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Effect of demonstrative and guided-inquiry approaches on students' performance in qualitative analysis in chemistry

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Abstract
The study seeks to examine the effectiveness of demonstrative and guided-inquiry approaches on students' performance in qualitative analysis in chemistry among senior secondary school 2 (SSS2) students in Emohua Local Government Area of Rivers Stae. A quasi-experimental design which used purposive random sampling technique. A total of 92 students constituted the study sample and a population of 208 students. Three research questions and three research hypotheses were generated to guide the study. The instrument for data collection was a Qualitative Achievement Test (QAT) made up of 50 items. The instrument was validated by experts in Chemistry and Science educators. Reliability coefficient of 0.81 was obtained using test-retest method. The experimental group was thought using guided-inquiry approach while the control group was taught using demonstrative method with a validated lesson notes prepared by the researcher. The hypotheses were tested using t-test at $p<0.05$. The result shows that students taught qualitative analysis using guided inquiry approach performed better than the demonstrative approach as well as a significant difference between the male students and the female students. The study recommended based on the findings that chemistry teachers should embrace guided-inquiry method when teaching qualitative analysis.

Keywords: qualitative analysis, demonstrative method, guided-inquiry approach and performance

Introduction

The need to strengthen the teaching and learning of Chemistry at the secondary school level appears to be of great concern to Chemistry educators. Owing to this, methods of delivery of instructions in Science especially Chemistry by exposing students to students-centre instructions such as demonstrative and guided-inquiry approaches for students performance to be enhanced needs to be developed. Non-utilization of instructional resources by science teachers has been noted worldwide as one of the challenges facing the teaching and learning of science, according to Agusiobio (2004) [1] in Dike and Ugbe (2011) [6]. This to a large extent has contributed to the poor performance of students in science subjects at all levels of education, especially at the secondary school level (WAEC, 2003) [14]. However, inadequate exposure of the students to laboratory practicals, has been seen to be one major factor that contributes to poor state of achievement in science (Nna and Arokoyu, 2015) [10].

The method of teaching adopted by Nigerian science teachers do not only encourage appreciable significance in the sustenance and acquisition of skills among science students but also enhances their performance in the subject area (Arokoyu and Nna, 2012) [3]. Chemistry is one of the Science subjects taught at the senior secondary school level, a stage when learners would have attained what Piaget called a formal operational stage. The teacher's job according to Piaget is to provide the individual with situations that encourages learners' active participation. The shift from the teacher-centred method of teaching science to child-centred activity based instructions which encourage and develops the child spirit of inquiry should be the concern of science teachers.

Experience has shown that the adequate and efficient use of instructional materials enhances the teaching and learning of science, hence the method adopted in the teaching is an essential ingredient for the smooth and successful growth and development of a more humane society (Okebukola, 2002) [11]. Science teachers have always recognized the importance of practical work as a means of introducing learners to the scientific process of experimentation. To this end, the United Nations Educational Scientific and Cultural Organization (UNESCO) and the International Union of Pure and Applied Chemistry (IUPAC) have participated in numerous international meetings to promote in expensive experimental based teaching in Chemistry. Inquiry teaching method is a style of teaching where the learner is seeking to discover and create answers to recognized problems through procedure of making a diligent search, some time with minimum guidance from the teacher (Callaham *et al.*; 1995). Inquiry teaching method is also a term used in science teaching that refers to a way of questioning, seeking knowledge, information or finding out about phenomena, it involves investigating data and arriving at the conclusion (Yagger and Akcay, 2010, Sola and Ojo, 2007) [15, 12]. A guided inquiry teaching method revolves around student learning through hands-on minds activities. Instructional approaches that been shown to be effective for improving students performance in science are active learning strategies as different methods have been suggested for involving students in lessons as well engaging them in active learning (Trowbridge, 2000) [13]. Guided inquiry teaching approach has been described as problem

solving, critical thinking, reflective inquiry, deductive thinking and not mere personal assumptions. It is a method that involves probing, finding out, investigating, analyzing, synthesizing, discovering, evaluating, questioning and thinking (Muhammad, 2007) [9]. Performance-based education motivates students to participate in interesting and meaningful tasks. The performance based approach to education enables students to use their knowledge and apply skills in realistic situation (Anguaye, 2007). Students' performance in Chemistry depends on many factors and stands out to show how well a student is doing. Festus (2007) [7], contend that performance appears generally to be the fundamental goal behind every life struggle, but the positive platform has consequential effects of improving the worth of the students and can only be achieved through acquisition of positive learning attitudes. The attitudes of a student trigger their behaviour because attitudes are antecedents which serve as inputs or stimuli that trigger actions.

Despite the position of Chemistry in the educational system and effort made by researchers to enhance students' performance, Chemistry students' performance is low. In view of this, Lawrence and Abraham (2011) [8] identified the following causes of poor performance in chemistry; inadequate laboratory facilities, poor instructional method, teachers' attitudes to the subject matter, lack of improvisation and non-professionalism. The methods adopted in the teaching of particular subjects are seen to be vital tool in the acquisition of useful skills that leads to self-reliance as well as students' performance in that subject matter. Thus, this study seeks to examine the effect of demonstration and guided inquiry approaches on students' performance in qualitative analysis.

Objectives of the Study

The main objective of the study is to compare the effectiveness of demonstration and guided-inquiry approaches on students' performance in qualitative analysis in secondary schools in Rivers State. Specifically, the study seeks to:

1. Compare the effects of demonstrative approach and guided-inquiry on students' performance in qualitative analysis.
2. Investigate the effect of the male students' performance in qualitative analysis taught using demonstrative approach and those taught using guided-inquiry.
3. Examine the performance of the female students taught qualitative analysis using demonstrative method and those taught using guided-inquiry.

Research questions

The following research questions guided the study.

1. What is the mean difference between the students taught qualitative analysis using demonstrative method and those taught using guided-inquiry approach?
2. To what extent does the performance of the male students taught qualitative analysis using demonstrative method differ from their counterpart taught using guided-inquiry?
3. What difference exists between the performance of the female students taught qualitative analysis using demonstrative method and their counterpart taught using guided-inquiry.

Research hypotheses

Three null hypotheses guided the study

1. There is no significant difference between the performance of students taught qualitative analysis using demonstrative method and those taught using guided-inquiry approach.
2. There is no significant difference between the performance of male students taught qualitative analysis using demonstrative method and those taught with guided-inquiry approach.
3. There is no significant difference between the performance of female students taught qualitative analysis using demonstrative method and those taught using guided-inquiry approach.

Research methodology

A quasi-experimental, non-randomized pretest, posttest design was adopted in the research. The experimental and control groups were in their intact classes. All senior school class 2 (SS2) Chemistry students in Emohua Local Government Area totally 208 (Source: School Register) constituted the study population. Purposive sampling technique was adopted to select 2 schools. A total of 92 students constituted the sample size randomly assigned two groups: one experimental and one control groups respectively. The experimental group was taught using guided-inquiry approach while the control was taught using demonstration approach. Research instrument tagged "Qualitative Achievement Test (QAT) constructed by the researcher made up of 50 items was used for data collection. The instrument was validated by experts in organic chemistry and science education with a reliability coefficient of 0.81. QAT was administered as pretest before treatment. The samples were taught the concept of anion and cation identification using a prepared and validated lesson packages in the two selected schools for three weeks. At the expiration of three weeks, the three groups were post tested with re-shuffled QAT. The scripts were retrieved on the spot by the researcher. Date obtained were descriptively analyzed using mean and standard derivation for research questions and t-test for the best of significant different (hypotheses).

Result and discussion

The results of this study are hereby presented in tables in accordance with the guiding research questions and hypotheses. All statistics were computed with SPSS 19.0 for windows.

Presentation of results

Research Question 1

What is the mean difference between the students taught qualitative analysis using demonstrative method and those taught using guided-Inquiry approach?

Table 1: Performance mean scores and standard deviation of the students taught qualitative analysis using demonstrative method and those taught using guided-Inquiry approach.

		Pretest		Posttest		Gain	
Model	**N**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
Demonstrative Method	44	13.59	7.67	47.00	9.75	30.30	8.71
Guided-Inquiry Approach	48	16.00	9.57	50.35	10.09	33.18	9.83

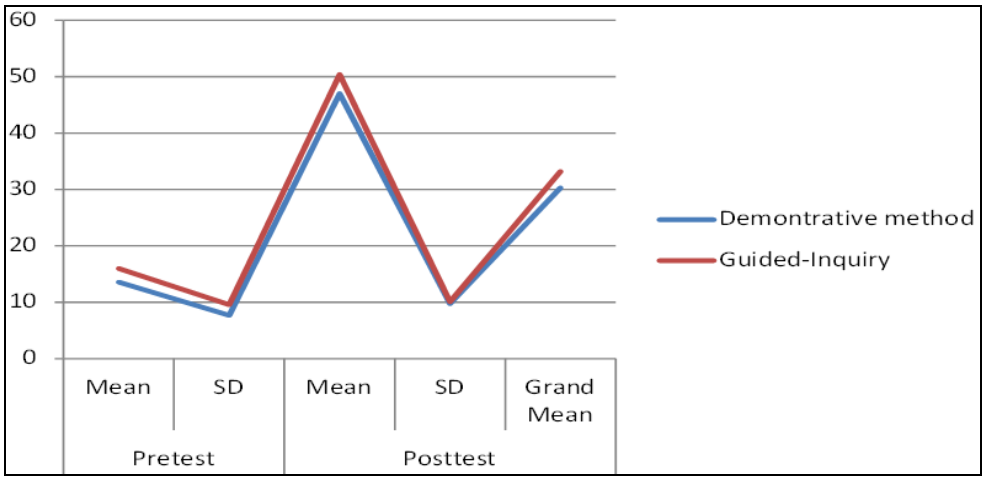

Fig 1

Research Question 2

To what extent does the performance of the male students taught qualitative analysis using demonstrative method differ from their counterpart taught using guided-inquiry?

Table 2: Performance mean scores and standard deviation of male students taught qualitative analysis using demonstrative method differ from their counterpart taught using guided-inquiry

			Pretest		Posttest		Gain	
Model	**Sex**	**N**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
Demonstrative Method	M	22	12.00	5.35	44.73	10.06	28.37	7.71
Guided-Inquiry Approach	M	22	15.50	8.41	44.38	5.59	29.94	7.00

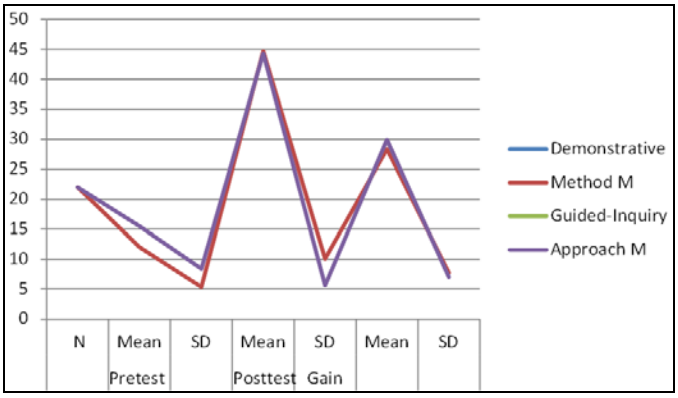

Fig 2

Research Question 3

What difference exists between the performance of the female students taught qualitative analysis using demonstrative method and their counterpart taught using guided-inquiry?

Table 3: Performance mean scores and standard deviation of female students taught qualitative analysis using demonstrative method and their counterpart taught using guided-inquiry

			Pretest		Posttest		Gain	
Model	**Sex**	**N**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
Demonstrative Method	F	24	15.18	9.13	49.27	8.45	32.23	8.79
Guided-Inquiry Approach	F	24	16.50	1.08	56.33	1.16	36.42	1.12

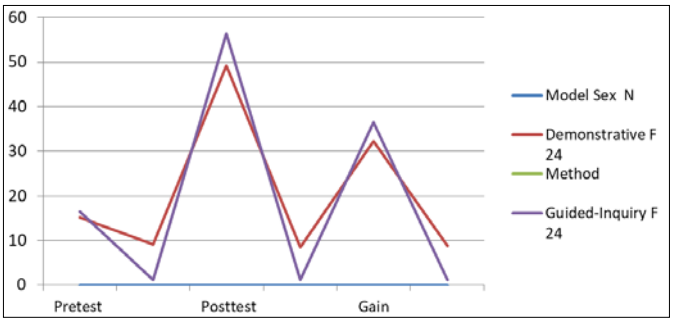

Fig 3

Ho$_1$: There is no significant difference between the performance of students taught qualitative analysis using demonstrative method and those taught using guided-inquiry approach.

Table 4: Summary of t-test analysis on the performance of students taught qualitative analysis using demonstrative method and those taught using guided-inquiry approach

Approach	N	$\bar{X}$	SD	DF	t_{cal}	t_{crit}	Decision at
D.M	44	30.30	8.71	90	4.495	1.465	0.158
G.I.A	48	33.18	9.83				

D.M=Demonstrative method, G.I.A=Guided inquiry approach.

Table 4 shows that t-cal (4.495) is greater than t-crit (1.465). This indicates a significant difference between D.M and G.I.A at df 90, $p < 0.05$. Research hypotheses 1 is hereby rejected.

HO$_2$: There is no significant difference between the performance of male students taught qualitative analysis using demonstrative method and those taught with guided-inquiry approach.

Table 5: Summary of t-test analysis on the performance of male students taught qualitative analysis using demonstrative method and those taught with guided-inquiry approach

Approach	N	$\bar{X}$	SD	DF	t_{cal}	t_{crit}	Decision at
D.M	22	28.37	7.71	42	0.563	2.181	0.579
G.I.A	22	29.94	7.00				

Table 5 indicates that there is no significant difference between the male students taught qualitative analysis using demonstrative method and those taught using guided inquiry approach. This is shown by the greater value of t-crit (2.181) than t-cal (0.563) at df 42 and p <0.05. Hypothesis 2 therefore was accepted.

HO3: There is no significant difference between the performance of female students taught qualitative analysis using demonstrative method and those taught using guide-inquiry approach.

Table 6: Summary of t-test analysis on the performance of female students taught qualitative analysis using demonstrative method and those taught with guided-inquiry approach

Approach	N	$\overline{X}$	SD	DF	t_{cal}	t_{crit}	Decision at
D.M	22	32.23	8.79	46	2.587	1.596	0.593
G.I.A	26	36.42	1.12				

The table 6 result shows that there is a significant difference between the female students taught qualitative analysis using demonstrative method and guide inquiry approach as the t-cal is greater than the t-crit at df 46 and p < 0.05. Thus, hypothesis 3 is rejected.

Discussion of finding

It is found from the study that students taught qualitative analysis using guided-inquiry approach performed better than those taught using demonstration approach. This finding was consistent with the findings of Brunner (1965) which opined that students' active participation in teaching-learning sequences promotes their performance as well as acquisition of useful skills. However, both male and female students taught using guided inquiry approach also performed better than their counterparts, taught using demonstration method. This is consistent with the findings of Akani (2009) who established that for sustainable development to be achieved there must be gender equity and as such, women should be given the same educational opportunities as their male counterparts.

The study also shows that there is a significant difference between the students taught using demonstrative approach and those taught using guided inquiry approach. Also, a significant difference was noticed in the female performance using the both methods but this was not the case of the male students taught using the both methods.

Conclusion and recommendation

From the findings and discussion in this paper on the effects of demonstration method and guided-inquiry approach on students' performance in qualitative analysis, the guide-inquiry approach was noticed to be the most effective method that enhances the performance of students in the concept of qualitative analysis regardless of gender.

Thus, the study recommends that Chemistry teachers should implore the use of guided-inquiry method that will allow students' active participation during the learning and teaching process in teaching some basic Chemistry concepts that will encourage discovery.

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