African Research Review

An International Multi-Disciplinary Journal, Ethiopia
Vol. 4 (4), Serial No. 16, October, 2010
ISSN 1994-9057 (Print) ISSN 2070-0083 (Online)

Effect of Guided-Discovery, Student- Centred Demonstration and the Expository Instructional Strategies on Students' Performance in Chemistry *(Pp. 389-398)*

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Abstract
This study investigated the relative effectiveness of guided-discovery, student-centred demonstration and expository methods of instruction on students' performance in chemistry. It was a quasi-experimental research using non-randomized- pre-test – post-test control group design with expository method as control. Two research questions and two hypotheses were formulated for answering and testing respectively. A sample of 118 SS2 chemistry students (62 males and 56 females) drawn from 3-co educational public secondary schools in Uyo Local Government Area of Akwa Ibom State was used for the study. Criterion sampling technique was used in selecting the sample. A researcher- developed test – Chemistry Achievement Test (CAT), with a reliability index of 0.78 determined using test-retest method was used in collecting relevant data. After classroom investigations, the results indicated that guided discovery was the most effective followed by student-centred demonstration. Consequently, it has been recommended that chemistry teachers in secondary schools make effective use of guided-discovery and student-centred-demonstration methods in communicating chemistry concepts and inculcating relevant entrepreneurial skills in learners.

Introduction

One of the major problems faced by science teacher today is not necessarily "what to teach" but how to teach; and the teachers' inability to teach science in a meaningful way is identified as one of the factors responsible for

students' poor performance in this area in both public and internal examinations. It is of note that the interest learners show and the mastery they demonstrate in their filed of study at the completion of the programme depends largely on how they were taught (Ojogan & Oganwu, 2006).

Educationist and educational psychologist have made earnest effort at developing psychological rationale essential for answering the question, "How should science be taught to ensure effective and meaningful learning?" As an outcome, several investigative strategies have been developed based on the assumption that meaningful learning occurs when the learners are actively involved in the knowledge getting process (Njoku, 2004). These include student-centred demonstration, the discovery and the inquiry teaching approaches. These strategies ensure a shift from teacher dominated classrooms to learners' use of their inquiry and innate abilities in explorative and interpretative manner to discover facts and principles, form new concepts and reformulate their knowledge; with the teacher functioning as a facilitator in the knowledge getting process.

The guided - discovery approach involves engaging the learners in simple experimental activities (structured or unstructured) involving genuine "Lets' find out' exercises; student-centred demonstration approach involves engaging the learners in displaying or exhibiting objects, equipment or apparatus with the intent to showing them their correct use or demonstrating experimental procedures; and the inquiry approach involves helping the learners use their inquiry and reasoning abilities to discover facts and principles (Gbamanja, 1991). Studies relating the use of these strategies with students' academic achievements seem to suggest that they are more effective than the traditional expository approach (Njoku, 2004; Udo & Udo, 2007). Studies on instructional approaches and gender performances in science show conflicting and inconclusive findings. While some findings allege male superiority (Ekeh, 2004), others allege female superiority (Galadima, 2003) and still others report zero effect of gender, maintaining that, given the right condition of learning both male and female would perform equally well in science (Ariyibi, 2004; Udo, 2004; Udo & Udo, 2007).

Though literature is replete with studies relating investigative teaching strategies with students' academic performance, there is paucity of studies comparing the relative effectiveness of guided-discovery, student-centred demonstration and the expository teaching approaches in enhancing students' performance in chemistry. The questions then are: How effective are these

strategies in facilitating students' learning of chemistry concepts? Which of these methods is more gender friendly?

The Objectives

The objectives of the study were:

1. To compare the performance of students in chemistry when taught with guided-discovery, student-centred demonstration and expository teaching approaches.
2. To determine the effects of guided-discovery, student-centred demonstration and expository teaching methods on the performance of male and female students in chemistry.

Research Questions

1. How do students differ in their performance in chemistry when taught using guided-discovery, student-centred demonstration and expository teaching methods?
2. How do male and female students taught using guided-discovery, student-centred demonstration and expository teaching methods differ their performance in chemistry?

Hypotheses

The following null hypotheses were formulated for testing:

1. There is no significant difference in students' performance in chemistry when taught with guided-discovery, student-centred demonstration and expository teaching methods.
2. There is no significant difference between the performance of male and female students in chemistry when taught using guided-discovery, student-centred demonstration and expository teaching methods.

Methodology

The study was a quasi-experimental research using non-randomized pre-test - post-test - control group design. The expository method was used as control.

The target population was all the 780 SS2 chemistry students in the 12 public secondary schools in Uyo Local Government Area of Akwa Ibom State during the 2008/2009 school year (Field survey).

The sample comprised 118 (SS2) chemistry students in 3 public secondary schools in the study area, drawn using criterion sampling techniques. The criteria were:

1. Schools with functional and separate chemistry laboratory.
2. Schools with graduate teachers with at least B. Sc degree in chemistry education.

Instrumentation

The instrument used in collecting data for the study was a researcher-developed, 25-item multiple choice objective test – Chemistry Achievement Test (CAT). The items were drawn from the following topics: water, solubility, acid, basis and salts; which were featured during classroom activities. The draft, of the instrument which contained 40 items, was submitted to three independent assessors, who are lecturers in chemistry education in the University of Uyo, Uyo for face validation. Their inputs were used in restructuring of the items. The final form of the instrument had difficulty and discrimination indices ranging between 0.25 and 0.70 respectively and a reliability index of 0.78 determined using test-retest approach. Each item answered correctly was scored 4 marks. Incorrect answers were scored zero. Hence, the maximum score was 100 marks and the minimum was zero.

Procedure

First, the researcher visited the selected schools and obtained permission from their principals to use the schools for the study. Thereafter, he took two weeks to train the subject teachers of the selected schools as research assistants using validated instructional packages developed by the researcher for the experimental and control groups. The instructional packages were also validated by the assessors who validated the instrument. This was followed by the administration of CAT as pre-test on the sample by the assistants, under strict supervision of the researcher. Thereafter, the assistants taught the selected concepts to their groups using the instructional packages from the researcher. Those in experimental group I were taught using guided-discovery approach; those in experimental group 2 were taught using student-centred demonstration and those in the control group were taught using the conventional traditional expository approach. At the end of the class activities the students were given a reshuffled version of CAT as post-test. Both the pre-test and post-test scripts from all the groups were scored by the

researcher; and the data generated were analyzed using Analysis of Covariance (ANCOVA).

Results

Answering the Research Questions

In this section the two research questions raised were answered using the results in Tables 1 and 2

Research Question 1: *How do students differ in their performance in chemistry when taught using guided-discovery, student-centred demonstration and expository teaching methods?*

In Table 1, the results displayed show that the students taught using guided – discovery method had mean gain score of 22.10; those taught using student-centred demonstration, 17.83; and those taught using the conventional expository method 16.35. This observation shows that the students taught by guided-discovery method had the best performance while the least performance was recorded by those taught by expository method. This observation, therefore, answered research question 1 – How do students differ in their performance in chemistry when taught using guided discovery, student-centred-demonstration and expository methods?

Research Question 2: *How do male and female students taught using guided-discovery, student-centred demonstration and expository teaching methods differ their performance in chemistry?*

In Table 2, the mean gains displayed are 22.64 and 21.52 respectively, for the male and female students taught using guided discovery method; that for the males in student-centred demonstration group is 17.77 while their female counterparts had 17.88; and the males and the females in the expository group had mean gain scores of 15.36 and 17.55, respectively. A comparison of these results shows that guided-discovery method had the best enhancing effect on the performances of both the male and the female students; followed by the student-centred demonstration, and expository methods in decreasing order. Considering research question two: How do male and female students taught using guided discovery student-centred demonstration and expository methods differ in their performance in chemistry? – the results show that guided-discovery had the best enhancing effect on the performances of both the male and female students; the performances of the male and the female students taught using student-centred demonstration

were , however, comparable; while the performance of the students taught with the expository method was in favour of the female students.

Testing the Hypotheses

The results in Table 3 were used in testing hypotheses 1 and 2.

With respect to hypothesis one, the results in Table 3 shows that the F-ratio for the main effects of the instructional methods (guided-discovery, student-centred demonstration and expository) is 16.53 while its significance level is 0.00 alpha at df 2,111. This level of significance (0.00 alpha) is less than 0.05 alpha indicating that the effect of the teaching methods used on the students' performance is statistically significant. Consequently, null hypothesis one – There is no significant difference in students' performance in chemistry when taught with guided-discovery, student-centred demonstration and expository teaching methods was rejected. The Scheffe post-hoc comparison of means in Table 4 shows which of the methods was most effective.

The mean differences in Table 4, show that those taught using guided-discovery method performed significantly better than those taught with student-centred demonstration (mean diff, 5.72), and expository method (mean diff, 7.27) respectively.

With respect to hypothesis two – There is no significant difference between the performance of male and female student in chemistry when taught using guided-discovery, student-centred demonstration and expository methods – the results in Table 3 show a calculated F-ratio for the main effect of gender as 0.01 and a significance level of 0.91 at df 1,111. The observed level of significance is greater than 0.05 alpha. This indicates that the F-cal is not statistically significant. That is, gender had no significant effect on the students' performances. Hence, the hypothesis was upheld.

Discussion

This study investigated the relative effects of guided-discovery, student-centred demonstration and expiatory methods of teaching on students' performance in chemistry, with gender as the intervening variable. The results in Tables 3 and 4 showed that guided-discovery method is the most facilitative, followed by student-centred demonstration; while the conventional expository method, is the least effective. The observed better performances of the students taught with guided-discovery and student-centred-demonstration approaches is attributed to their activity-oriented nature which ensures adequate involvement of the learners in the teaching-

learning process. The significantly better effect of guided-discovery over student-centred demonstration is explained in terms of the intrinsic motivation the learners have from their discoveries. The observation with respect to guided-discovery, student-centred demonstration and expository methods further affirm the relative effectiveness of students-centred instructional approaches on their academic performances (Ajewole, 1990; Archibong, 1997; Njoku, 2004; Udo & Udo, 2007).

With respect to gender, the findings showed that this variable is not a significant determinant of students' performance in chemistry. The observation agrees with those of (Ariyibi, 2004; Udo, 2004; Udo & Udo, 2007).

Conclusion

Consequent upon the findings of this study it has been hereby concluded that activity-based instructional strategies are the most effective and gender friendly.

Implications

The findings of this study underscore the importance of activity-based learning in facilitating concept attainment in learners. It should be noted that, presently, efforts in education in science is directed towards equipping the learners with relevant entrepreneurial skills which will enable them live comfortably and contribute meaningfully to the development of the society. Teachers of chemistry should, therefore, use every class opportunity to inculcate relevant skills in learners that will help them in later years by engaging them in relevant hands-on, heads -on and hearts-on activities.

Recommendations

Consequent upon the findings of this study, it is recommended that:

1. chemistry teachers should endeavour to involve their students in relevant activities in every class situation by using student-centred approaches as the guided-discovery and student-centred demonstration methods to enhance their skills acquisition and concept attainment.
2. teachers should not consider gender as a significant factor in students' academic performance but should encourage all in their class towards academic excellence irrespective of gender differences.

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Table 1: Summary of mean and standard deviation scores of the students in pre-test and post-test

Treatment Group	N	Pre-test		Post-test		Mean
		X	SD	X	SD	Gain
Guided-discovery	43	34.37	7.09	56.47	6.72	22.10
Student-centred demonstration	35	32.91	8.63	50.74	6.98	17.83
Expository	40	32.85	9.11	49.20	6.16	16.35
Total	118	33.42	8.24	52.31	7.31	18.89

X = mean score; SD = standard deviation score

Table 2: Summary of mean and standard deviation scores of students in pre-test and post-test classified by treatment and gender

Treatment Group/Gender	N	Pre-test		Post test		Mean
		X	SD	X	SD	Gain
Guided-discovery:						
Male	22	33.36	8.03	56.00	6.76	22.64
Female	21	35.43	5.97	56.95	6.80	21.52
Student-centred demonstration:						
Male	18	33.56	8.25	51.33	7.16	17.77
Female	17	32.24	9.22	50.12	6.95	17.88
Expository:						
Male	22	33.91	9.04	49.27	6.34	15.36
Female	18	31.56	9.29	49.11	6.11	17.55

Table 3: Summary of Analysis of Covariance (ANCOVA) of students' post-test scores classified by instructional methods and gender with pretest as covariate

Source of Variance		Sum of Squares	df	Mean Square	F	Sig. of F
Covariate (Pre-test)		1828.76	1	1828.76	63.87	.00
Main Effects: Treatment (methods)		946.53	2	473.27	16.53	.00
Gender		0.14	1	0.41	0.01	.19
Interaction Effects Treatment Gender	*	11.82	2	5.91	7.21	.18
Error		3178.10	111	28.63	-	-
Total		6245.02	117	-	-	-

F is significant at p < 05 alpha

Table 4: Summary of Scheffe post-hoc comparison of the students' post test performance classified by teaching methods

Method (i)	(J)	Mean Difference	Standard Error	Sig.
Guided-discovery	Student-centred demonstration	5.72*	1.51	.001
	Expository	7.27*	1.45	.000
Student-centred demonstration	Guided-discovery	-5.72*	1.51	.001
	Expository	1.54	1.53	.603
Expository	Guided-discovery	-7.27*	1.45	.000
	Student-centred demonstration	-1.54	1.53	.603

* = significant at p <. 05 alpha.