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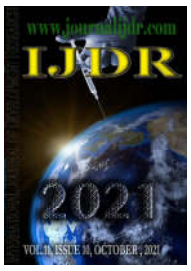

RESEARCH ARTICLE OPEN ACCESS

EFFECT OF COMPUTER NUMERICAL CONTROL MACHINES ON STUDENTS' ACHIEVEMENT IN MECHANICAL ENGINEERING PROGRAMME IN STATE AND FEDERAL POLYTECHNICS IN ADAMAWA, TARABA AND GOMBE STATE NIGERIA

***Samaila Yerima Sule and Engr. Aminu Baba Usman**

Department of Mechanical Engineering, College of Engineering Technology, State Polytechnic Yola, Adamawa State

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***Corresponding author:**
Samaila Yerima Sule

ABSTRACT

The study will investigate to find out the effect of Computer Numerical Control machine on student achievement in Mechanical Engineering programmed in all state and federal Polytechnics in Adamawa, Taraba and Gombe State, four research questions in line with the purpose of the study will be formulated for the study. Four hypotheses will be formulated and tested at 0.05 level of significance study will be made. The study will be conducted using quasi–experimental design. Specifically, the pre - test post – test non-equivalent control group design. This implies that intact classes (non-randomized groups) will be use in the study. The study will be carried out in Adamawa, Taraba, and Gombe State which are located in the North-East Region of Nigeria. The target population of this study consisted of 40 diploma II students enrolled in 2018/2019 academic session in the Department of Mechanical Technology, in all state and federal Polytechnics in Adamawa, Taraba and Gombe State. The instrument for data collection will be tagged Machine Tool Achievement Test (MTAT) developed by the researcher. The instrument will be a multiple-choice question containing 40 items. Each item will have options A - D from which the respondents will choose the correct option. Questions willbe drawn from past school examination question papers of 2014 - 2019 session to form Machine Tool Achievement Test (MTAT). The statistical tools that will be used for analysis is ANCOVA. The independent variable will be the use of CNC machine and analog lathe machine. The dependent variable will be the students' achievement scores obtained after the treatment (post-test). The pre-test performance scores will be obtained prior to the commencement of the treatment and will be use as covariate to control the group differences. Analysis of Covariance will be conducted to determine whether there is a significant difference between the students taught using CNC machine and those taught using analog lathe machine.

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INTRODUCTION

Education is considered as the most effective means that brings about total change in the entire society which ensure rapid national and economic growth development for any nation. Over the last few decades, the use of analog machines tools has been replaced with computer numerical control machines. Lathe is one of the most versatile and widely used machine tools all over the world, it is commonly known as the mother of all other machine tools. The main function of a lathe is to remove metal from a work piece to give it the required shape and size (Singh, 2006). The work piece is securely and rigid1y held in the chuck or in between centers on the lathe machine and then turned against a single point cutting tool which removes metal from the work piece in the form of chips. An engine lathe is the most basic and simplest form of the lathe. It derives its name from the early lathes, which obtained their power from engine (Singh, 2006). Besides the simple turning operation as stated above, lathe can be used to carry out other operations such as drilling, reaming, boring, taper turning, knurling, screw thread cutting and grinding (Singh, 2006). The lathe is a truly time-honored tool, used for hundreds of years to produce parts for machines, furniture and many other items.

Being such a useful piece of equipment, it has benefitted from many modifications and advances to make it (lathe) easier to use and able to make a larger range of items in less time. These modifications included the use of Numerical Control. According to Venkata (2016), Computer Numerical Control (CNC) is a modern concept in the

manufacturing and production industries. However, the concept of CNC dates back to the basic idea of NC or Numerical Control. The idea of numerical control started when the automation of machine tools originally incorporated specific concepts of programmable logic. In the beginning, the first NC machines were built back in the 1940s. Slightly more advanced machines came along in the 1950s. These manufacturing machines were constructed based on existing tools that were modified with motors designed to move the controls of the machine. These controls followed specific points that were fed into the machine on punched tape. These early mechanisms were soon improved with both analog and digital computers. The introduction of computer technology into the concept of numerical controlled to what is now known as Computer Numerical Control (Venkata, 2016). The concept of Numerical Control technology progressed into the 1960s and 1970s. The uses of a CNC lathe and milling machine today and it has started to take site. Digital technology then entered the fray, and automation in production processes became more efficient than ever. In fact, many individuals can purchase and even design their own homemade CNC machines. Because of how advanced computers are nowadays, it is more common than ever to find CNC lathe and milling machines in all industries (Venkata, 2016). In the 1940s, Numeric Control (NC) technology was developed by using computer technology to work with numerical programming of classical machining technologies (Xu &Newman, 2006).

In the past, the use of Computer Numeric Control (CNC) lathe and milling became widespread as the structure of the day-to-day NC-controlled looms was integrated into the computer. The fact that classical looms cannot create a competitive power in the industry necessitated the technical elements to get and use CNC looms which entrepreneurs in manufacturing industry could compete with (Xu & Newman, 2006). In today's industry, CNC lathe and milling machines have a very important place. Because of this, CNC education in engineering education curriculum has an important place (Newman, 2008, and Şahin. 2007). On the other hand, training on CNC lathe and milling machines, which are costly in education institutions, is only provided by showing theoretical and pictorial information about the operation and use of these CNC machines (Altintas, 2012 and Çelik, 2002). Another problem experienced in educational institutions with CNC countertops is that the number of students to the course instructor is so high that it can cause the students to miss important points of the course, lack of attention and motivation, which can adversely affect the quality of education (Čuboňová, 2008). The CNC is one in which the functions and motions of a machine tool are controlled by means of a prepared program containing coded alphanumeric data. CNC can control the motions of the workpiece or tool, the input parameters such as feed, depth of cut, speed, and the functions such as turning spindle on/off, turning coolant on/off. There are many types of CNC machines. The common CNC machines are two -axis and three-axis. The two-axis machine can move on vertical and horizontal only which are X and Y axis. Three-axis machine can do movement starting with three primary axis which are X, Y and Z. The Z axis is being parallel with spindle (Nanfara, 2001). CNC machine operation starts with the collection of data from programming that is extracted from Computer-Aided Design (CAD) and Computer-Aided Manufacturing (CAM). The programs produce the computer file and then extract the command to operate the machine. The program will be transferred via post-processor and then loaded into the CNC lathe and milling machines to start the machining. CNC have benefits and drawbacks despite their ease of operation.

Research Questions: This study sought to find answers to the following research questions;

- What is the mean achievement score of students taught turning operation using Computer Numerical Control Lathe Machine and those taught using analog lathe machine?
- What is the mean achievement score of students taught drilling operation using Computer Numerical Control Lathe Machine and those taught using analog lathe machine?

Hypotheses: The following null hypotheses guided the study and were tested at 0.05 level of significance:

HO_1: There is no significant difference in the mean achievement of students who were taught turning operation using CNC machine and those taught using analog lathe machine.

HO_2: There is no significant difference in the mean achievement of students who were taught drilling operation using CNC machine and those taught using analog lathe machine.

METHODOLOGY

The study was conducted using quasi–experimental design. Specifically, the pre - test post – test non-equivalent control group design was used. This implies that intact classes (non-randomized groups) were used in the study. According to Ofo (2002), quasi experimental research design permits the use of intact classes. This design was adopted because it was not possible for the researcher to randomly sample the subjects and assign them to groups without disrupting the academic programmed of the Polytechnics that are involved in the study.

Hence, the design was considered quite suitable for conducting this study. The design is illustrated below:

$$E = \underline{O_1\ X_1 \quad O_2\ O_3}$$
$$C = O_1\ X_2 \quad O_2\ O_3$$

Where: E = Experimental Group,
C = Control Group
X1 = Treatment 1 (Computer Assisted Instruction);
X2 = Treatment 2 (conventional teaching methods)
01= Pre – test
02 = post-test
03= Retention test
(Ofo 2002)

The population of this study consisted of 44 student diploma II enrolled in 2017/2018 academic session in the Department of Mechanical Technology, College of Engineering Technology, Adamawa State Polytechnic, Yola,

RESULTS

The results are presented in the order of research questions and hypotheses that guided the study.

Research question 1: What is the mean achievement score of students taught turning operation using Computer Numerical Control Lathe Machine and those taught turning operation using analog lathe machine?

This research question is answered by table1.The result in Table 1 shows the pre-test and post-test mean achievement scores of students in experimental and control groups. The result of post test scores shows pass in both groups with means of 45.43 and 59.64 respectively.

This result indicates that the use of computer numerical control lathe machine in teaching turning operation improved academic achievement of students compared to the use of analog lathe machine.

Research question 2: What is the mean achievement score of students taught drilling operation using Computer Numerical Control Lathe Machine and those taught drilling operation using analog lathe machine?

Table1. Mean Achievement Scores of Students Taught Turning Operation Using Computer Numerical Control Lathe Machine and those Taught Turning Operation Using Analog Lathe Machine

Group	Symbol	Pre-test	Post-test	Mean Gain	Mean Gain Differences
Control	N	22	22		
	$\bar{X}$	26.55	45.43	19.08	
					12.93
Experimental	N	22	22		
	$\bar{X}$	27.63	59.64	32.01	

Table 2. Mean Achievement Scores of Students Taught Drilling Operation Using Computer Numerical Control Lathe Machine and those Taught Turning Operation Using Analog Lathe Machine

Group	Symbol	Pre-test	Post-test	Mean Gain	Mean Gain Differences
Control	N	22	22		
	$\bar{X}$	36.37	58.74	22.37	
					0.28
Experimental	N	22	22	22.65	
	$\bar{X}$	38.72	61.37		

Table 1. ANCOVA Mean Achievement Test of Students Taught Using CNC Machine and those Taught Using Analog Lathe Machine on Turning Operation

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	5131.249[a]	2	2565.624	15.010	.000	.238
Intercept	20666.191	1	20666.191	120.905	.009	.557
Pretest	539.833	1	539.833	3.158	.000	.032
Group	4590.203	1	4590.203	26.854	.009	.219
Error	16409.241	134	170.930			
Total	333125.500	136				
Corrected Total	21540.490	135				

a. R Squared = .238 (Adjusted R Squared = .222)

Table 2. ANCOV A Mean Achievement Test of Students Taught Using CNC Machine and those Taught Using Analog Lathe Machine on Drilling Operation

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	5138.642[a]	2	1712.881	9.921	.000	.239
Intercept	9368.004	1	9368.004	54.260	.079	.364
Pretest	542.926	1	542.926	3.145	.000	.032
Group	4597.596	1	2298.798	9.315	.049	.219
Error	16401.848	41	172.651			
Total	333125.500	44				
Corrected Total	21540.490	43				

a. R Squared = .239 (Adjusted R Squared = .215)

This research question is answered by table2. The result in Table 2 shows the pre-test and post-test mean achievement scores of students in experimental and control groups. The result of post test scores shows pass in both groups with means of 58.47 and 61.37respectively. This result indicates that the use of computer numerical control lathe machine in teaching drilling operation improved academic achievement of students compared to the use of analog lathe machine.

Hypothesis One: There is no significant difference in the mean achievement of students who were taught using CNC machine and those taught using analog lathe machine on turning operation. Analysis of Covariance (ANCOVA) was conducted to determine whether there is a significant difference between the students taught using CNC machine and those taught using analog lathe machine on turning operation. The result in Table 5 shows that there was a significant difference in the mean academic achievement of students taught using CNC machine and those taught using analog lathe machine on turning operation., $F(1, 135) = 26.854$, $P<0.05$, since the computed p-value 0.009 is less than 0.05 level of significance with a partial eta squared =0.219. This implies that null hypothesis of no significant difference is rejected.

Hypothesis Two: There is no significant difference in the mean performance of students who were taught using CNC machine and those taught using analog lathe machine on drilling operation. Analysis of Covariance (ANCOVA) was conducted to determine whether there is a significant difference between the students taught using CNC machine and those taught using analog lathe machine on drilling operation. The result in Table 6 shows that there was a significant difference in the mean academic achievement of students taught using CNC machine and those taught using analog lathe machine on drilling operation., $F(1, 43) = 9.315$, $P<0.05$, since the computed p-value 0.049 is less than 0.05 level of significance with a partial eta squared =0.219. This implies that null hypothesis of no significant difference is rejected.

Based on the research questions and the hypotheses formulated to guide the study, findings were made. These finding were stated as follows:

- The study found that the use of computer numerical control lathe machine in teaching turning operation improved academic achievement of students compared to the use of analog lathe machine.

- It was found that the use of computer numerical control lathe machine in teaching drilling operation improved academic achievement of students compared to the use of analog lathe machine.
- This result indicates that the use of computer numerical control lathe machine in teaching threading operation improved academic achievement of students compared to the use of analog lathe machine.
- This result indicates that the use of computer numerical control lathe machine in teaching milling operation improves academic achievement of students compared to the use of analog lathe machine.

Recommendations

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

- The use of computer numerical control machines should be made compulsory in all Polytechnics. This will assist in executing practical task adequately and improve skill acquisition.
- The is need for the school to supply more Computer Numerical Control machines so that it can encourage the students and their teachers and also to attend seminars and workshop on computer numerical control machines This will help them update their knowledge in the current technological world. By this the students will be able to meet up with the challenges of technological development is posing to teaching and learning process.
- The National Board for Technical Education (NBTE) should incorporate into the Polytechnic courses, Computer Numerical Control machines in learning and teaching Mechanical Engineering.
- Adamawa State Government should support Polytechnic with the relevant devices and other materials for practical.

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