EFFECTS OF DEMONSTRATION AND PROBLEM SOLVING METHODS OF TEACHING ON STUDENTS' ACHIEVEMENT IN BASIC TECHNOLOGY

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Abstract

The study experimentally determined the effects of demonstration and problem solving methods of teaching on students' achievement in Basic Technology in Junior Secondary Schools in Niger State. Two research questions were articulated and two hypotheses were formulated to guide the study. The study employed a quasi-experimental research design. Out of 195 Junior Secondary Schools, purposive random sampling technique was employed to select three Junior Secondary Schools each from each education zone, one single sex male, one co-educational and one single sex female Junior Secondary Schools were selected. In each of the Junior Secondary Schools selected, three intact classes were also considered in two (JSS II). Seven hundred and twenty (720) students in the eighteen intact classes constituted the sample for the study. The instrument for data collection was a 40-item 'Basic Technology Achievement Test' (BTAT). The instrument was face and content validated. Using Kuder Richardson 20, a reliability index of 0.80 was obtained based on the table of specification. Research questions were answered using mean and standard deviation. Hypotheses were tested using Analysis of Covariance (ANCOVA) at 0.05 level of significance. The result of the study revealed that students taught with the problem solving method, demonstration method and conventional lecture method had significant effects on students' achievement. The educational implications of those findings were discussed and various recommendations were made such as: efforts should be made by teachers to integrate thoroughly both the demonstration and problem solving approaches in the teaching of Basic Technology in Junior Secondary Schools.

Introduction

Nigerian government has made the teaching of Basic Technology compulsory as this will help to promote self reliance. The Federal Republic of Nigeria (2004) in its attempt to achieve this goal outlined the basic objectives of Basic Technology at the Junior Secondary Schools level as follows:

- To stimulate and sustain students interest in Basic Technology.
- To inculcate in students Technological skills.
- To enable students acquire basic knowledge and practical skills in Basic Technology.
- To enable students integrate knowledge with skills in Basic Technology.

conventional lecture methods on students' achievement in Basic Technology in Junior Secondary Schools in Niger State.

Research Questions

1) What is the students' mean achievement scores in Basic Technology Achievement Test (BTAT) when taught with demonstration, problem solving and conventional lecture methods?
2) What are the academic achievement scores of male and female students taught Basic Technology with demonstration, problem solving and conventional lecture methods?

Hypotheses

HO_1: There is no significant difference in the mean achievement scores among the students taught with the demonstration, problem solving and conventional lecture methods of teaching Basic Technology.

HO_2: There is no significant difference in the mean achievement scores of male and female students taught with demonstration, problem solving and conventional lecture methods of teaching Basic Technology.

Methodology

The study employed a quasi-experimental research design. The pre-test was used to establish equality or no difference between the treatment groups at the beginning of the experiment only.

The design was as represented in the table below:

Table 1

Sample	Grouping	Pre-Test	Research Conditions	Post-Test
- None	Experimental group I (Demonstration Method)	Q1	X1	Q2
- None	Experimental group II (problem solving method)	Q1	X2	Q2
- None	Control group (Lecture method)	Q1	-	Q2

Where Q1 = Shows test before treatment
X1 = Shows treatment condition 1
X2 = Shows treatment conditions 2
- = Shows no treatment
Q2 = Shows post-test (after treatment)
- None = Shows non-random setting of experimental and control groups

The experimental Junior Secondary Schools selected does not have less than three arms or streams. Two of the arms or streams were randomly assigned to experimental condition while the rest one was randomly assigned to control conditions.

The study was carried out in Niger State and the population of the study consisted of all the Junior Secondary Schools II (JSS II) students in 195 Junior Secondary Schools in Niger State, In 2011/2012 academic session where Basic Technology was offered as a compulsory subject.

There are six education zones in Niger State. Using purposive sampling technique, the sample for this study consisted of six Junior Secondary Schools drawn from each of the educational zone in the 2011/2012 academic session.

The sample for this study was 720 (JSS II) students drawn from six Junior Secondary Schools offering Basic Technology. The purposive sampling technique was used to select the six Junior Secondary Schools from the existing 195 Junior Secondary Schools. The six Junior Secondary Schools purposively selected from the 195 Junior Secondary Schools were based on the criteria of gender, type of Junior Secondary Schools and location of Junior Secondary Schools.

In each of the three urban and three rural Junior Secondary Schools, two arms (streams) of JSSII each were assigned to the treatment (experimental) and the third arm (stream) to the control group so that for the two groups, twelve arms (streams) of JSS II from the six Junior Secondary Schools were assigned to the treatment group while six arms (streams) were assigned to the control group.

The assignment of classes to treatment and control groups was through a simple random technique. In each of the groups in Junior Secondary Schools, one intact class was drawn for the study through a simple random sampling technique. There were 18 intact classes that were used for the study, 12 for the treatment and 6 for the control.

The instrument used for data collection in this study was a 40 item Basic Technology Achievement Test (BTAT) drawn from the five identified difficult topics/areas in the curriculum for Junior Secondary Schools (JSS II).

The Basic Technology Achievement Test (BTAT) was face and content validated by three experts in Industrial and Technology Education from Federal University of Technology, Minna.

The measure of internal consistency of the BTAT was established using the trial testing procedure. A sample of 40 Basic Technology Students was drawn from an equivalent sample at Zone B of Niger State was used for trial-testing of the instrument. The essence of the trial-testing was to find out how the respondents would react to the instrument. The actual time for the test was also determined by taken the average time by the first and last tests to complete the test which was then taken to be the actual duration for the test.

Experimental Procedures

The Lesson Notes

Three lesson notes were prepared by the researcher. Two were written using the demonstration and problem solving methods respectively and these were given to trained permanent teachers teaching the subject. The third lesson note was with the usual conventional lecture method. The experimental and control groups were taught the same contents.

Treatment Procedure

Three instructional methods were used for this study. The first two approaches would involve the use of demonstration and problem solving methods, while the third approach would make use of conventional lecture method. The three methods were identical in terms of content, basic instructional objectives and mode of evaluation.

Two days within the week was set aside for data collection. This was necessary because the test required about 2 hours and it was therefore appropriate to use two days to make it convenient for the Junior Secondary Schools, the students and the researcher. The first day was used for introduction and administration of BTAT to intact JSS II Basic Technology class. The test duration was one hour.

At the beginning of the experiment, the researcher with the regular Basic Technology teachers in the Junior Secondary Schools administered the pre-test of the BTAT to the treatment and control groups. At the end of the experiment the BTAT was be administered to the two groups as post-test. For each of the groups, data for the pre-test and post-test were recorded separately. The researcher ensured that the sampled Junior Secondary Schools within the same town or location took the test the same day to avoid contamination effect. The scoring of both the pre-test and post-test was effected by the researcher and his assistants using the marking scheme to be provided by the researcher. The marking scheme was provided for the study. The researchers' presence in all the Junior Secondary Schools allow for similar test conditions.

The four research questions were answered using the mean and standard deviation. Hypotheses were being tested using analysis of co-variance (ANCOVA) at 0.05 level of significance.

Presentation and Analysis of Data

Research Question 1: What is the students' mean achievement scores in Basic Technology Achievement Test (BTAT) when taught with demonstration, problem solving and conventional lecture methods? This question was answered by the data analyses shown in Table 2.

Table 2: Relative students' mean achievement scores in Basic Technology Achievement test (BTAT) taught with demonstration, problem solving and conventional lecture methods

Group	Symbol	Pretest	Posttest	Mean Gain Difference
Demonstration method (Experimental Method 1)	N	240	240	
	$\overline{X}$	47.77	66.57	18.82
	SD	4.48	7.75	
Problem solving model (Experimental Method 2)				
	N	240	240	
Conventional lecture method (control).	$\overline{X}$	47.09	72.27	25.18
	SD	3.93	7.54	
	N	240	240	
	$\overline{X}$	46.33	61.47	15.14
	SD	4.30	6.25	

N= Number of subjects, x = Mean, SD = Standard deviation

Table 2 shows that prior to the use of demonstration method and problem solving method (Experimental methods 1 and 2) in the teaching of Basic Technology by Basic Technology teachers in the experimental group, their mean score were 47.77; 47.09 while their standard deviations were 4.48 and 3.93 respectively. The mean score of the experimental group two (x = 47.77) is slightly higher than that of the experimental group one (x = 47.09). The control group has a pre-test mean score of 46.33 the standard deviation of 4.30 in the BTAT and this is lower than that of experimental groups. The standard deviations of 4.48 and 3.93 respectively for the experimental groups as against 4.30 for the control group showed that the range of scores between the experimental and control group was very narrow. But after the treatment which was teaching the students in both groups, the post-test mean scores for the experimental students improved appreciably from 47.77 to 66.57 for demonstration method and 47.09 to 72.27 for problem solving model while their standard deviation show a decrease from 7.75 for demonstration to 7.54 for problem solving method thereby showing a high level of narrowness of the test scores. But for the control group, it was an improvement from a mean score of 46.33 to 61.47 and an increase in standard deviation of 4.30 to 6.05. But when compared with the experimental groups, it was low. This shows that there is a slight closeness in the test scores. The table also shows that the mean gain difference was 25.18 in problem solving method followed by 18.82 for demonstration method and 15.14 in conventional lecture method. This implies that subjects taught with problem solving method performed best in the achievement test followed by those of demonstration method and least by those taught with conventional lecture method. A moderate performance difference exist between the experimental and control group subjects.

Ho_1: There is no significant difference in the mean achievement scores among the students taught with demonstration, problem solving and conventional lecture methods of teaching Basic Technology.

Table 3: Analysis of covariance of the mean achievement scores of students taught Basic Technology with different methods

Source of Variance	Sum of Squares	Df	Mean Square	F	Sig. level at 0.05
DM & CLM	14181.089	1	14181.089	273.73	S
GPSM & CLM	30099.812	1	30099.812	580.99	S
DM & GPSM	3184.62	1	3184.62	61.47	S
DM, GPSM & CLM (Group)	14155.740	2	7077.87	136.62	S
Group (Methods)	9760.770	2	4880.385	133.992	S
Pretest	187.029	1	187.029	3.61	NS
Error	37094.151	716	51.807		
Total	**228903.282**	**719**			

* DM -Demonstration method *GPSM - problem solving method * CLM- Conventional lecture method

In Table 3 above, the calculated F-ratio in each row is compared with the table F-ratio at 0.05 level of significance to find out if the hypothesis is accepted or not. The calculated F-ratio between DM (experimental method 1) and CLM (control) was found to be 273.73 and the table F value df1, 716 at 0.05 level of significance was 24.4. Since the calculated F-ratio was greater than table F value at df1, 716 at 0.05 level of significance, the stated null hypothesis is therefore rejected meaning there was a significant difference between the mean achievement score of students taught with demonstration method and conventional lecture method. Students taught with demonstration method recorded higher test mean scores than those taught with conventional lecture method (Table 2).

In the cases of GPSM and CLM, the calculated F-ratio was 580.99 and the table F value at df 1 and 716 at 0.05 level of significance was 24.4. This shows that there was a significant difference between the performance of students taught with GPSM and CLM as F-ratio calculated was greater than table F value at df 1, 716 at 0.05 level of significance thus making the null hypothesis formulated to be rejected. This therefore shows that students taught with GPSM performed higher than those taught with the CLM (Table 2). Comparing the two experimental methods (DM&GPSM), the calculated F-ratio was 61.47 and the table F value at df 1, 716 at 0.05 level of significance was 24.4 showing that a significance difference existed between the performances of students with the two experimental methods. Between the three (3) methods (DM, GPSM and CLM), there was a significant difference in the impact of the three methods since the calculated F-ratio of 136.62 was greater than the table F value of 19.41 at df 2, 716 at 0.05 level of significance. On the whole, the null hypothesis formulated was therefore rejected and the alternative that there was a significant difference in the mean test scores of students taught with the three methods of teaching Basic Technology was therefore accepted. This shows that students perform highest with GPSM higher with DM and lowest with CLM (Table 2).

From the post-hoe analysis using Tukey-Kramen Multiple test to determine the direction of difference in the mean performance of the three groups (DM, GPSM and CLM), it was observed that students taught with GPSM performed far better in the achievement test and this was closely followed by DM and lastly by the CLM

Research Question 2: What is the academic achievement scores of male and female students taught Basic Technology with demonstration, problem solving and conventional lecture methods?

This research question was answered using the data collected and the result is shown on Table 4 below.

Table 4: Mean academic achievement scores of male and female students taught Basic Technology with the experimental and the conventional lecture methods

Gender	Teaching method	Symbol	Pretest	Posttest	Mean Gain Difference
Male	Demonstration (Experimental method 1)	N	126	126	
		$\overline{X}$	47.52	70.30	22.78
		SD	4.52	5.36	
Female	Demonstration (experimental Method 1)	N	114	114	
		$\overline{X}$	48.04	62.44	14.40
	problem solving method (Experimental method 2)	SD	4.35	7.98	
Male	problem solving method (Experimental method 2)	N	133	133	
		$\overline{X}$	46.32	75.80	29.48
		SD	3.66	5.34	
Female	Conventional lecture method (Control)	N	107	107	
		$\overline{X}$	48.05	67.88	19.83
		SD	4.07	7.59	
Male	Conventional lecture method (Control)	N	128	128	
		$\overline{X}$	45.55	64.37	18.82
		SD	3.58	4.27	
Female	Conventional lecture method (Control)	N	112	112	
		$\overline{X}$	47.23	58.17	
		SD	4.87	6.53	10.94

N= Number of subjects, $\overline{x}$ = Mean, SD = Standard deviation

Table 4 above shows that the pre-test mean scores of students taught with the three methods of teaching i.e. demonstration (Experimental method 1), problem solving (Experimental method 2) and conventional lecture method (Control) were found to be 47.52, 46.32 and 45.55 for male and 48.04, 48.05 and 47.23 for female respectively; while the post-test result shows 70.30, 75.80 and 63.37 for male and 62.44, 67.88 and 58.17 for female respectively. These results show there is a difference between the students' pre-test and post-test scores in each method of teaching. The difference is highest with the problem solving method, followed by the demonstration method and lowest with the conventional lecture method. The

mean gain scores of the male students are 29.48 for problem solving method, 22.98 for the demonstration method and 18.32 for the conventional lecture method; for the female students the mean gain scores are 14.40, 19.83 and 10.94 in each method respectively.

The results further shows that the difference in post-test mean scores is highest among male students taught with problem solving method followed by those taught with demonstration method and least by those taught with conventional lecture method. Also for female students it was highest with problem solving method followed by the demonstration method and the conventional lecture method respectively. In the case of variability of test scores, the standard deviation obtain in each case shows a minimal spread of scores. In the case of variability of test scores, the standard deviation obtained in each case showed a minimal spread of scores. It was also noticed that there was a little increase in the post-test mean scores for female students taught with demonstration, problem solving and conventional lecture methods.

Ho_2: There is no significant difference in the mean achievement scores among the students taught with demonstration, problem solving and conventional lecture methods of teaching Basic Technology based on gender.

Table 5: Analysis of covariance of mean achievement scores of group of students taught Basic Technology with different methods based on gender

Source of Variance	Sum of Squares	Df	Mean Square	F	Sig. level at 0.05
DM & GPSM	2123.724	1	2123.724	36.31	S
DM & CLM	3344.832	1	3344.832	52.19	S
GPSM & CLM	3492.083	1	3492.083	57.70	S
DM, GPSM & CLM	14962.063	2	7481.0315	129.9	S
Group (Method)	12936.775	2	6468.388	171.06	S
M and F	3823.438	1	3823.438	65.37	S
Group * Sex	128.263	2	64.131	1.696	NS
Intercept	20208.460	2	10104.23	172.75	S
Pretest	974.742	1	974.742	16.66	NS
Error	41879.556	716	58.491		
Total	**100567.668**	**719**			

* DM - Demonstration method * GPSM- problem solving method
* CLM - Conventional lecture method * F – Female * M- Male

Table 5 above shows that the calculated F-ratio between the two experimental methods (DM and GPSM) was found to be 36.31 and the table F value at df 1, 716 at 0.05 level of significance was 24.4. The calculated F-ratio was greater than the table F value of 24.4. It therefore means that the hypothesis of no significant difference between the performances of students taught Basic Technology with the DM and those taught with the GPSM was rejected. The students taught with the GPSM therefore performed higher than those taught with DM.

As for the DM and CLM, the calculated F-ratio was 59.19 and the table F- value at df 1, 716 at 0.05 level of significance was 24.4. Thus making the null hypothesis formulated to be rejected. This then shows that there was a significant difference between the performance of students taught Basic Technology with the DM and the CLM with the DM group scoring higher than the CLM group (Table 4). Also between the GPSM and the CLM, the calculated F-ratio was 59.70 and the table F value at df 1, 716 at 0.05 level of significance was 24.4 making the null hypothesis to be rejected. These therefore means that significant difference exists between the performance of students taught Basic Technology with the GPSM and those with the CLM. The performance of students taught with the GPSM was therefore higher than those taught with the CLM (Table 4). Comparing the three methods (DM, GPSM and CLM) the calculated F-ratio of 129.90 was greater than the table F value at df 2 and 716 at 0.05 level of significance was 19.41. The calculated F-ratio was greater than the table F value therefore the hypotheses of no significant difference between the performance of students taught Basic Technology with the three methods was therefore rejected. Again with gender, the calculated F-ratio of 65.37 at table F value at df 1 and 716 at 0.05 level of significance was 24.4. Again with gender, since the calculated F-ratio was greater than the table F value, the null hypotheses formulated was therefore rejected. It therefore implied that male students performed higher than their female counterpart in the BTAT tasks (Table 4).

The hypothesis further revealed that the calculated F-ratio of 1.696 is less than the table F value of 19.41 at 0.05 level of significance. On that note, the researcher upholds the null hypothesis and concludes that there is no significant interaction effects of methods and gender on students' mean achievement scores in the Basic Technology Achievement Test (BTAT).

The Post-hoc analysis using Tukey Kramer multiple test shows that male students taught with Basic Technology with GPSM had higher mean score in the achievement test follow by those taught with DM and CLM. The performance of the female counterparts also followed the same pattern.

Findings of the Study

A. Influence of teaching methods on students' mean achievement scores in Basic Technology.

Based on data analysis the following were the findings were made:

1. The pre-treatment mean test scores of the respective groups of Basic Technology students were 47.77 for the group taught with DM; 47.09 for GPSM and 46.03 for CLM group (Table 2).
2. The post-treatment mean test scores were 66.57 for DM; 72.27 for GPSM and 61.47 for CLM respective groups (Table 2).

Test of hypothesis one showed that there was a significant difference ($P < 0.05$).

1. There was a significant difference in the academic achievement scores of students separately thought Basic Technology with the DMGSPM and CLM respectively.
2. There was a significant difference between the post treatment ASBT mean scores of students taught Basic Technology with the GPSM and those taught with the DM. Students taught with GPSM performed higher than those taught with the DM.

B. Influence of teaching methods on students' mean achievement scores in Basic Technology (BTAT) based on gender.

The following findings were made based on data analysis

1. Male students taught with the DM scored higher ($\bar{x}$ = 70.30) than female students ($\bar{x}$ = 62.44) (Table 4).
2. In the case of the GPSM, male students scored higher ($\bar{x}$ 75.80) than the female group ($\bar{x}$ = 67.88).

Test of hypothesis two showed that there was a significant difference ($P < 0.05$):

1. Between post-treatment mean scores of male and female students taught with the DM and those taught with the GPSM.
2. Between post-treatment mean scores of male and female students taught with the DM and those taught the CLM.

Conclusion

From the foregoing findings, and discussion it could be concluded that:

Most students taught with demonstration method and problem solving method performed excellently well in the achievement test items, when compared with those taught with conventional lecture method.

Students taught Basic Technology using problem solving method and demonstration method performed better than those taught with the conventional lecture method. Generally, students taught with the use of problem solving method performed better than those taught with demonstration and conventional lecture methods. The students taught Basic Technology with problem solving method also performed better than those taught with demonstration method while those taught with demonstration method was higher than those taught with the conventional lecture method.

Male students from single sex male Junior Secondary Schools performed better than those students from single sex female and co-educational Junior Secondary Schools when taught with problem solving method. Male students from single sex male Junior Secondary Schools performed better than those students from single sex female and co-educational Junior Secondary Schools when taught with demonstration method and they also performed better than those students from single sex female and co-educational Junior Secondary Schools when taught with conventional lecture method. Generally, problem solving method appeared more effective in promoting students mean achievement scores in Basic Technology than demonstration and conventional lecture methods.

Recommendations

1. The findings of this study revealed that Junior Secondary Schools students particularly those taught with conventional lecture method performed poorly in the BTAT tasks in Basic Technology. Junior Secondary Schools teachers, therefore, should avoid the continuous use of conventional lecture method in the teaching of Basic Technology.

2. On the other hand, the finding of the study revealed that students taught with problem solving method performed better in the BTAT tasks than those taught with demonstration and conventional lecture methods which requires that the trend should be encouraged and that efforts should be intensified by teachers to aggressively adopt this method in Basic Technology in all classes at the Junior Secondary Schools level with the intention to promote students performance.
3. The findings of the study revealed that significant differences existed in the mean achievement scores in favour of the students taught Basic Technology using (demonstration and problem solving) procedures as opposed to those taught with the conventional lecture method. This requires teachers to make efforts to integrate thoroughly both the demonstration and the problem solving approaches into the teaching of Basic Technology in Junior Secondary Schools.
4. Attention should be adequately paid to the female folds by advising teachers of Basic Technology to apply both the demonstration and problem solving methods. This is because the result of the study has shown a significant difference in their mean achievement scores in favour of males.
5. Similarly, curriculum developers should as a matter of priority, be reviewing Basic Technology curriculum on a continuous basis with a view to incorporating problem solving method. This will help promote the performance of students in Junior Secondary Schools certificate examination in Basic Technology.
6. Also, textbook writers should consider it as a priority, to include in their texts, the uses and application of the problem solving and demonstration methods in the teaching and learning of Basic Technology so that the teachers and learners should apply them when the need arises.

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