EFFECT OF IMPROVISED FURNACE ON STUDENTS' ACHIEVEMENT AND INTEREST IN GENERAL METALWORK IN TECHNICAL COLLEGES IN KATSINA STATE

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Abstract

This study was to determine the effect of improvised furnace on students' achievement and interest in General metalwork in Technical Colleges in Katsina State using four topics in General Metalwork that required the use of furnace namely; heat treatment, soldering, forging and foundry. The study adopted quasi-experimental design. It involved the use of experimental group, control group, pre-test – post test design. The population of 160 students from three technical colleges in Katsina state was used for the study. The instrument for data collection was made up of General Metalwork Achievement Test (GMWAT) developed by the researcher. The achievement test consisted of 40-multiple choice items with four options of A-D. The test items were identified and selected from the content of NABTEB syllabus on General Metalwork. Test re-test method was used to establish the reliability of the instrument; the tests yielded 0.86 and 0.70 for the achievement test and interest questionnaire respectively. Three lecturers and one industrial expert in metalwork technology were involved in both face and content validity of the improvised furnace and 40 multiple-choice test items. The results obtained from the test scores were compiled and analyzed using statistical tools such as; percentage, mean, and Analysis of Variance (ANOVA) and Analysis of Covariance (ANCOVA) in answering two research questions and testing two hypotheses at 0.05 level of significance. The teacher constructed furnace had positive effects on students' performance. The difference in achievement between those taught using improvised furnace and those taught using conventional teaching aids was found to be significant at 0.05 levels of significance. Also there was significant difference in interest mean scores. Based on the findings of the study, the researcher recommended that government, technical college principals and the different agencies should provide fund to procure the materials and component for designing and constructing furnace by the teacher for teaching heat treatment in technical colleges in Katsina State. Also, constant power supply, generators, accumulators, soldering iron, solder, anvil, steel vessel, pipes and electric blower should be provided and distributed by the ministry of education to the technical colleges for construction of furnace for effective teaching of soldering and forging in Katsina State.

Introduction

Technical Colleges are regarded as the principal vocational institutions in Nigeria; they give full vocational training to prepare students for entry into various occupations. Technical colleges give technical education that leads to the acquisition of skill and techniques in chosen occupation or profession to enable an individual earn a living which is a major focus of vocational and technical colleges. Technical education is described as result oriented. It bring about technological advancement and aims to provide manpower for employment and provide further training for those already qualified, so that they can keep up with modern working methods (Uwaifo, 2009).

Technical colleges offered courses in various trades such as block laying, bricks laying and concreting, motor vehicle mechanics (MVM), radio and television, electrical electronics, carpentry and joinery and welding and fabrication among others. General Metalwork as a course is been offered among Engineering trades such as MVM, Mechanical Engineering craft practice, Welding and fabrication craft practiced. General Metalwork (GMW) consists of topics and sub-topics relevant to these trades such as: heat treatment, soldering, foundry and forging. These aspects of the courses can be successfully delivered using furnace.

Furnace is a device used for heating and melting metals for industrial use (Yusuf, 2013). Examples of furnace are blast furnace, electric furnace, basic oxygen furnace and open hearth furnace. Their heating sources could be coal, charcoal, gas or electricity. It therefore follows that without a functional furnace, and it will be difficult for the teacher to develop the students' skills in metal related work. Furnaces may be obtained in capacities ranging from small ones with a chamber measuring about 150 mm wide x 100 mm high x 200 mm deep, suitable for small tools, to huge structures of about 10 metres long for heat-treating large bars and forgings. Studies conducted by several authors such as: Ogundu, (2015), Onaga, (2014), Mbata, (2010) revealed that in most technical colleges particularly in Katsina state this important teaching aids has not been available for instruction. Therefore, teaching heat treatment, soldering, foundry and forging in a workshop without functional furnace is a challenge to the teacher. The teacher's positive response to the challenge is shown by the extent of improvisation made towards effective instruction. One of such improvisation by the teacher is the improvised furnace. The use of this improvised furnace may lead to improved achievement of students in General Metalwork.

Achievement can be described as a measure of the ability of students to gain or reach a set goal through effort and skill. According to Ogbu, (2016) achievement in education specifically refers to students' success in learning specified curriculum content. Ogbu, explained that a paper and pencil test, called achievement test, set specifically to cover the taught curriculum content, is usually involved. Achievement test is concerned with measuring what a candidate has learned (Olatoye&Aderogba, 2011). In other words, it measures amount of knowledge acquired after learning process. The test measures the gains of educational programmes; what a student has acquired from the process of learning. When achievement is below expectation, it is referred to as poor achievement or under-achievement, which in most cases is usually a product of inadequate teaching methods and students' lack of interest in learning.

Interest is a persisting tendency to pay attention and enjoy some activity or content. Adeyemo, (2005) defined interest as emotionally oriented behavioral trait which determines a student's vim and vigor in tackling educational programmes or other activities. Chukwu, (2013) opined that, interest is an activity or object that can be sustained depending on what an individual whose interest is engaged stand to gain or lose by so doing. Interest is an important variable in learning Elementary Structural Design because when students are interested in an activity, they are likely to achieve highly in that activity and learned facts retained. Hence, learning is strictly an individualized act and process (Nworgu, 2015). It is the learners who must be interested and engaged for learning to occur. The learner is the one who must make the commitment to learn for learning to be meaningful (authentic). In other words, the gears of teaching must engage the cogs of learning (Oranu, 2016). Lack of interest in Elementary Structural Design class therefore inhabits learning and retention.

The use of this instructional aid by the teacher may likely affect the student's achievement and interest in areas of skill development and passing of their examination. According to Ndukwe (2016), at the end of the approved period of study, Technical College students take various examinations, particularly, the National Technical Certificate Examination. National Business and Technical Examination Board (NABTEB 2017) reported that there is a decline in student's achievement, retention and interest in General Metalwork. The document showed that students' achievement and interest in General Metalwork in Technical Colleges have been dwindling in recent time and the situation calls for immediate attention in the Technical Colleges. FME (2017) maintain that Technical Colleges are expected to produce craftsmen. In the last decade, Technical Colleges have recorded high failure rate of over 60 per cent in National Business and Technical Examination Board (NABTEB). It is also on record (NABTEB, 2017) from the Chief examiners reports that the General Metalwork students who sat for the examination performed very poorly.

Furthermore, NABTEB examination conducted on General Metalwork in May/June, 2017 recorded 30 per cent failure in questions on sheet metal practice, 60 per cent failure in forging and 65 per cent failure in foundry (NABTEB, 2016) The National Business and Technical Education Board (NABTEB, 2016) grade distribution from 2015-2016 May/June result revealed failure of 46 per cent for the students who sat for the examination in General Metalwork. The results also revealed unsatisfactory achievement and retention of the students in questions bordering on heat treatment and soldering with failure rate of 42.5 and 45.5 per cent respectively. This is an indication of overall achievement, retention and interest of candidates achieving below average during the examinations. It has been observed by NABTEB (2016) that the persistent poor achievement, retention and interest emanates mainly from the inappropriate teaching methods and instructional aids adopted by technical teachers. Moreover, NABTEB (2017) added that only 2 percent of the total students that were enrolled for the examination in General Metalwork attempted question on use of furnaces which they performed poorly.

Ideally, General Metalwork should be taught using the same equipment the practitioners are using in the field, because teaching General Metalwork involves the study of industrial technology. It therefore requires industrial facilities that include machinery or simulated industrial setting known as workshop. This workshop must have amongst other equipment functional furnaces which are not available for teaching in technical colleges in Katsina state as such teachers use conventional teaching aids such as drawing, pictures of furnace. Hence, the researcher seeks to investigate the effects of improvised furnace on students' achievement and interest in General Metalwork in Technical Colleges in Katsina state, Nigeria.

Statement of the Problem

In technical colleges, students are educated theoretically and practically to make them employable in commerce and industry or any type of enterprises that requires the use of tools and machinery for the operation, production, preservation and distribution of goods and services (Joshua, 2012). For effective practical, instructional aids are made available for learning of the students such as furnaces where necessary. But lack of functional furnace may have contributed to the students' poor exposure to practical classes which is a major problem in Katsina State Technical colleges. There is lack of functional furnace in Katsina State Technical Colleges. Even where furnaces are available, the high voltage electricity needed to power it is not reliable. Lack of functional furnace has possibly led to poor achievement, retention and interest of the students in external examination such as National Business and Technical

Examination. Candidates performed poorly because, according to the report from NABTEB Exam Ethics project (2017), students were unable to attempt questions on blacksmith shop equipment and other equipment for General Metalwork which contributed to poor achievement of students in General Metalwork. It therefore become necessary to find out what effect improvised furnace will have on students' achievement and interest in General Metalwork in Technical Colleges in Katsina state, Nigeria.

Aim and Objectives of the Study

Specifically, the objectives of the study determined:

(i) Effect of improvised furnace on students' achievement in General Metalwork in Technical Colleges in Katsina state, Nigeria.

(ii) Effect of improvised furnace on student's interest in General Metalwork in Technical Colleges in Katsina state, Nigeria.

Research Questions

The following research questions guided this study:

(i) What is the effect of improvised furnace on student's achievement in General Metalwork in Katsina State?

(ii) What is the effect of improvised furnace on student's interest in General Metalwork in Katsina State?

Research Hypotheses

The following null hypotheses were formulated and will be tested at 0.05 levels of significance:

HO_1: There is no significant difference in the mean achievement of Technical College students taught General Metalwork using improvised furnace and those taught with conventional teaching aids in Katsina State.

HO_2: There is no significant difference in the mean interest of Technical College students taught General Metalwork using improvised furnace and those taught with conventional teaching aids in Katsina State.

Methodology

This study adopted quasi-experimental research design. Quasi- experimental design involved the use of pre-test and post-test design with experimental and control groups. This design implies that intact classes was used for the study and that this experimental design helps in controlling almost all the threats to internal validity of an experiment especially in education. This design was necessary because it will not be possible for the researcher to randomly sample the students and assign them to groups without disrupting the normal academic programme of the Technical Colleges involved in the study.

The population of the study comprises 160 final year students of the three Colleges offering General Metalwork. Final year students were used because topics that required the use of furnace are in Technical College III scheme of work.

The population of 160 students is manageable, hence was used for the study. However, selection of the Technical Colleges into the experimental and control groups was carried out using the simple random sampling techniques. Random sampling was also used to select the students for Experimental and Control. In each of the schools, students were grouped into Experimental and Control group which is shown in the table below.

The improvised furnace was constructed following these steps:

(i) The improvised furnace is an improvised teaching material that is made up of sheet metal, folded and twisted sheet metal, blower, 1.5mm plate, angle iron, socket, plat bar and screw. The body is made up of steel plate with sheet twisted round; the steel is hardened with carbon molybdenum of ratio 0.25 percent, 0.70 percent respectively. It is lined with welded angle iron ½ inches and is fired with charcoal using an electric blower connected to a low voltage generator.

(ii) The National Business and Technical Examination Board Syllabus in General Metalwork was carefully analyzed to determine which aspects of the syllabus require the use of furnace in teaching. After the content areas have been identified, the specific tasks requiring the furnace were identified such as heat treatment, soldering, forging and foundry.

The instrument for data collection was General Metalwork Achievement Test (GMWAT) developed by the researcher. 40 test items was used which cover four modules as follows: heat treatment, soldering, forging and foundry as contained in the National Business and Technical Examination Board (NABTEB) syllabus, see appendices B and C for details.

The researcher, in developing GMWAT, prepared a table of specification/test blue print to guide the development of the test items. The construction of the test blue print was guided by the Technical College (NABTEB) syllabus for final year students. The content determined the number of test items on a particular topic, objectives and number of tasks stipulated in the objectives of the syllabus. The test blue print was sub-divided into content dimension contained in the units taught in the study while the ability process dimension were sub-divided into knowledge, comprehension and application of knowledge. The number of test items in each of the syllabus section reflected the relative importance of the different activities and remarks highlighted in the objectives. Summarily, a total of 40 test items were developed and selected to reflect the specification in the blue print.

The GMWAT consists of items with four optional questions A-D as possible answer to each question raised. The students were required to indicate the correct answer by ticking the right answer corresponding to the questions. Only one option is the correct answer from the option A-D. The test was in two sections in which the students are expected to respond to, these include: section A design to obtain information about student school, class and gender. Section B reveals information on the student cognitive level based on the learned contents. The student were given 2.5marks for each of the correctly answered question but was later converted to percentage.

The researcher was subjected the test items for the study to both face and content validation. The face validation was done to determine if the questions are suitable enough for the students and where anyone question is not suitable and noted by the validators, it was replaced. The content validation was done with the use of item analysis to determine if the content of the subject area is adequately covered to determine the cognitive strength of the student and corrections was made where necessary. The test item was validated by a total of three lecturers who teach Metalwork Technology in tertiary institutions; two from Federal University of Technology Minna, one industrial expert from Dana Steel Rolling Mill Katsina. They checked the content of the instrument and lesson plan against NABTEB syllabus in General Metalwork and they observed the test instrument if actually complying with the content of the study.

The test re- test method was used to establish the reliability (the measure of stability) of the instrument items. The GMWAT test item was administered on 24 final year students in General Metalwork in Technical College Dawakin Tofa Kano State. The school has two arms (A&B). Class A was used as experimental group and was taught with the improvised furnace while B was used as control group and teaching aids such as drawings and pictures were used as conventional teaching aids. At the end of the teaching exercise, the objective test was administered and the scores recorded and computed. The second test was administered after three weeks of the administration of the first test. KR 21 was used in analyzing the data and the tests yielded reliability index of 0.86 which shows that the test instrument is suitable the research. The reliability coefficient of interest questionnaire was 0.70 which shows that the Interest Questionnaire was suitable for this study.

The conduct of the study took place during the normal school lesson periods, following the normal timetable in each school. The regular teachers in each school taught their classes. Prior to the commencement of the lesson, the test items was administered as pre-test to both the treatment and control groups on the first day.

The teaching started from the second day. During the lessons the teachers taught the experimental group using furnace, adhering strictly to the lesson procedures prepared by the researcher. The control group was taught the same General Metalwork topics using conventional teaching aids. As the lessons were going on, the researcher used the General Metalwork teachers as research assistants to assist in supervising the use of improvised furnace. At the end of teaching each topic, the post-test was administered to the two groups and the scores were recorded. The field work lasted for eight weeks from when the furnace was constructed.

This study has two research questions and two hypotheses. The research questions were answered by comparing the mean difference between the pretest and posttest of each group of experimental and control groups. The null hypotheses were tested using inferential statistics. The pretest was tested using ANOVA and when it was significant, ANCOVA was used to analyze the hypotheses at 0.05 level of significance using Statistical Package for Social Sciences (SPSS) version 20.

Results and Discussion

ANOVA analysis of pretest scores of the three groups was carried out and ANCOVA was used to analyze the posttest scores in two hypotheses

$HO_{1:}$ There is no significant difference in the mean achievement scores of Technical College students taught General Metalwork using improvised furnace and those taught with conventional teaching aids in Katsina State.

Table 1: Summary of Analysis of Covariance (ANCOVA) of Mean Achievement Scores of Experimental Group and the Control Group

Source	Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	13148.863[a]	2	6574.431	83.474	.000
Intercept	44171.765	1	44171.765	560.840	.000
Covariate (Pretest)	723.750	1	723.750	9.189	.003
Main Effect (Treatment)	10515.766	1	10515.766	133.516	.000
Error	24966.937	157	78.760		
Total	1287116.000	160			
Corrected Total	38115.800	159			

*: Significant at 0.05 levels

Table 1 showed the ANCOVA result of the comparison of posttest scores of students in Experimental Group and the Control Group. An examination of the Table shows ($F_{(1, 159)} = 133.516$, $p < 0.05$). On the basis of this, hypothesis one was rejected. Therefore, there was significant difference in the achievement of students taught General Metalwork using Improvised Furnace and those taught using conventional teaching aids. This implies that Improvised Furnace enhances academic achievement of students better that conventional teaching aids.

$HO_{2:}$ There is no significant difference in the mean interest scores of Technical College students taught General Metalwork using improvised furnace and those taught with conventional teaching aids in Katsina State.

Table 2: Summary of Analysis of Covariance (ANCOVA) of Mean Interest Scores of Experimental Group and the Control Group

Source	Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	611.130[a]	2	305.565	15.737	.000
Intercept	14977.980	1	14977.980	771.403	.000
Covariate (Pretest)	8.876	1	8.876	.457	.499
Main Effect (Treatment)	249.441	1	249.441	12.847	.000
Error	6155.042	157	19.417		
Total	2506895.000	160			
Corrected Total	6766.172	159			

*: Significant at 0.05 levels

Table 2 showed the ANCOVA result of the comparison of posttest scores of students in Experimental Group and the Control Group. An examination of the Table shows ($F_{(1, 159)} = 12.847$, $p < 0.05$). On the basis of this, hypothesis three was rejected. Therefore, there was significant difference in the mean interest scores of students taught General

Metalwork using Improvised Furnace and those taught using conventional teaching aids. This implies that Improvised Furnace increases students' interest in General Metalwork.

Discussion of Results

The finding above was supported by Ogundu (2015) who found out that improvised furnace had positive effects on students' performance in heat treatment. In the same vein, it corroborates the finding of Ogundu (2012) who said that inadequate supply of equipment affected effective workshop operations at a moderate extent; though the groups' (teacher's and students') perspectives on the inadequate supply of equipment differed significantly and that inadequate supply of equipment affect the students' academic achievement. The finding also corroborates the finding of Mandor (2014) who observed that effects of constructivist based circuits on acquisition of vocational and science process skills among junior secondary schools are as follows: (i) the involvement in the classroom caused the students to acquire science process skills easily, making understanding of science concept easier and learning become less difficult. (ii) The learning, understanding of vocational and science concepts did not depend on the type of schools or gender but the total involvement of the students in the classroom. Also that students taught with circuit had higher achievement and retain the concept better than students taught without circuits.

The finding above is supported by Okafor (2010) carried out a study on administrative and teaching strategies for increasing the interest of Senior Secondary School students in technical drawing and discovered administrative strategies needed to increase students' interest in Technical Drawing include among others: a better teaching technique for Technical Drawing teachers by the subject head; retention of good and experienced Technical Drawing teachers in schools by preventing frequent transfer by the ministry and the use of appropriate evaluation methods.

Conclusion

From the findings of this study, it can be concluded that Improvised Furnace enhances academic achievement of students better that conventional teaching aids and their interest was improved towards General Metalwork. The study has provided an additional literature to the existing body of knowledge in the use of Improvised furnace. This provides an empirical evidence for the use of Improvised Furnace for teaching technical colleges students in Nigeria. This study has strong implication for teaching and learning processes in Nigeria technical colleges as made evident in the findings of the study.

Recommendations

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

(i) Teachers should endeavour to adapt and utilize Improvised furnace for teaching in technical colleges.

(ii) Government, technical college principals and the different agencies should provide fund to procure the materials and component for designing and constructing furnace by the teacher for teaching heat treatment in technical colleges in Katsina State.

(iii) Also constant power supply, generators, accumulators, soldering iron, solder, anvil, steel vessel, sheet metal and electric blower should be provided and distributed by the ministry of education to the technical colleges for construction of furnace for effective teaching of soldering and forging in Katsina State.

(iv) The industries, government, non-governmental agencies and private enterprises and communities should provide components, consumable materials necessary for teaching foundry and supply the materials directly to the individual technical colleges in Katsina State.

(v) Government and curriculum developers should embrace student-centred learning approach in teaching and learning process so that instructional package like Improvised furnace will be aware by various stakeholders in education.

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