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# Effect Of Problem-Based Teaching Technique On Students' Performance In Refrigeration Craft In Technical Colleges In Rivers State

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**ABSTRACT**
The study investigated the effect of problem-based teaching technique on students' performance in refrigeration craft in technical colleges in Rivers State. Two research question and hypotheses guided the study. Quasi-experimental design, specifically, the non-randomized control group design involving two intact classes were used. The population was 60 National Technical Certificate (NTC) mechanical craft practice students of two technical colleges in Rivers State. Refrigeration Performance Test (RPT) instrument were developed, validated and used for data collection. Reliability of the instrument was 0.74. 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 problem-based teaching technique has significant effect on student's performance in Refrigeration repairs. This is evident in the mean performance of students taught with the problem-based teaching technique in Refrigeration repairs x = 35.28. While students taught with conventional teaching technique had a mean performance of x = 25.54. It is recommended that state and federal ministries of education including professional bodies should organize workshops, seminars and conferences to train and encourage teachers on the use of this innovative technique among others.
**Keywords**: Problem-Based, Teaching Technique, Student's Performance, Refrigeration, and Technical Colleges.

## INTRODUCTION

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. According to Federal Government of Nigeria (2004), 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. This specialized education offered in technical institutions is saddled with training of middle level manpower, including Technical Colleges.

Technical Colleges in Nigeria are established to produce craftsmen at the craft level and master craftsmen at the advance craft level (Federal Ministry of Education, 2004). 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 according to Federal Government of Nigeria (2004) are grouped into related trades. These include; the Computer trades, Electrical/Electronic trades, Building trades, Wood trades, and Mechanical trades. Mechanical trade is a general name used in describing trades that have direct bearing with metal welding/forming and servicing/repairs of machines or machine related equipment and appliances. The trades in this group include agricultural implement and equipment, Mechanics work, Auto-electrical work, Auto-mechanics works, Auto-body building, Auto parts merchandising, Metal Technology , Mechanical

Engineering craft practice, Welding and Fabrication engineering craft practice, Foundry craft practice, Instruments mechanics work and Refrigeration Mechanics Works.

Refrigeration mechanic works is one of the units that constitute the field of technical education. The general Objective include: To produce skilled craftsmen with good knowledge of the working principles of refrigeration system, the techniques and safety practices involved in its maintenance.

However, the skills in refrigeration involve the application of scientific knowledge and practical skills. The goal of refrigeration mechanic work according to National Board for Technical Education NBTE (2000) is to Understand the working Principles of a Cold Store and be able to apply them in (i) interpreting the design layout of a cold store; and (ii) installing and commissioning of cold store to given specifications and (iii) Maintain a cold store in good working condition. In extension, the objectives of installation and insulation of pipes and ducts is (i) to Interpret installation drawings of pipes and ducts for refrigeration (ii) select appropriate tools and equipment (iii) identify various types of insulating materials and explain the purpose of insulation to pipes and ducts in refrigeration system (iv) State the properties of good insulating materials (v) Select and describe tools and equipment used for pipe and duct installation and list necessary materials from specifications thereafter carry out simple installation from same specifications (NBTE 2000).

These goals, can however be achieved only when refrigeration mechanic work 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.

Problem-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. Erick and Reed (2002) asserted that problem 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 understand 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. Problem-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 problem 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 problem based method, students learn not only concepts and principles but self-direction, responsibility and social communication.

Therefore, to maximize the utilization of problem-based teaching, important key elements or tools need to be adopted in problem 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 problem 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 problem 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 problem process to the knowledge and ability level of their students. Warner and Myers (2006), pointed out that when using problem-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 problem is student's engagement during the learning process. The degree of the students' engagement or involvement during classes also depends on the problem teaching technique adopted. The problem 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).

The chief examiners' report (NABTEB, 2008) show that students' performance in refrigeration mechanic works in technical colleges has 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). From record (NABTEB, 2008) the chief examiners reports that the refrigeration students who sat for the examination performed very poorly.

Furthermore, NABTEB examination conducted on refrigeration mechanic works 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 refrigeration mechanic work. 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 problem-based teaching technique. Ideally, refrigeration mechanic 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. Refrigeration mechanic works 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 refrigeration mechanic 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.

Performance could be perceived as a method of expressing students' scholastic standing. It could be grades for subjects, or trade courses as symbolized by a score or mark in an achievement test, expressed in numerical scale (Lavin, 2009). According to Collins, Kenway, and Mcleod (2000), performance is quantified by measure of the students' academic standing in relation to those of other students of their age. Atherson (2003) contended that student's performance is dependent upon several factors among which are instructional methods, learning environment and the learner. Achievement in academics can be in cognitive or psychomotor domain. The cognitive domain according to Okoro (2006) involves knowledge and the development of intellectual skills. These include the recall or recognition of specific facts, procedural patterns and concepts that serve in the development of intellectual abilities and skills.

Thus learning in this domain could be in form of identification of metals or recall the safety rules to be observed in the workshop to more intellectual skills such as determining and selecting the best or the combination of appropriate techniques in metalwork project. Teachers with good teaching methods challenge students to work at higher intellectual level. On the other hand, psychomotor domain is concerned with the development of muscular skills coordination. Objectives from this

domain emphasize motor skills, manipulation of materials or subjects or an act which requires neuromuscular coordination (Knoll, 2004). This could be a performance task as simple as using a screwdriver to fasten a screw or as using series of tools and instruments in overhauling a machine. In other to sustain gains in cognitive and psychomotor achievement, teaching method must be capable of bridging the achievement gap between gender.

**Statement of the Problem**

There is a general concern over the low performance of technical college graduates, most especially those of refrigeration mechanic works who cannot cope with the world of work. The goal of refrigeration in technical colleges in Nigeria according to NBTE (2008) is to produce skilled craftsmen with good knowledge of the working principles of refrigeration and the techniques and safety practices involved in refrigeration maintenance. Technical college graduates have prospects of either being employed in the industries or set-up their own refrigeration workshops and become self-employed. 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 not capable of earning them a living. 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 Business and Technical Examination Board (NABTEB) (2008) 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.

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 refrigeration mechanic works and possibly encourage higher enrolment of students in the trade. Therefore, the problem of this study is : how can problem-based teaching technique affects the performance in refrigeration mechanic works students 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 problem-based teaching technique on the performance in refrigeration mechanic works students in Rivers State technical colleges. Specifically, the study will compare the effect of:

1. Problem-based teaching technique on student's performance in installation of pipes and ducts for refrigeration system.
2. Problem-based teaching technique on student's performance in cold store installation and maintenance.

**Research Questions**

The following research questions were formulated to guide the study:

1. What are the effect of problem-based teaching technique on student's performance in installation of pipes and ducts for refrigeration system?
2. What are the effect of problem-based teaching technique on student's performance in cold store installation and maintenance?

**Hypotheses**

Two hypotheses were formulated for the study and were tested at 0.05% level of significance:

1. There is no significant difference in the effect of problem-based teaching technique on student's performance in installation of pipes and ducts for refrigeration system.
2. There is no significant difference in the effect of problem-based teaching technique on student's performance in cold store installation and maintenance.

## MATERIALS AND METHODS

This study adopted quasi-experimental design. 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 Problem technique on students' performance in refrigeration mechanic works. The experimental design of the study is symbolically represented as follows: E =Experimental group, C= Control group, $O_1$=Pre-test, $O_2$ =Post-test, − Treatment and ≠ No Treatment. The study was carried out in Rivers State. Rivers State is one of the States in South-South Geopolitical Zone. It has boundaries 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 that can use of these technical graduates. The technical colleges in the state have more refrigeration students and teachers who can form the population to be used in the research. The population for the study comprised 60 National Technical Certificate (NTC) II refrigeration mechanic works students in the two technical colleges in Rivers State selected for the study (Records Unit, Rivers State Post Primary School Board, 2014). The choice of National Technical Certificate (NTC) II students is based on the selected topics for the study which falls within National Technical Certificate (NTC) II refrigeration curriculum.

**Sample and Sampling Technique**

The study adopted purposive sampling technique. This is because out of the four functional technical colleges in the state only two of them offer refrigeration mechanic works with laboratory and therefore was used for the study. The technical colleges are government technical college Port-Harcourt and government technical college Ahoada. The sample size for the study was all the 60 year II refrigeration students in the two technical colleges offering refrigeration. These comprised 46 males and 14 females' students hence the entire population of the study was used it is of manageable size.

**Instrument for Data Collection**

One instrument was developed for this study. The refrigeration Performance Test (RPT) which has two parts according to the topics 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. The development entails constructed test items on the following specific refrigeration topics which was covered in the study: installation of pipes and ducts for refrigeration system and cold store installation and maintenance. The relative weights of emphasis on the test items are installation of pipes 25% and cold store installation and maintenance 25%. The table of specification was developed based on the topics outlined.

**Validation of the Instrument**

An initial pool of 40 items was drawn up based on the table of specifications or test blue print and sent to three experts for face-validation. The experts comprised two refrigeration lecturers of 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 experts were requested to ascertain the suitability of the test items for the study. The experts focused on adequacy of content, logical sequence and suitability of the technical term used. The items was corrected based on the validates' criticisms and suggestion before testing. The reliability co-efficient of Refrigeration Performance Test was determined using Kuder Richardson formula 20 (KR-20). The students' scores were computed which yielded a reliability index of 0.74. 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 refrigeration teachers in both groups. The data for the two research questions of this study was analyzed using mean and standard deviation. The hypotheses were tested at 0.05% level of significance using analysis of covariance (ANCOVA). 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 value of calculated f-ratio being less than the table f-ratio value, the null hypotheses was 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**

**Research Questions 1:** *What are the effects of problem-based teaching technique on student's performance in installation of pipes and ducts for refrigeration system?*

**Table 1: Mean and Standard Deviation Scores of Students Taught with Problem-based Teaching Technique and Students Taught Using the Conventional Teaching Technique in installation of pipes and ducts for refrigeration system.**

| **Group** | **School** | **N** | **Pre-test** | | **Post-test** | | **Mean-Gain** |
|---|---|---|---|---|---|---|---|
| | | | $\overline{x}$ | **SD** | $\overline{x}$ | **SD** | |
| Experimental | GTC Ahoada | 30 | 16.14 | 2.63 | 35.10 | 2.67 | 18.96 |
| Control | GTC PH | 30 | 15.79 | 2.28 | 25.79 | 2.28 | 10 |

Table 1 shows the pre-test and post-test mean score of students' performance in installation of pipes and ducts for refrigeration system for both treatment and control groups. Result shows that the students in the treatment group had a pre-test mean score of 16.14 with a standard deviation of 2.63 and a post-test mean score of 35.10 with a SD of 2.67. The difference between the pre-test and post-test mean for the experiment group was 18.96, while the control group had a pre-test mean score 15.79 with a standard deviation of 2.28 and a post-test mean score of 25.79 and SD of 2.28. This shows that the mean score for the treatment group is higher than the control group, indicating that those taught with the problem-based teaching technique performed better.

**Research Questions 2:** *What are the effect of problem-based teaching technique on student's performance in cold store installation and maintenance?*

**Table 2: Mean and Standard Deviation Scores of Students Taught with Problem-based Teaching Technique and Students Taught Using the Conventional Technique in cold store installation and maintenance**

| Group | School | N | Pre-test | | Post-test | | Mean-Gain |
|---|---|---|---|---|---|---|---|
| | | | $\overline{x}$ | SD | $\overline{x}$ | SD | |
| Experimental | GTC Ahoada | 30 | 14.14 | 2.73 | 35.28 | 2.89 | 21.14 |
| Control | GTC PH | 30 | 15.54 | 2.26 | 25.54 | 2.46 | 10 |

Table 2 shows the pre-test and post-test mean score of students' performance in cold store installation and maintenance for both treatment and control groups. Result shows that the students in the treatment group had a pre-test mean score of 14.14 with a standard deviation of 2.73 and a post-test mean score of 35.28 with a SD of 2.89. The difference between the pre-test and post-test mean for the experiment group was 21.14, while the control group had a pre-test mean score 15.54 with a standard deviation of 2.26 and a post-test mean score of 25.54 and SD of 2.46. This shows that the mean score for the treatment group is higher than the control group, indicating that those taught with the problem-based teaching technique performed better.

**Hypotheses**

**Hypothesis 1:** There is no significant difference in the effect of problem-based teaching technique on student's performance in installation of pipes and ducts for refrigeration system.

**Table 3: The analysis of covariance (ANCOVA) of Difference Between Students Taught with Problem-based Teaching Technique and those Taught with Conventional Teaching Technique in installation of pipes and ducts for refrigeration system**

| Source | Type III Sum of Squares | Df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Corrected Model | 1183.871[a] | 2 | 591.936 | 115.924 | .000 |
| Intercept | 637.069 | 1 | 637.069 | 124.763 | .000 |
| PRE-TEST_C | 62.431 | 1 | 62.431 | 12.226 | .001 |
| GROUP | 1078.067 | 1 | 1078.067 | 211.127 | .000 |
| Error | 250.206 | 49 | 5.106 | | |
| Total | 50788.000 | 60 | | | |
| Corrected Total | 1434.077 | 51 | | | |

**Significance at $\alpha \leq 0.05$**

The analysis of covariance of students performance scores presented in Table 3 showed that f-calculated for teaching methods in the two groups is 211.127 at 0.000 significant level. It therefore implies that the null hypothesis is rejected. Thus, there is a significant difference in the mean scores of students taught with problem-based teaching technique and conventional teaching technique respectively**.**

**Hypothesis 2:** There is no significant difference in the effect of problem-based teaching technique on student's performance in cold store installation and maintenance.

**Table 4: The ANCOVA of Difference Between Students Taught with Problem-based Teaching Technique and those Taught with Conventional Teaching Technique in cold store installation and maintenance.**

| Source | Type III Sum of Squares | Df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Corrected Model | 1322.769[a] | 2 | 661.385 | 120.072 | .000 |
| Intercept | 765.257 | 1 | 765.257 | 138.929 | .000 |
| PRE-TEST_D | 95.769 | 1 | 95.769 | 17.386 | .000 |
| GROUP | 1322.710 | 1 | 1322.710 | 240.133 | .000 |
| Error | 269.904 | 49 | 5.508 | | |
| Total | 50885.000 | 60 | | | |
| Corrected Total | 1592.673 | 51 | | | |

## DISCUSSION OF THE FINDINGS

The study revealed that Problem-based teaching technique would improve students' performance in installation of pipes and ducts for refrigeration system. This is in agreement with the conclusions of Ogwo and Oranu, (2006), and Repp and McCarthy (1986), that when there are many operational steps, then a guide is necessary to successfully carry out the operation.

The study further revealed that problem-based teaching technique would improve students' performance in cold store installation and maintenance. This finding seems to confirm Baird (1972) position that providing the student with concise, explicit, and definite explanation and direction as to the best way to perform or approach learning activities enhances performance; and these are important aspects of the problem-based teaching technique. Furthermore, Miller and Rose (1975), Ogwo and Oranu (2006) believed that instruction organized in a series of progressive steps serves to carry on the individual learner or group of learners, starting at the beginner level , through a systematic, orderly process of learning; under this condition, learners usually appreciates the opportunity to advance and respond well to learning activities.

## CONCLUSION

Based on the findings of the study, the following conclusions are drawn. An problem-based teaching technique for teaching performance skills in refrigeration mechanic works has been developed and its efficacy based on syllabus for technical colleges was tested. The mean performance of the students taught with the problem-based teaching technique is better than those taught with conventional teaching technique. This performance is consistent in all of the two refrigeration mechanic works and this cannot be said to have occurred by chance, but rather due to the effectiveness of the problem-based teaching technique. Therefore, the problem-based teaching technique for teaching refrigeration mechanic works skills has yielded better performance.

## RECOMMENDATIONS

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

1. Standardization and harmonization of programmes being part of the responsibilities of National Board for Technical Education (NBTE), this board should consider introducing problem-based teaching technique as a standardized guide for the implementation of a uniform instructional strategy in metal-work technology in technical colleges.
2. Refrigeration teachers should always adopt the components of constructivism. This will enable them as to cater for diverse learning styles of students in their classrooms and hence, improve their academic achievement and development of practical skills.
3. Students should always be allowed to participate actively in class by interacting freely with the teacher and their colleagues as this will improve their academic ability and performance in their trade subject.

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