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Effect of Inquiry-Based Teaching Technique on Student's Performance in Lathe-Machine Operation in Rivers State Technical Colleges

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Abstract
The study investigated the effect of Inquiry-Based Teaching Technique on student's performance in lathe-machine operation in Rivers State technical colleges. Two research questions guided the study. Quasi-experimental design, specifically, the non-randomized control group design involving two intact classes were used. The population was 62 National Technical Certificate (NTC) II metal-work trades students of two technical colleges in Rivers State. Lathe-machine Performance Test (LMPT) instrument were developed, validated and used for data collection. Reliability of the instrument was 0.82. Mean and standard deviation were used to analyze data collected in respect to the research questions. Findings of the study revealed that inquiry-based teaching technique has significant effect on student's performance in lathe-machine operation. This is evident in the mean performance of students taught with the inquiry-based teaching technique in chamfering operation x = 32.07, and grooving operation x = 31.85. While students taught with conventional teaching technique had a mean performance of x = 26.50 in chamfering operation and grooving operation x = 24.75. It implies that from the findings, that there is need for teachers of lathe-machine operation to employ the use of inquiry-based teaching technique in teaching as it proves more effective in improving student's performance in lathe-machine operation. It is recommended that state and federal ministries of education including professional bodies such as Nigerian Vocational Association (NVA), Science Teachers Association of Nigeria (STAN) and National Commission for Colleges of Education (NCCE) should organize workshops, seminars and conferences to train and encourage teachers on the use of this innovative technique among others.

Keywords: *Inquiry-Based, Teaching Technique, Student's Performance, Lathe-Machine Operation, Technical Colleges.*

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Background to the Study

For socio-economic development in developing countries like Nigeria, there is no substitute to vocational and technical education as the key driver. But unfortunately, while the west and Far East are making tremendous ways in the vocational technological advancement, Africa especially sub Saharan region is still living in the backwardness of under development occasionally stunted growth in vocational technology. Technical and Vocational education is the foundation of nation's wealth and development. It 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 for national development. According to Federal Government of Nigeria (2013), technical and vocational education is 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 national development. This specialized education offered in vocational institutions is saddled with training of middle level manpower, including Technical Colleges.

The courses offered at the technical colleges leads to the award of National Technical Certificate (NTC) and Advance National Technical Certificate (ANTC). The curriculum programmes of technical colleges are organised into related trades. These include; the computer trades, electrical/electronic trades, building trades, wood trades, and mechanical engineering trades. The trades in mechanical engineering include agricultural implement and equipment, mechanics work, air-conditioning and refrigeration mechanics works, welding and fabrication engineering craft practice, foundry craft practice, and lathe-machine operation.

Lathe-machine operation is one of the units that constitute the field of technical education. Lathe-machine operation comprises a blend of both theory and practical that leads to the production of goods and services by the use of tools, equipment and metal-work materials. Lathe-machine operation as a discipline which aimed at training students on the general properties and use of metal in order to help them in materials selection for particular job, train them on how to differentiate the techniques and approaches for a specific work and teach them how to utilize the safety rules and regulations in the workshops. In technical colleges, based on the objective of technical colleges, the National Technical Certificate (NTC) programme was designed to include a multi-dimensional and multi-disciplinary curriculum, which contains various programmes in which learners acquire various technical skills. One of the programmes is lathe-machine operation. As stipulated in the National Board for Technical Education (NBTE, 2003) minimum standards, the NTC curriculum in lathe-machine operation is designed in modules which include General Fitting, Milling, Shaping/Planning, Drilling And Grinding, General Metalwork l, General Metalwork ll, and Turning/Lathe Machining,

Lathe is considered as one of the oldest machine tools and is widely used in industries. The primary task of a lathe is to generate cylindrical workpieces. The process of machining a workpiece to the required shape and size by moving the cutting tool either parallel or perpendicular to the axis of rotation of the workpiece is known as turning. In this process, excess unwanted metal is removed. The machine tool useful in performing plain turning, taper turning, thread cutting, chamfering and knurling by adopting the above method is known as lathe. lathe is the fundamental of all machine tools. This is because the basic operation skills necessary for lathe operations apply to the operation of other tools, most of which are the modifications or adaptation of the lathe (Repp & McCarthy, 1984). Therefore, competence in manipulating the lathe is advantageous in carrying out other machine processes as well. Lathe operation is the act of shaping metal which is accomplished by removing material from a work piece or by pressing it into the desired shape. Hence lathe-machine operation include the following: facing which is the first practical exercise to be carried out by a beginner in lathe operations, Chamfering is the operation of bevelling the extreme end of the workpiece. The form tool used for taper turning may be used for this purpose. Chamfering is an essential operation after thread cutting so that the nut may pass freely on the threaded workpiece. Grooving is the process of cutting a narrow goove on the cylindrical surface of the workpiece. It is often done at end of a thread or adjacent to a shoulder to leave a small margin. The groove may be square, radial or bevelled in shape.

However, the skills in lathe-machine operation involve the application of scientific knowledge and practical skills. The goal of lathe-machine according to National Board for Technical Education NBTE (2003) is to produce skilled craftsmen with good knowledge of the working principles of metals, the techniques and safety practices involved in its maintenance. This goal can however be achieve only when lathe-machine operation is appropriately taught to learners. 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 do not use students to their full capacity, and for this reason, teachers should use appropriate teaching method that is student-centered as against teacher-centered.

Hence, teacher-centered teaching methods is 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 and Toby, 2000). They 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. (inquiry based teaching technique). This technique focuses on student's constructed learning as opposed to teacher transmit information. In learning through inquiry-based 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.

Inquiry-based teaching technique is one of the methods that involve active learner participation in learning process. According to Agboola and Oloyede (2007), it creates situations in which students take the role of a scientist. This is because ; students take the initiative to observe and question phenomena, pose explanation of what they see, device and conduct test to support or contradict their theories, analyze data, draw conclusion from experimental data, design and build models or any combination of these. The America National Scientific Foundation (2000) viewed inquiry-based learning as an approach to learning that involve the process of exploring the natural or material world, and that lead to asking questions, making discoveries, rigorously testing those discoveries in the search of new understanding. Inquiry-Based teaching technique is the activities associated with *discovery learning* in which students "discover" ideas instead of learning ideas from the explanations of a teacher or textbook. In-extension, inquiry-based teaching technique are more generally, as any activity in which students *explore situations* and *try to solve problems.* Erick and Reed (2002) asserted that inquiry teaching method is a project-oriented pedagogy strategy based on constructivist and social constructivist theories of learning. It is a method that elicits critical thinking skills. It is also a mental process that engages in cognitive process to understanding conflicting factors in a situation (Moon, 2001; Davis, 2003).

This mental engagement results in a persons' actively constructing knowledge about a situation in-order to develop a strategy to proceed within that situation. Inquiry-based teaching technique can be regarded as teacher designed situations whereby pupils are caused to employ procedures used by research scientist to recognize problems, ask questions and apply investigative procedures, which might be in form of laboratory or practical activities. This is with a view to providing consistent description, predictions, and explanations which are compatible with shared experience of the physical world and which are capable of eliciting critical thinking in students. According to Moore (2000) critical thinking requires a lot of thinking that is more of evaluation and synthesis than analysis or application. Thus inquiry helps students to develop higher order thinking skills by prompting students to relate new knowledge to their previous knowledge: to think in both abstract and concrete terms (Hmole and Ferrari, 2008). In inquiry based method, students learn not only concepts and principles but self-direction, responsibility and social communication.

Therefore, to maximize the utilization of inquiry-based teaching, important key elements or tools need to be adopted in inquiry class. One of such elements is the concept presentation. The concept explanation or principles underlying a given problem to be solved by teachers is to enable and prompt students reflection based on newly presented information (Moon, 2001) . Another inquiry tool is the wait time usage. This is waiting a few seconds after putting questions to students, thereby giving them time to think before answering the question. The effective usage of wait time by teachers promotes critical thinking in students. The bringing of real life experience by teachers to classroom learning activities also provides real situation and contextualize knowledge about new information the students are learning. Furthermore, collaborative learning which is

another inquiry tool in which students explore their understanding and misunderstanding together helps them to think about what they already know, what they need to know and how they would defend and present their own ideas in reaction to an instructional situation (William, 2004). All this skills are necessary tools that will assist the teachers in the teaching of the skills required of modern metalwork.

However, teachers play vital roles in adapting the inquiry process to the knowledge and ability level of their students. Warner and Myers (2006) pointed out that when using inquiry-based learning, teachers are responsible in starting the process, promoting students diagnoses, transitioning between small groups and classroom discussions, intervening to clear misconceptions or develop students understanding of content materials, modeling scientific procedures and attitude and utilizing students experiences to create new contents. Based on the objectives of the lesson and the abilities of the students, teachers must decide how much guidance they will provide. Regardless of the amount of assistance that teachers provide, the fundamental goal of inquiry is student's engagement during the learning process. The degree of the students' engagement or involvement during classes also depends on the inquiry teaching technique adopted. The inquiry teaching method has been found to be the most suitable for the teaching of science oriented courses by different scholars than the traditional teaching methods (Erick and Reed, 2002: Avarado and Herr, 2003: Glenda, Hebrank, Ybara and Kenk, 2005). From the chief examiners' report (NABTEB, 2008) showed that student's performance in metalwork in technical colleges have been dwindling in recent time and the situation calls for immediate attention in the technical colleges. In the last decade, technical colleges have recorded high failure rate of over 60% in National Business and Technical Examination Board (NABTEB). It is also on record (NABTEB, 2008) from the chief examiners reports that the metal work students who sat for the examination performed very poorly.

Furthermore, NABTEB examination conducted on metal work in May/June, 2004, recorded 30% failure in questions on sheet metal practice, 60% failure in forging and 65% failure in foundry (NABTEB, 2008). The National Business and Technical Education Board (NABTEB 2008) grade distribution from 2007-2008 May/June result revealed failure rate of 46% for the students who sat for the examination in metal work technology. The result also revealed unsatisfactory performance of the students in questions bordering on heat treatment and soldering with failure rate of 42.5 and 45.5% respectively. This is an indication of overall performance of candidates achieving below average during the examinations. It has been observed by NABTEB (2008) that the persistence poor performance emanate mainly from the inappropriate teaching methods adopted by the technical teachers. (Osagie 1997, Onuoha 1997) also stated that the poor performance of students in practical skills is traceable to the lack of inquiry-based teaching technique. Ideally, metal work technology should be taught using the same equipment the practitioners are using in the field that is because teaching metalwork technology involve the study of industrial technology. Metalwork therefore requires industrial facilities which include machinery or simulated industrial settings known as

workshop. However, what is prevailing now in Rivers State is that the lathe-workshop is not standardized, forcing the teacher to use the conventional teaching aids such as drawing, pictures, explanations. The conventional teaching aids cannot be used by the teacher to teach manipulative skills effectively. Ogwo and Oranu (2006) emphasize that unless the teachers stimulates student's interest in learning, student's achievement will be minimal. Hence it is essential that technical college teachers use teaching methods which ensures student's active involvement in learning to stimulate interest and improve performance.

Statement of the Problem

There is a general concern over the low performance of technical college graduates, most especially those of lathe-machine operation who cannot cope with the world of work. The goal of lathe-machine operation in technical colleges in Nigeria according to NBTE (2003) is to produce skilled craftsmen with good knowledge of the working principles of lathe-machine operation and the techniques and safety practices involved in lathe-machine operation. Better still, technical college graduates should have the opportunity of furthering their education in higher institutions. Contrary to achieving the above goal, majority of students have been completing the programme with very poor academic performance and inadequate skills which is incapable of earning them a living. In this regard, the employers of labour responded by non-demand of the graduates of technical colleges which has created unemployment in the country. Employers prefer to develop their own in-house craftsmen instead of employing the half baked graduates produced in technical colleges. This decline in students performance has been associated to a number of factors, among which is the strategy employed in impacting knowledge to the learners (Akinyele, 2000). The National Technical and Business Examination Board (NABTEB) (2008) chief examiner's report observed that the poor performance of the students in National Technical Certificate (NTC) examinations in recent years is partly due to the teaching methods employed by the teachers. Moreover, it has been discovered that the persistent poor academic performance of students in lathe-machine operation and other technical subjects is as a result of the inappropriate teaching methods adopted by the teachers (Aina, 2000).

This unsatisfactory situation could lead to breakdown in the economy, industrial, technological and educational growth of a nation since the main goal of technical education is to achieve self-reliance. The foregoing therefore underscores the need to explore other teaching approaches that would enhance and facilitate understanding and acquisition of knowledge of what is been taught in lathe-machine operation and possibly encourage higher enrolment of students in the trade. Therefore, the problem of this study is : how can inquiry-based teaching technique affects student's performance in lathe-machine operation as compared to those students taught using conventional teaching technique.

Purpose of the Study

The general purpose of the study is to determine the effect of inquiry-based teaching technique on student's performance in lathe-machine operation in Rivers State technical colleges. Specifically, the study will compare the effect of:

1. Inquiry-based teaching technique on student's performance in chamfering operation.
2. Inquiry-based teaching technique on student's performance in grooving operation.

Research Questions

The following research questions were formulated to guide the study:

1. What is the effect of Inquiry-based teaching technique on student's performance in chamfering operation.
2. What is the effect of Inquiry-based teaching technique on student's performance in grooving operation.

Methodology

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. The study was carried out in Rivers State. The state has more technical and oil servicing industries that can use these technical graduates. The study was conducted in two out of the four technical colleges in the State. The population for the study comprised 62 National Technical Certificate (NTC) II lathe-machine students in the two technical colleges in Rivers State selected for the study. The Lathe-Machine Performance Test (LMPT) 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 40 items questions from the topic. LMPT instrument has four options A-D , the students are expected to circle the correct answer. The lathe-machine performance test that was used in this study was developed by the researcher. The test consists of 40 objective questions base on technical college curriculum content for NTC ll students. Each item has four alternative options. Every correct answer has one point while an incorrect answer has 0 point. The development entails constructed test items on the following specific lathe-machine topics which was covered in the study: chamfering operation and grooving operation. The instrument was validated by three experts. The experts comprised two lecturers from industrial technical education department, Ignatius Ajuru University of Education, Rivers State and a lecturer of industrial technical section of vocational teacher education department, University of Nigeria, Nsukka. The instrument was pilot tested on 26 NTC ll lathe-machine students of Government Technical College Nsukka. The reliability co-efficient of lathe-machine Performance Test was determined using Kuder Richardson formula 20 (KR-20). This help to establish the internal consistency of the items. The students' scores were computed which yielded a reliability index of 0.82 .

Method of Data Collection

Data was collected through the use of pre-test post-test for each topic in each week. The test was administered to the students by the lathe-machine teachers in both groups.

Results

Research question 1

What is the effect of inquiry-based teaching technique on student's performance in chamfering Operation?

Table 1: Mean and Standard Deviation Performance Scores of Students Taught with the Inquiry-based Teaching Technique and Students Taught using the Conventional Teaching Technique in chamfering Operation

Group	School	N	Pre-test		Post-test		Mean-Gain
			$\bar{x}$	SD	$\bar{x}$	SD	
Experimental	GTC Ahoada	33	15.60	3.14	32.07	2.98	17.1
Control	GTC PH	29	16.50	3.40	26.50	3.43	10

Table 1 shows the pre-test and post-test mean score of students' performance in chamfering Operation for both treatment and control groups. Result shows that the students in the treatment group had a pre-test mean score of 15.60 with a standard deviation of 3.14 and a post-test mean score of 32.07 with a SD of 2.98. The difference between the pre-test and post-test mean for the experiment group was 17.1, while the control group had a pre-test mean score 16.50 with a standard deviation of 3.43 and a post-test mean score of 26.50 and SD of 3.43. This shows that the mean score for the treatment group is higher than the control group, indicating that those taught with the inquiry-based teaching technique performed better.

Research Question 2

What is the effect of inquiry-based teaching technique on student's performance in grooving Operation?

Table 2: Mean and Standard Deviation Performance Scores of Students Taught with Inquiry-based Teaching Technique and Students Taught Using the Conventional Teaching Technique in grooving Operation

Group	School	N	Pre-test		Post-test		Mean-Gain
			$\bar{x}$	SD	$\bar{x}$	SD	
Experimental	GTC Ahoada	33	14.21	3.49	31.85	4.48	17.64
Control	GTC PH	29	15.00	3.55	24.75	3.99	9.75

Table 2 shows the pre-test and post-test mean score of students' performance in grooving Operation for both treatment and control groups. Result shows that the students in the treatment 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 SD of 17.64. The difference between the pre-test and post-test mean for the experiment group was 17.64, while the control group had a pre-test mean score 15.00 with a standard deviation of 3.55 and a post-test mean score of 24.75 and SD of 3.99. This shows that the mean score for the treatment group is higher than the control group, indicating that those taught with the inquiry-based teaching technique performed better.

Discussions of Findings

The findings of the study are discussed in line with research questions.

Chamfering Operation

The study revealed that students taught using inquiry-based teaching technique performed better than their counterparts taught with conventional teaching technique. The trend of such performance by the treatment group is as a result of the real experience provided by the teacher which helped the students to have good mastery of inquiry-based lessons without much difficulty than the conventional lessons, it could be as a result of excitement over the new teaching technique and handling of tools, equipment and machines. The bridging of gap from abstract knowledge to actual performance provided by the inquiry-based technique made the students in this group to perform better than those in the conventional group. This do not come as a surprise, because it is in line with the assertion of Repp and McCarthy (1982), that chamfering Operation with its few steps and less complicated steps is one of the simplest operations that a beginner can perform on the Lathe Machine with minimal effort. However, it would be noticed that a better performance is achieved with the treatment group due to the effect of the inquiry-based teaching guide. The inquiry-based teaching guide therefore, with its emphasis on the following detailed instruction on performing an operation (Ogwo and Oranu, 2006), had a positive influence on the performance of students in chamfering operation.

Grooving Operation

Table 2 indicated the mean performance of the treatment group which is higher than that of the control group. The difficulty level of carrying out a grooving operation is not high due to the few steps involved in the operation. However, the positive effect of inquiry-based teaching guide is very clear on the treatment group. This finding is in agreement with the theoretical assertion of Baird (1976) that the less the operational steps involved in carrying out a practical work, the easier and better the performance of the trainee in the particular exercise.

Recommendations

Based on the findings of this study, the following recommendations are made: In line with the responsibility vested on practicing technical teachers in technical colleges for guiding students to improve their performance in metal-work technology, technical teachers should subject this newly developed technique to further try-outs in order to

serve as means of further assuring its performance usefulness, and eventual adoption for continual use in teaching performance skills in lathe-machine operation. Using the inquiry-based teaching technique will yield a better student performance in lathe-machine operation.

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