWL}$, SD_{MWL} = number, mean and standard deviation of Metalwork technology lecturers. N_{CMO}, X_{CMO}, SD_{CMO} = number, mean and standard deviation of CNC machine operators, and X_A, SD_A = Average mean and standard deviation OF Metalwork technology lecturers and CNC machine operators.

The summary of the mean and standard deviation of responses of metalwork technology lecturers and CNC machine operators on the new content in CNC lathe machine operation necessary for inclusion in metalwork technology education curriculum in universities in North Central Nigeria are shown in table 1. The result show that item 11 was rated strongly agree with a mean rating of 3.54. In the same vein, all the remaining 15 items were rated agree with their mean ratings ranging between 2.69 and 3.33. These mean that the respondents agreed that all the 16 items are the content in CNC lathe machine operation necessary for inclusion in metalwork technology education curriculum in universities in North Central Nigeria. Furthermore, the results also show that all the 16 items

had standard deviation values that are between the range of 0.23 and 0.70, indicating that the responses were clustered close to the mean. Additionally, none of the items deviated up to 1.96, which is the statistical standard deviate; hence the average means of the items have reliabilities.

Research Question 2

What are the new contents in CNC shaping machine operation necessary for inclusion in metalwork technology education curriculum in universities in North Central Nigeria?

Table 2: Mean and standard deviation of respondents on the new content in CNC shaping machine operation necessary for inclusion in metalwork technology education curriculum in universities in North Central Nigeria

S/No	*New content in CNC shaping machine operation necessary for inclusion in metalwork technology education curriculum in Nigerian universities in North Central Nigeria*	$\bar{X}_{MWL}$	SD_{MWL}	$\bar{X}_{CMO}$	SD_{CMO}	$\bar{X}_{A}$	SD_{A}	*REMARK*
1.	Skills in machining horizontal surfaces using CNC shaping machine	3.16	0.37	3.20	0.90	3.18	0.64	Agreed
2.	Proficiency in performing shaping of flat surface operations	2.79	0.54	3.02	0.13	2.91	0.34	Agreed
3.	Carrying out shaping of vertical surfaces	2.95	0.62	3.02	0.83	2.99	0.73	Agreed
4.	Skills in machining a shoulder on a workpiece	3.32	0.58	2.73	0.76	3.03	0.67	Agreed
5.	Proficiency in squaring up a block workpiece on shaping machine	2.68	0.82	2.60	0.49	2.64	0.66	Agreed
6.	Skills in machining dovetail grooves operations shaping machine on CNC shaping machine	3.74	0.45	3.02	0.13	3.38	0.29	Agreed
7.	Performing shaping operation on angular surfaces operations	2.89	0.81	2.93	0.25	2.91	0.53	Agreed
8.	Machining V-block on a workpiece	2.68	1.00	2.98	0.87	2.83	0.94	Agreed
9.	Skills in machining a tongue and groove joint operations	2.84	0.76	2.93	0.25	2.89	0.51	Agreed
10.	Skills in carrying out T-Slot machining operations	3.21	0.42	3.43	0.50	3.32	0.46	Agreed
11.	Skills in machining a rack gear operations	2.79	0.79	3.43	0.50	3.11	0.65	Agreed

12.	Performing shaping operation on irregular surfaces using CNC	2.63	0.68	3.35	0.48	2.99	0.58	Agreed
13.	Skills in setting up work piece on the CNC shaping machine	3.05	0.52	3.10	0.30	3.08	0.41	Agreed
14.	Practical understanding and interpretation of Computer Aided Machining (CAM) programming language peculiar to CNC shaping machine	3.21	0.54	3.72	0.45	3.47	0.50	Agreed
15.	Skills in loading or installing a CAM software	2.79	1.03	2.52	0.50	2.66	0.77	Agreed
16.	Skills in translating product specification and work instructions into machine readable format	3.21	0.63	3.77	0.43	3.49	0.53	Agreed
	TOTAL	**3.00**	**0.66**	**3.11**	**0.49**	**3.05**	**0.58**	**Agreed**

N_{MWL}, $\bar{X}_{MWL}$, SD_{MWL} = number, mean and standard deviation of Metalwork technology lecturers. N_{CMO}, X_{CMO}, SD_{CMO} = number, mean and standard deviation of CNC machine operators, and X_A, SD_A = Average mean and standard deviation OF Metalwork technology lecturers and CNC machine operators.

Table 2 show the mean and standard deviation of the responses of metalwork technology lecturers and CNC machine operators on the new contents in CNC shaping machine operation necessary for inclusion in metalwork technology education curriculum in universities in North Central Nigeria. From the table, all the 16 items were rated agreedby the respondents with average mean ratings in the range of 2.64 and 3.49. This means that the respondents agreed that the 16 items are new contents in CNC shaping machine operation necessary for inclusion in metalwork technology education curriculum in universities in North Central Nigeria. Additionally, the results indicated that the 15 items had standard deviation values that are between the range of 0.30 and 0.91, which means that the ratings were close to the average mean of each item. None of which deviated up to the normal deviate of 1.96, implying that the average means of the items are valid.

Hypothesis 1

HO_1: There is no significant difference between the mean responses of Metalwork Technology Lecturers and CNC machine operators on the new content in CNC lathe machine operation necessary for inclusion in metalwork technology education curriculum in universities in North Central Nigeria.

Table 3: t-test Analysis of differences in the responses of Metalwork Technology Lecturers and CNC machine operators on the new contents in CNC lathe machine operation necessary for inclusion in metalwork technology education curriculum in universities in North Central Nigeria

	Levene's Test for Equality of Variances		*t-test for Equality of Means*						
	F	**Sig.**	**T**	**Df**	**Sig. (2-tailed)**	**Mean Difference**	**Std. Error Difference**	**95% Confidence Interval of the Difference**	
								Lower	**Upper**
Equal variances assumed	11.333	.001	1.519	77	.133	.12927	.08508	.04014	.29868
Equal variances not assumed			2.266	72.889	.026	.12927	.05705	.01557	.24298

Table 3 presents a summary of the t-test analysis of differences in the responses of metalwork technology lecturers and CNC machine operators on the new content in CNC lathe machine operation necessary for inclusion in metalwork technology education curriculum in universities in North Central Nigeria. The result of the analysis showed that the significant criterion (sig.) of the Levene's test for equality of variance was 0.001, which is less than 0.05 (the confidence level). Therefore, equal variance not assumed t statistics was used. Hence, equal variance not assumed t value of 2.266 was compared with 0.05 level of significance. Since 2.266is greater than 0.05, the hypothesis was therefore accepted. Hence, there is no significant difference between the mean responses of Metalwork Technology Lecturers and CNC machine operators on the new content in CNC lathe machine operation necessary for inclusion in metalwork technology education curriculum in universities in North Central Nigeria.

Hypothesis

HO_2: There will be no significant difference between the mean responses of Metalwork Technology Lecturers and CNC machine operators on the new contents in CNC shaping machine operation necessary for inclusion in metalwork technology education curriculum in universities in North Central Nigeria.

Table 4: t-test Analysis of differences in the responses of Metalwork Technology Lecturers and CNC machine operators on the new contents in CNC shaping machine operation necessary for inclusion in metalwork technology education curriculum in universities in North Central Nigeria

	Levene's Test for Equality of Variances		*t-test for Equality of Means*						
	F	**Sig.**	**T**	**Df**	**Sig. (2-tailed)**	**Mean Difference**	**Std. Error Difference**	**95% Confidence Interval of the Difference**	
								Lower	**Upper**
Equal variances assumed	4.225	.043	1.514	77	.134	.11086	.07323	.25668	.03497
Equal variances not assumed			1.792	42.002	.080	.11086	.06187	.23571	.01399

A summary of the t-test analysis of differences in the responses of Metalwork Technology Lecturers and CNC machine operators on the new contents in CNC shaping machine operation necessary for inclusion in metalwork technology education curriculum in universities in North Central Nigeria is shown in table 4. From the table, the significance criterion (sig.) of the Levene's test for equality of variance was 0.043, which is less than 0.05 (the confidence level). Therefore, equal variance not assumed t value of 1.792 was compared with 0.05 level of significance, and since it is greater than 0.05, the hypothesis was accepted. Therefore, there is no significant difference between the mean responses of Metalwork Technology Lecturers and CNC machine operators on the new contents in CNC shaping machine operation necessary for inclusion in metalwork technology education curriculum in universities in North Central Nigeria.

Findings of the Study

Based on the analyses of data, the following findings emerged:

1. All the 16 items were agreed on by respondents as the new contents in CNC lathe machine operation necessary for inclusion in metalwork technology education curriculum in universities in North Central Nigeria with strong emphasis on items addressing; Skills in performing coupler turning using CNC lathe machine, Skills in carrying out control arm spacer using CNC lathe machine, Carrying out shoulder turning operation using CNC lathe machine, and Skills in installing a machining software programme into the CNC lathe according to product requirements.

2. Metalwork technology lecturers and CNC machine operators agree on all the 16 items, these include; Skills in translating product specification and work instructions into machine readable format, Practical understanding and interpretation of Computer Aided Machining (CAM) programming language peculiar to CNC shaping machine, skills in machining dovetail grooves on CNC shaping machine, and Skills in carrying out T-Slot machining operations, among others, as the new contents in CNC shaping machine operation necessary for inclusion in metalwork technology education curriculum in universities in North Central Nigeria.
3. There is no significant difference between the mean responses of Metalwork Technology Lecturers and CNC machine operators on the new contents in CNC lathe machine operation necessary for inclusion in metalwork technology education curriculum in universities in North Central Nigeria.
4. There is no significant difference between the mean responses of Metalwork Technology Lecturers and CNC machine operators on the new content in CNC shaping machine operation necessary for inclusion in metalwork technology education curriculum in universities in North Central Nigeria.

Discussion of Findings

The findings on the new contents in CNC lathe machine operation revealed that all the 16 items were agreed on by respondents as the new content in CNC lathe machine operation necessary for inclusion in metalwork technology education curriculum in universities in North Central Nigeria with strong emphasis on items addressing; Skills in performing coupler turning using CNC lathe machine, Skills in carrying out control arm spacer using CNC lathe machine, Carrying out shoulder turning operation using CNC lathe machine, and skills in installing a machining software programme into the CNC lathe according to product requirements. In line with this, the of analysis showed that there was no significant difference between the mean responses of Metalwork Technology Lecturers and CNC machine operators on the new contents in CNC lathe machine operation necessary for inclusion in metalwork technology education curriculum in universities in North Central Nigeria. This implies that computer numerical control lathe machine operations contents are necessary for inclusion in metalwork technology education curriculum in order for metalwork graduates to

perform optimally in industries as well as school practical metalwork machine workshop.

This view is line with the submission of Odigiri and Ede (2010) who reported that 41 innovations were perceived as important to be integrated into appropriate modules of the curriculum for training metalwork graduates to enhance their performance in industries. A possible explanation for this could be that the respondents had become concerned that the existing curriculum has failed to adequately meet the world current standards in terms of skills impartation and competency metalwork students' employment potentials, and were convinced that the additional contents developed in this study are capable of leading the way to the attainment of the desired goals. In addition to this, the fact that there was no significant difference in the opinions of the respondents confirm that metalwork graduates are direly in need of CNC lathe machine operations content. Similar findings were made by Atsumbe *et al* (2012a) who reported that there was no significant difference in the mean responses of mechanical engineers and master craftsmen and craftsmen on the practical skill improvement needs of technical college mechanical engineering craft practice curriculum in Nigeria. This further strengthens the need for metalwork graduates to possess adequate skills in CNC lathe machine operation to be able to function at their best in today's industries.

This view was supported by Atsumbe *et al* (2012b) who revealed that the 82 mechanical engineers and 140 mechanical engineering technologists they studied the were most deficient in areas of the use of automatic, NC, and CNC machines and require retraining. This does not come as surprise as Kah and Martikainen (2012) has earlier predicted that "as materials become ever more sophisticated in their chemical composition to provide ever-better functionally specific properties, a more complete and precise understanding of how such materials can be joined for optimal effectiveness and efficiency will become essential". This therefore, means that the metalwork technology graduate will have to be armed with adequate skills necessary to meet up with the emerging innovations.

Also, the finding on the new content in CNC shaping machine operation revealed that metalwork technology lecturers and CNC machine operators agree on all the 16 items, these include; Skills in translating product specification and work instructions into machine readable format, Practical understanding and interpretation of Computer Aided Machining (CAM) programming language peculiar to CNC shaping machine, Skills in machining dovetail grooves operations shaping machine on CNC shaping machine, and Skills in carrying out

T-Slot machining operations, among others, as the new content in CNC shaping machine operation necessary for inclusion in metalwork technology education curriculum in universities in North Central Nigeria. Additionally, the hypothesis tested revealed that there is no significant difference between the mean responses of Metalwork Technology Lecturers and CNC machine operators on the new content in CNC shaping machine operation necessary for inclusion in metalwork technology education curriculum in universities in North Central Nigeria.

This implies that the respondents agree that the curriculum currently being used to train metalwork graduates has fallen short of modern trends in terms of the impartation of the adequate skills needed in modern industries and so needs to be upgraded with new contents. In congruence with this, Ede and Ariyo (2015) reported that the 35 metalwork teachers studied needed improvement in 18 competencies CNC machine operation. This further shows that the new contents developed in this study are indeed necessary for inclusion in the curriculum for training metalwork technology graduates in Nigerian universities. Sunardi (2015) and Mohammed *et al* (2017) do not differ either, when he hinted that new technological innovation of automobiles should be integrated into the automotive curriculum of technical education programs at higher education.

Conclusion

Based on this study it was learned that for metalwork technology education curriculum to be in conformity with global best practice, it has to include contents in computer numerical control (CNC) machining operations in lathe, and shaping machine. The lack of these skills, have hitherto, placed metalwork technology graduates at a disadvantage position. A situation that has made them to lose out in employment opportunities in the ever competitive labour market in Nigeria.

Recommendations

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

1. The National Universities Commission (NUC) should lay more emphasis on curriculum review as when due to update the contents of the curriculum of courses like metalwork technology in order to address the technological advancement across all technology education courses in the universities in Nigeria.
2. Emphasis should be made in purchasing modern machines such as CNC machines to enhance practical among teachers and students towards effective practical teaching.

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