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Effect of Guided Discovery Teaching Technique on Students' Academic Achievement in Machine shop Practice in Rivers State Universities

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Abstract: The study investigated the effect of guided discovery teaching technique on students' academic achievement in machine shop practice in Rivers State Universities. Two research questions and corresponding hypotheses guided the study. Quasi-experimental design, specifically, the non-randomized control group design involving two intact classes were used. The population was all students of Mechanical/Metal Work Technology while stratified random sampling technique was used to select 53 final year students of Mechanical/Metal Work Technology of Rivers State Universities. Metal-Work Performance Test (MWPT) instrument was developed, validated and used for data collection. Reliability of the instrument was 0.85. Mean and standard deviation were used to analyze data collected in respect to the research questions while ANCOVA was used to test the null hypotheses. Findings of the study revealed that guided discovery teaching technique has significant effect on student's achievement in drilling and turning operation. This is evident in the mean achievement of students taught with the guided discovery teaching technique in drilling and turning operation x = 31.85 and 33.32. While students taught with conventional teaching technique had a mean achievement of x = 24.75 and 25.58. It implies that from the findings, that there is need for teachers of machine shop practice to employ the use of guided discovery teaching technique in teaching as it proves more effective in improving student's achievement in drilling and turning operation. It is recommended that lecturers of Mechanical/Metal Work in Rivers State Universities should be given on-the-job training opportunities such as short-term courses, seminars and workshop to enable them update their knowledge; this will help them to constantly keep abreast with the ever-changing scientific knowledge and various modern methods of teaching technology subjects.

Keywords: Guided Discovery, Teaching Technique, Students' Achievement, Drilling and Turning Operations.

Introduction

Technical Vocational Education and Training (TVET) is a result oriented programme. It brings about technological advancement and aims to fit new manpower for employment and provide continuing training for those already qualified, so that they can keep pace with modern and emerging work environment. TVET are by design intended to develop skills that can be used in specific occupation or job (Olaitan 1998). The objectives and content of the curricula of TVET according to the World Bank (2013) are derived from occupational standards or more directly from analysis of the task that are to be carried out on the job. The effectiveness of these curricula can thus be measured by the extent to which trained beneficiaries can use their skills for self-employment or probably to be employers of labour. In line with this, the Federal Government of Nigeria in her National Policy on Education (FGN, 2013) affirmed that the purpose of TVET is to:

(i) Enable individuals acquire vocational and technical skills.
(ii) Expose the individuals to career awareness by exposing useable options in the world of work.
(iii) Enable youth acquire an intelligent understanding of the increasing complexity of technology.
(iv) Stimulate creativity.

Based on the above assertion, Amadi, Orlu and Obed (2015) opined that TVET is a type of education that is meant to produce skilled and technical manpower necessary to restore, revitalize, energize, operate and sustain the national economy and substantially reduce unemployment in a country. According to Federal Government of Nigeria (FGN, 2013), views technical and vocational education as a form of education involving, in addition to general education, the study of technologies and related sciences and the acquisition of practical skills, attitudes, understanding and knowledge relating to occupations in various sectors of economic and social life. For Deebom (2019), TVET is an education program that is organized to orient people into skills acquisition, and as well teach them the attitude and knowledge necessary for the appropriate utilization of such skills. TVET is training or retraining programme given in schools or classes under supervision and control. The learning experiences according to Abubakar (2010) may occur in variety of learning context, including educational institutions and workplace. Teaching of skills in Nigeria is done both in

the formal sector (institutions) and a registered vocational trade centres. In these institutions and training centres, individuals are provided with needed skills that will enable them become proficient in both the public workplace and private employment. TVET is a continue process of adaptation of the worker's training towards acquiring the minimum knowledge required.

The National Policy on Education (FGN, 2013) highlight the Nigeria's desired to achieve national goal through quality education, hence the need for acquisition of appropriate skills and competence both mental and physical as equipment for the individual to life and to also contribute to growth of the society. Thus, no society can develop to appreciable level without relevant functional and technological based TVET programme. TVET programme would help develop sufficient skills in their chosen occupational skills so as to help them obtain and hold employment on graduation. TVET provides various opportunities for discovering and developing the individual's potentials for work. Accordingly, Oziengbe (2009) opined that TVET has a broadening effect, which motivates learners to be more exploratory, realize their capabilities and develop their potentials for success in the workplace. It has been noted by Deebom (2019) that TVET provides the needed employable skills and attitudes required for job performance at the workplace for the youths (graduates). This means that, in TVET, the youth undoubted would have the opportunity of being productive and become useful to themselves and the society. This can however be achieve only when teaching and learning of TVET programmes and its courses are appropriately carried out. This can be possible by making teaching learning process to be student-centered as against being teachers-centered and by also viewing students as problem solvers rather than direction followers. Salami (2004) observed that many teaching methods in technology institutions do not use students to their full capacity, and for this reason, teachers should use appropriate teaching methods such as field trip, assignment, guided discovery method among others that are student-centered as against lecture and dictation methods that are teacher-centered.

Hence, teacher-centered teaching methods are capable of achieving only minimum students' performance with the result that teachers contribute more and more to accomplish less and less in terms of both learning, productivity and quality of the learning experience (Okoli & Toby, 2000). Okoli and Toby (2000), further explained that, recent discoveries in psychology and neurophysiology have led to other theories of learning. One of such theories is the theory of constructivism which has resulted into emergence of a more productive and student-centered. Constructivist teaching is based on the fact that skills and knowledge acquisition are not by passively receiving information and rote learning but involves active participation of the learners through knowledge construction, hands-on and minds-on activities (Akinbobola & Afolabi, 2010). Ogunbiyi (2012) noted that Vocational Education curriculum demands the adoption of more progressive strategies of discovery, inquiry, discussion, problem solving, dramatization/role playing, computer-assisted instruction and other relaxed classroom learning and teaching activities. This technique focuses on students' constructed learning as opposed to teacher transmit information. In learning through guided discovery teaching technique, learners are place in a problem situation and are surrounded by lots of appropriate and suitable materials with which to explore the environment and solve problems.

Guided discovery method according to Uwameiyi and Ogunbemeru (2005), is a method of teaching that has the advantages of allowing learners to use process skills to generate content information. Guided discovery method activity engages learners in first hand real world learning. Uwameiyi and Ogunbemeru (2005) stated further that guided discovery method encourages learners to explore the content through the use of concrete experience. In this study, guided discovery method is defined as a method of teaching that fosters the philosophy of learning by doing, problem solving through guided experimentation and that which enhances students' participation and creativity. The researchers' further asserted that guided discovery method also enables students to make references with limited guidance from the teacher. Guided discovery method allows the students the opportunity to discover principles or explanations (Spence, Jensen & Shepherd 2004). In using guided discovery as a teaching method, according to Reinchart (2005), the teacher devises series of statements or questions that will guide the learner to use a step by step series of discoveries that can lead to a single predetermined goal. The teacher initiates a stimulus and the students react by engaging in active inquiry, thereby discovering the appropriate response. Also Ajewole (1990) pointed out six steps or procedures to follow for a successful use of guided discovery teaching method by a teacher. These procedures involve:

i. The teacher to first of all identify the topic to be taught.
ii. He then selects the relevant activities that will enable students acquire desirable attitude and skill.
iii. He also conducts pre-section, where he tries his hands on the activities he wishes to teach.
iv. The teacher introduces the lessons and provides an instructional material which stimulates the learner's interest.
v. He groups students around available materials.
vi. Lastly he acts as a questioner or sustainer of inquiry.

Fatokun and Yallams (2007) also describes guided discovery method as resource- based learning which is an innovation that reverses the usual role of the teacher from that in which he is the main authority and source of all knowledge to that in which he acts simply as a guide to the students to enable them to make use of other source of information which increases their academic achievement.

Academic achievement is the outcome of education, that is, the extent to which a student, teacher or institution has achieved their educational goals. According to Jimoh, Idris and Olatunji (2016), academic achievement is the degree of success attained by students after being exposed to one form of learning or the other. Ezenwosu and Nworrgu (2013) noted that academic achievement is commonly measured using classroom exercise, assignment and continuous assessment as well as internal and external examination. Jimoh (2014) corroborate that academic achievement is the level of success attained by students in school subjects. Jimoh further explained that academic achievement can be used to indicate students' level of success in a particular task previously exposed to and it can also be used as indices for determining students' ability to effectively undertake another task such as drilling and turning operation as a task in machine shop practice.

Drilling and turning processes machine shop practice activities that are typically carried out on a lathe which is a typical machine needed for machine shop practice in mechanical/metal workshop. Lathe is a machine used principally for shaping pieces of metal, wood, or other materials by causing the work piece to be held and rotated by the lathe while a tool bit is advanced into the work causing the cutting action. The lathe is one of the most important machines in any mechanical/metal workshop. Its main objective is to remove material from outside by rotating the work against a cutting tool. It is a power driver, well purpose machine tool, which is used for producing cylindrical work piece. An engine lathe is a power-driven, general-purpose machine tool used for producing cylindrical work-pieces. As the piece of metal to be machined is rotated in the lathe, a single-point cutting tool is advanced radically into the work piece a specified depth and moved longitudinally along the axis of the work piece, removing metal in the form of chips. Both inside and outside surfaces can be machined on a lathe by using attachments and accessories. Other operations such as reaming, boring, taper and angle turning, screw-thread chasing, form turning, knurling, milling, grinding, and drilling may be performed.

Drilling is a cutting process that uses a drill bit to cut a hole of circular cross-section in solid materials. The drill bit is usually a rotary cutting tool, often multipoint. The bit is presses against the work piece and rotated at rates from hundreds to thousands of revolution per minute.. This forces the cutting edge against the work piece, cutting off chips from the hole as it is drilled. Operations in drilling includes: Spot drilling: The purpose of spot drilling is to drill a hole that will act as a guide for drilling the final hole. The hole is only drilled part way into the work piece because it is only used to guide the beginning of the next drilling process. Center drilling: The purpose of center drilling is to drill a hole that will act as a center of rotation for possible following operations. Center drilling is typically performed using a drill with a special shape, known as a center drill. Deep hole drilling: Deep hole drilling is defined as a hole depth greater than ten times the diameter of the hole (Paris, 2005). These types of holes require special equipment to maintain the straightness and tolerances. Other considerations are roundness and surface finish, gun drilling. Gun drilling was originally developed to drill out gun barrels and is used commonly for drilling smaller diameter deep holes. The depth-to-diameter ratio can be even greater than 300:1. The key feature of gun drilling is that the bits are self-centering; this is what allows for such deep accurate holes. The bits use a rotary motion similar to a twist drill; however, the bits are designed with bearing pads that slide along the surface of the hole keeping the drill bit on center. Gun drilling is usually done at high speeds and low feed rates. Microdrilling: Microdrilling refers to the drilling of holes less than 0.5 mm. Drilling of holes at this small diameter presents greater problems since coolant fed drills cannot be used and high spindle speeds are required. High spindle speeds that exceed 10,000 RPM also require the use of balanced tool holders.

Turning is a machining process in which a cutting tool, typically a non-rotary tool bit, describes a helix tool path by moving more or less linearly while the work piece rotates. The tool's axes of movement may be literally a straight line, or they may be along some set of curves or angles, but they are essentially linear (in the non mathematical sense). Usually the term "turning" is reserved for the generation of *external* surfaces by this cutting action, whereas this same essential cutting action when applied to *internal* surfaces (that is, holes, of one kind or another) is called "boring". Thus the phrase "turning and boring" categorizes the larger family of (essentially similar) processes. The cutting of faces on the work piece (that is, surfaces perpendicular to its rotating axis), whether with a turning or boring tool, is called "facing", and may be lumped into either category as a subset.

Turning can be done manually, in a traditional form of lathe, which frequently requires continuous supervision by the operator, or by using an automated lathe which does not. Today the most common type of such automation is computer numerical control, better known as CNC. CNC is also commonly used with many other types of machining besides turning. When turning, a piece of relatively rigid material (such as wood, metal, plastic, or stone) is rotated and a cutting tool is traversed along 1, 2, or 3 axes of motion to produce

precise diameters and depths. Turning can be either on the outside of the cylinder or on the inside (also known as boring) to produce tubular components to various geometries. Although now quite rare, early lathes could even be used to produce complex geometric figures, even the platonic solids; although since the advent of CNC it has become unusual to use non-computerized tool path control for this purpose. The turning processes are typically carried out on a lathe, considered to be the oldest machine tools, and can be of four different types such as *straight turning*, *taper turning*, *profiling* or *external* grooving. Those types of turning processes can produce various shapes of materials such as *straight*, *conical*, *curved*, or *grooved* work piece. In general, turning uses simple *single-point cutting* tools. Each group of work piece materials has an optimum set of tools angles which have been developed through the years. Due to the complex nature associated with machine shop operation such as turning and drilling, its teaching should be students' centred where the students will be guided only by the teacher.

Statement of the Problem

Graduate of mechanical/metal technology requires drilling and turning skills to enable them embark on either self or paid employment in contemporary world. However, there is a general concern over the low performance of these graduates, most especially in drilling and turning operation where they cannot cope with the world of work. The general objectives of drilling and turning operation in mechanical/metal technology is to produce skilled craftsmen with good knowledge of the working principles of metalwork and the techniques and safety practices involved in metalwork maintenance.

But these graduates as it was observed by the researchers with dismay find it very difficult to carry out drilling and turning operation using lathe machine and hence they are neither self employed nor employed by the industries where drilling and turning operation are part of their system. This decline in students performance has been associated to a number of factors, among which is the techniques employed in impacting knowledge to the learners (Akinyele, 2000). Moreover, it has been discovered that the persistent poor academic performance of students in machine shop practice in mechanical/metal work technology is as a result of the inappropriate teaching techniques adopted by the teachers (Aina, 2000). To assure that these graduates acquire employability skills and be competent in modern industries, they most acquire the skills in drilling and turning operation. It is in the light of the above that this study was designed to establish the effect of guided discovery teaching technique on students' achievement in machine shop practice in Rivers State Universities.

Purpose of the Study

The purpose of the study is to determine the effect of guided discovery teaching technique on students' academic achievement in machine shop practice in Rivers State Universities. Specifically, the study determines the effect of:

1. Guided discovery teaching technique on student's academic achievement in drilling operation.
2. Guided discovery teaching technique on student's academic achievement in turning operation.

Research Questions

The following research questions were posed to guide the study:

1. What is the effect of guided discovery teaching technique on students' academic achievement in drilling operation?
2. What is the effect of guided discovery teaching technique on students' academic achievement in turning operation?

Hypothesis

The following null hypotheses were formulated to guide the study and were tested at 0.05 level of significance;

1. There is no significant difference in the mean achievement of students taught drilling operation using guided discovery teaching technique and those taught using conventional teaching technique.
2. There is no significant difference in the mean scores of students taught turning operation using guided discovery teaching technique and those taught using conventional teaching technique.

Methodology

Design of the Study

A quasi-experimental design was used in this study. Specifically, the pre-test, post test, non-equivalent control group design was adopted for the study. According to Gall, Gall and Borg (2007), quasi-experimental design can be used when it is not possible for the researcher to randomly sample the subject and assign them to

treatment groups without disrupting the academic programmes of the schools involved in the study. Gall et al (2007) stated further that in a non-equivalent control group design, it is possible to have all groups receive treatments. This design was considered suitable for the study because intact classes (non-randomized groups) were assigned to the two different techniques of teaching. This is in order to determine the effect of the Guided Discovery Technique on students' academic achievement in drilling and turning operation. The experimental design of the study is symbolically represented as follows:

Table 1: Research Design Illustration for the Experiment

Group	Pre-testing	Treatment	Post-testing
E	O_1	X_1	O_3
C	O_2	X_2	O_4

Where the symbols are represented as:
E = Guided Discovery Method (Experimental Group)
C = Demonstration Group (Controlled Group)
O_1 and O_2= Pre-testing
X_1 = Treatment
X_2 = No treatment
O_3 and O_4= Post-testing

Area of the Study

The study was carried out in Rivers State Universities. These universities are Rivers State University (RSU), Port Harcourt and Ignatius Ajuru University of Education (IAUE), Rumuolumeni. Rivers State is one of the States in South-South Geopolitical Zone. It has boundary with Abia, Akwa-Ibom, Delta and Imo States. The State has 23 local government areas with eight ethnic groups. The state has more technical and oil servicing industries as well as multinational companies that can make use of these mechanical/metal work graduates. The universities in the state have more metal-work students and teachers who can form the population to be used in the research. The study was conducted in the two universities. The rationale for choosing these universities is based on the fact that they offer mechanical/metalwork technology and its facilities are within the school premises.

Population for the Study

The population for the study comprised of all the mechanical/metal work technology students in Rivers State Universities. As at the time of the study, there are about 235 students of mechanical/metal work technology out of which 73 from Ignatius Ajuru University of Education while 81 from Rivers State University were used for the study (Institution's Departmental Exams and Records Unit, 2019).

Sample and Sampling Technique

The study adopted stratified random sampling technique. This is because out of the different levels or years, only final level or year 4 students were used for the study. The sample size for the study was all the final students that were used to form intact classes of 32 and 21 respectively for Rivers State University and Ignatius Ajuru University of Education. Rivers State University was used as the experimental group that was expose to Guided Discovery Teaching methods (Treatment) while Ignatius Ajuru was considered as the control group.

Instrument for Data Collection

One instrument was developed for this study. The Metal Work Performance Test (MWPT) which has two parts according to the topics outlined was used for data collection. Each part of the instrument has two sections; section A elicits personal information from the students and session B carries the 50 items questions from the topic. Each question item of MWPT instrument has four options A-D out of which the students were expected to circle the correct answer or option. The Metal Work Performance Test that was used in this study was developed by the researchers. Every correct answer has one point while an incorrect answer has 0 point. This implies that that the instrument has a total of 50 points. The development entails constructed test items on the following specific metalwork topics which were covered in the study: drilling operation and turning operation.

Topics on drilling operation were taught in the first two weeks as contained in the lesson, while turning operation topics were as well taught for another two weeks, hence, the lesson lasted for four weeks. The weights were based on the weight of the unit coverage. The relative weights of emphasis on the test items are drilling

operation 25% and turning operation 25%. The table of specification was developed based on the topics outlined.

Validation of the Instrument

The research instrument that was used for the pre-test, post–test is tagged Metal Work Performance Test. The experts comprised of two lecturers in Mechanical/Metal Work from the Department of Industrial Technical Education, Ignatius Ajuru University of Education, Port Harcourt. The experts were requested to ascertain the suitability of the test items for the study. They validate the instrument in terms of adequacy of content, logical sequence and suitability of the technical term used. Their corrections, comments and suggestions were incorporated in to the final version before administration.

Reliability of the Instrument

The instrument used for the study is Metalwork Performance Test. The instrument was pilot tested on 23 year 3 Mechanical/Metal Work students selected through simple random sampling technique who were not part of the sample. The reliability co-efficient of Metalwork Performance Test was determined using Kuder Richardson formula 20 (KR-20). This formula is used because the Metalwork Performance Test is a multiple choice question. This help to establish the internal consistency of the items. The students' scores were computed which yielded a reliability index of 0.85.

Method of Data Collection

Data were collected through the use of pre-test post-test for each topic in each week. The test was administered to the students by the metal-work teachers in both groups. The test result that was submitted by the lecturers was used for analysis.

Experimental Procedures

The study involved two groups of subjects. They were those taught with guided discovery teaching technique and those taught with conventional teaching technique. The guided discovery based group was the experimental group (students of Rivers State University) while the conventional teaching technique was the control group (Students of Ignatius Ajuru University of Education). In all, a total of 53 students were involved in the study which was the sample size of the study.

On the first day of the experiment, the test instrument: metalwork performance test was typed in white papers and administered as pre-test to all students involve in the study. After this, both groups: guided discovery based group and conventional group were taught metalwork for a period of four weeks. A total of four lesson periods were involved which covers drilling operation, and turning operation as contained in both teaching techniques. The regular metalwork lecturers were guided and provided with the teaching manual as to master the principles of guided discovery teaching technique in two days time before the commencement of the study.

Prior to the commencement of the experiment, the researchers and the lecturers trained the students on how to use the teaching manual and also make provision of the manual to the students. Lesson plan for the two groups; guided discovery teaching technique and conventional teaching technique were developed by the researchers for the students. Both groups were taught metalwork for four weeks. Students who encountered difficulties in the course of the study were assisted by the course lecturer.

Control of Extraneous Variables

The following measures were employed to control some of the extraneous variables in this study;

(a) Initial Group Differences: Randomization is one of the procedures used to control initial group differences in experimental studies. However, this was not allowed in this study since the process would disrupt normal school administration. In place of that, intact classes were used.

(b) Experimental Bias: When researchers involve external subjects in the experiments, these students become sensitized that they are being used for the study. Based on that, they tend to behave mechanically and fake most of their actions. This could introduce experimental bias in the study. In order to avoid the bias in this study, the regular metalwork lecturer in each school was guided and used. The researcher monitored these occasionally as to ensure that they strictly and effectively adhere to the instruction.

(c) Lecturer Variable: When different lecturers get involve in experiment, the problem of lecturer-variable arises since different lecturers possess different standards in terms of knowledge of the content, methodology and so on. As a measure to control this variable in this present study, the researchers prepared lesson plans for guided discovery teaching technique on metalwork topics which ensured strict compliance with the lesson plans.

(d) Variability of Instructional Situation: Homogeneity of instruction across groups was ensured as follows:
   (I) The researchers guided the course lecturers on the instructional procedure involved.
   (II) Both groups were taught the same topics and within the regular periods allotted to basic metalwork in the school time table.

(e) Effect of Pre-test and Post-test: As a way to minimize influences of memory and forgetfulness, the time lag between the pre-test and post-test was three days which was considered to be neither too long nor too short. This relatively short experimental duration serves to control pre-test sensitization as well as minimize the effect of maturation and history. The pre-test items were rearranged and renumbered both in terms of serial number and option and then reproduced in another paper before being used as the post performance test. This was done to minimize the level of remembering of the question due to similarity and guess work by the student.

(f) Training of Lecturers: Lecturers who administered the experimental treatment to the students were guided by the researcher to enable them acquire the necessary competences required to effect the implementation of uniform experimental conditions.

Method of Data Analysis

The data for the two research questions of this study were analyzed using mean and standard deviation. The hypotheses were tested at 0.05 level of significance using Analysis of Covariance (ANCOVA). The pre-test was used to control the initial differences, across the groups as well as increasing the precision due to the extraneous variables reducing errors variance. The Statistical Package for Social Sciences (SPSS) was used for all data analysis in this study.

Decision Rule

With the calculated f-ratio being greater than the table or critical f-ratio, the null hypotheses were rejected. The values of calculated f-ratio being less than the table f-ratio value, the null hypotheses were accepted. The value of f-ratio at 0.05 level of significance and above was accepted while the value of f-ratio less than 0.05 level of significance was rejected.

Results

The result of the study were presented below.

Research Question 1

What is the effect of guided discovery teaching technique on student's academic achievement in Drilling Operation?

Table 2: Mean and Standard Deviation Performance Scores of Students Taught with Guided Discovery Teaching Technique and Students Taught Using the Conventional Teaching Technique in Drilling Operation

Group	School	N	Pre-test		Post-test		Mean-Gain
			$\bar{x}$	SD	$\bar{x}$	SD	
Experimental	RSU	32	14.21	3.49	31.85	4.48	17.64
Control	IAUE	21	15.00	3.55	24.75	3.99	9.75

Source: Researchers' Field Result, 2019

Table 2 shows the pre-test and post-test mean score of students' performance in drilling operation for both treatment and control groups. Result shows that the students in the experimental group had a pre-test mean score of 14.21 with a standard deviation of 3.49 and a post-test mean score of 31.85 with a standard deviation of 4.48. The difference between the pre-test and post-test mean for the experimental group was 17.64, while the control group had a pre-test mean score of 15.00 with a standard deviation of 3.55 and a post-test mean score of 24.75 and standard deviation of 3.99. The difference between the pre-test and post-test mean for the control group was 9.75. This shows that the mean score for the experimental group is higher than the control group, indicating that those taught drilling operation with the guided discovery teaching technique performed better.

Research Question 2

What is the effect of guided discovery teaching technique on student's academic achievement in Turning Operation?

Table 3: Mean and Standard Deviation Scores of Students Taught with Guided Discovery Teaching Technique and Students Taught Using the Conventional Teaching Technique in Turning Operation

Group	School	N	Pre-test		Post-test		Mean-Gain
			$\bar{x}$	SD	$\bar{x}$	SD	
Experimental	RSU	32	16.29	2.98	33.32	3.78	17.03
Control	IAUE	21	15.50	2.14	25.58	2.04	10.08

Source: Researchers' Field Result, 2019

Table 3 shows the pre-test and post-test mean score of students' performance in turning operation for both treatment and control groups. Result shows that the students in the experimental group had a pre-test mean score of 16.29 with a standard deviation of 2.98 and a post-test mean score of 33.32 with a standard deviation of 3.78. The difference between the pre-test and post-test mean for the experimental group was 17.03, while the control group had a pre-test mean score 15.50 with a standard deviation of 2.14 and a post-test mean score of 25.58 and standard deviation of 2.04. The difference between the pre-test and post-test mean for the control group was 10.08. This shows that the mean score for the experimental group is higher than the control group, indicating that those taught with the guided discovery teaching technique performed better.

Hypothesis 1

There is no significant difference in the mean achievement of students taught drilling operation using guided discovery teaching technique and those taught using conventional teaching technique.

Table 4: Analysis of Covariance (ANCOVA) Table Showing Difference Between Students Taught with Guided Discovery Teaching Technique and those Taught with Conventional Teaching Technique in Drilling Operation

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	691.898[a]	2	345.949	19.467	.000
Intercept	1671.541	1	1671.541	94.058	.000
PRE-TEST_A	39.135	1	39.135	2.202	.144
GROUP	680.757	1	680.757	38.307	.000
Error	870.794	49	17.771		
Total	44028.000	53			
Corrected Total	1562.692	52			

Significance at $\alpha \leq 0.05$

The analysis of covariance of students performance scores presented in Table 4 showed that f-calculated for teaching methods in the two groups is 38.307 at 0.000 significant level. It therefore implies that the null hypothesis is rejected. Thus, there is a significant difference in the mean achievement of students taught with guided discovery teaching technique and conventional teaching technique respectively.

Hypothesis 2

There is no significant difference in the mean achievement of students taught turning operation using guided discovery teaching technique and those taught using conventional teaching technique.

Table 5: Analysis of Covariance (ANCOVA) of Difference between Students Taught with Guided Discovery Teaching Technique and those Taught with Conventional Teaching Technique in Turning Operation

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	907.019[a]	2	453.510	63.722	.000
Intercept	482.309	1	482.309	67.769	.000
PRE-TEST_B	133.210	1	133.210	18.717	.000

GROUP	563.667	1	563.667	79.201	.000
Error	348.731	49	7.117		
Total	47279.000	53			
Corrected Total	1255.750	52			

Significance at $\alpha \leq 0.05$

The analysis of covariance of students performance scores presented in Table 5 showed that f-calculated for teaching methods in the two groups is 79.201 at 0.000 significant level. It therefore implies that the null hypothesis is rejected. Thus there is a significant difference in the mean achievement of students taught with guided discovery teaching technique and conventional teaching technique respectively.

Discussion of Findings

To carry out a drilling operation, the drill bit has to be securely held in stock with a chuck or drill holder. Table 2 indicated the mean performance of the experimental group which is higher than that of the control group. The difficulty level of carrying out a drilling operation is not high due to the few steps involved in the operation. However, the positive effect of guided discovery teaching guide is very clear on the experimental group. This finding is in agreement with the theoretical assertion of Millar, Tiberghien and Le Maréchal (2002) that the role of practical work in the teaching and learning of science content is to help students make links between two 'domains' of knowledge: the domain of objects and observable properties and events on the one hand, and the domain of ideas on the other.

Turning operation is subdivided in to straight and taper turning operation. Straight turning produces cylindrical shapes through a number of manipulative exercises that are carried out requiring skillful manipulation and handling of precision equipment by the operator. In carrying out a straight turning operation therefore, the understanding of and following of detail procedures strictly is essential for successful operation. A taper is generated by, (1) clamping the work piece securely in the head stock, (2) mounting the cutting tool securely in the tool post, (3) setting the tail stock off-center or using taper attachment or by using the compound rest adjustment, and finally, (4) skillful and careful feeding of and manipulation of the compound rest. With its many steps requiring precision measurement, taper turning requires a high level of precision and dexterity in handling tools and making adjustments. Even though the mean performance of the treatment group is better than the performance of the control group is an indication that the use of the guided discovery teaching guide positively affected the performance of the treatment group. This is to be expected because according to Bralla (1999) the ability of a beginner-machinist to successfully carry out an operation requiring high precision finishing by complex adjustment is enhanced by the use of systematic and orderly procedure of carrying out the operation which the guided discovery teaching guide provides. It is also clear that with guided discovery teaching guide to assist students in carrying out straight and taper turning operation, good performance should be expected (Ogwo & Oránu, 2006).

Conclusion

Based on the findings of the study, the following conclusions are drawn. The mean performance of the students taught with the guided discovery teaching technique is better than those taught with conventional teaching technique. This performance is consistent in all of the two metal-work operations and this cannot be said to have occurred by chance, but rather due to the effectiveness of the guided discovery teaching technique. Therefore, the guided discovery teaching technique for teaching metal-work skills in lathe machine operations has yielded better performance when compared to the conventional teaching method.

Recommendations

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

1. Mechanical trade related teachers in Rivers State Universities should be given on-the-job training opportunities such as short-term courses, seminars and workshop to enable the lecturers to update their knowledge; this will help them to constantly keep abreast with the ever-changing scientific knowledge and various modern methods of teaching trade subjects.
2. Students should always be allowed to participate actively in class by interacting freely with the lecturer and their colleagues as this will improve their academic ability and performance in their trade subject.

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