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Research Article

Effectiveness of Enriched Demonstration and Lecture Instructional Strategies on Senior Secondary School Students' Achievement in Chemistry

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Abstract: The study determined the relative effectiveness of enriched demonstration and lecture instructional strategies on senior secondary school students' achievement in Chemistry. To achieve this, two research questions and three hypotheses were formulated to guide the study. Quasi-experimental design: specifically the pre-test, post-test, non-equivalent and non-randomized control group was adopted for the study. A total sample of one hundred and sixty-six (166) SS 1 students, drawn using multi-stage sampling technique were used for the study. The instrument used for data collection was Chemistry Achievement Test (CAT, r=0.82). Mean and standard deviation were used to answer the research questions, while analysis of covariance (ANCOVA) was used to test the hypotheses. Findings from the study revealed that: there is significant difference between the achievement of students exposed to two enriched instructional strategies and those exposed to enriched traditional lecture strategy; there is no significant difference between male and female students exposed to the three modes of instructional strategies; and there is no significant interaction effect between the instructional strategies and gender. It was recommended that chemistry educators should focus attention on reforming or enriching the traditional instructional strategies and that chemistry teachers should particularly make use of the enriched demonstration strategy in their classroom interactions, among others.

Keywords: effectiveness, enriched demonstration, enriched lecture, instructional strategy, students' achievement in chemistry

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Introduction

Chemistry is first introduced to students as a subject at the senior secondary school level of the Nigerian educational system. This level of education is for students of age range of 16-18 years. In recognition of the importance of chemistry to national development as contained in the National Senior Secondary Chemistry Education curriculum, the Federal Ministry of Education (2007) reviewed the senior secondary chemistry curriculum to meet the contemporary needs of the society. The objectives of the revised curriculum, among others are to enable students to acquire basic theoretical and practical knowledge and skills, apply skills to meet societal needs of creating employment and wealth; and be positioned to take advantage of the numerous career opportunities offered by chemistry after further studies at higher institutions of learning. Thus the curriculum is packaged with contents that lead to the achievement of the above objectives.

Consequently, the curriculum content focuses on practical activities with emphasis on inquiry. This calls for activity-based teaching and learning in order to achieve the objectives of the curriculum. The activity-oriented teaching encourages enquiry, questioning, friendly classroom interaction and cooperation of the students, among others. The use of appropriate instructional strategies allows the chemistry teachers to achieve the above objectives.

As a result, various instructional strategies that are activity-based have been advocated by chemistry educators. Some of them are: inquiry/discovery (Oloyede, 2010); co-operative learning (Effandi and Zanatin, 2007); computer-assisted learning (Oyelekan and Olorundare, 2011); concept mapping (Okonkwo, 2012); mind mapping (Okeke, 2011); and personalized instruction (Samuel, 2007). All these instructional strategies and models have been considered to be effective in enhancing students' understanding and high achievement in chemistry. Senior secondary school chemistry teachers have been called upon to adopt them in place of conventional methods of teaching chemistry in order to motivate, arouse and sustain students' interest in chemistry, thereby enhancing their academic achievement in Chemistry.

Despite the emphasis on the use of contemporary and innovative instructional strategies, to enhance students' achievement in chemistry, three years (2007-2009) after the first cycle of the implementation of senior secondary school chemistry curriculum, the academic achievement of students in chemistry was below average in the West African Senior School Certificate Examination (WASSCE) conducted by the West African Examinations Council (WAEC). Within the three years of the second cycle (2010-2012), the academic achievement of the students in Chemistry remained consistently low. The scenario is presented in Table 1.

Year	No Sat	Distinction & Credit (A1-C6)	%
2008	456993	198624	43.46
2009	468546	204725	43.69
2010	565643	236059	50.70
2011	565692	280250	49.54
2012	627302	270570	43.13

Table 1: General Enrolment and Performance of Students in WASSCE May/June Chemistry Examination for the years 2008-2012
Source: WAEC Test Development and Research Unit, Lagos, Nigeria (2013)

Efforts have been made by several chemistry education researchers to identify factors associated with students' low performance in chemistry, especially ten years after the implementation of the new chemistry curriculum. One of the major factors identified by the researchers for this prevailing scenario was teacher-related problem and specifically their refusal and/or inability to adopt innovative instructional strategies such as inquiry, co-operative, guided discovery, concept-mapping, mind-mapping, computer-assisted instruction, game and simulation, and problem-solving that are recommended for the implementation of the revised chemistry curriculum (Lamidi, Oyelekan and Olurundare, 2015; Achimugu and Onojah, 2017). On the other hand, it has been discovered that chemistry teachers predominantly use conventional instructional strategies in teaching chemistry (Oyelekan, Olorundare and Anyimigbo, 2013; Achimugu, 2016). It was further discovered that lecture and demonstration instructional strategies are the most popularly used conventional teaching strategies (Ibe and Nwosu, 2003; Ernest, 2010; Alfa 2012; Atusa and Abdullahi, 2015).

The lecture teaching method, otherwise known as the "chalk and talk" method is one in which the teacher verbally present ideas, concepts and facts to learners. Anaekwe, Nzelum, Olisakwe and Okpala (2010) defined lecture method as a process of delivering verbally a body of knowledge according to pre-planned scheme. The lecture method is the easiest, cheapest and can be used to cover the syllabus and teach large groups of students. However, using this method reduces students to passive listeners and does not encourage the acquisition of critical thinking skills and students' active participation in the lessons. This traditional lecture strategy was used as a control in this study.

Although traditional lecture strategy is heavily criticised, it can be improved upon or enriched by proper planning and encouraging students to ask and answer questions to assure their participation or even combining it with other methods such as questioning and discussion strategies. Therefore, an enriched lecture strategy refers to the strategy that is used in conjunction with other strategies such as questioning skills that will ensure active participation of students in the classroom interaction pattern. In this strategy a good chemistry teacher should ensure a two-way communication pattern and shared responsibility by asking questions and encouraging

students to ask their own questions. A good teacher should direct questions to volunteers and non-volunteers of the class and should also reward good answers to ensure full participation of all the students in the class. This enriched lecture strategy was used in this study as experimental group two.

Demonstration teaching strategy is the process involving displaying, showing and doing activity for the benefit of the students. This method is characterised by showing and listening; doing and observing; using teaching materials and deducing; questioning and answering questions, etc. Demonstration can be carried out by invited guest or class teacher or students. Demonstration method helps students to develop listening skills, observation skills, manipulative skills, interest, and enthusiasm. It also stimulates thinking and concept formation.

Demonstration strategy can be enriched or improved upon if demonstration is experimental and involves problem-solving. It can also be combined with other modes of instruction such as discussion strategy. Therefore, enriched demonstration instructional strategy entails structuring traditional demonstration in the classroom in such a way that the students are at the centre of learning while the teacher acts as a facilitator. In this strategy students are encouraged to carry out the demonstration themselves, while the teacher ensured active participation through questioning, brainstorming and debates during the lesson. By so doing, a good chemistry teacher ensures that students' interest and attention span are captured during the lesson. This enriched demonstration strategy was used in this study as experimental group one.

Many researchers have carried out studies on the effect of demonstration instructional strategy. Some of the studies are discussed in this section. Ibe and Nwosu (2003) investigated the effect of guided inquiry, demonstration and lecture methods of teaching secondary school biology students and found that, students taught using the guided inquiry and demonstration methods performed significantly better than those taught with the lecture method. Nwosu and Nwachukwu (2007) studied the effect of demonstration method on different levels of students' cognitive achievement in senior secondary biology and revealed that students in student-led demonstration group had significant higher mean score in the biology achievement test than the students in conventional lecture method. They also found that there was no significant difference in the scores of male and female students taught with demonstration method. A study by Alfa (2012) on the impact of lecture and demonstration method on students in Physics of remedial class of Niger State College of Education Minna, Nigeria revealed that there was no significant difference between male and female students using demonstration method. A study by Atsua and Abdullahi (2015) on effectiveness of demonstration and lecture methods in teaching economics at senior secondary schools in Benue State revealed that demonstration method was significantly more effective than lecture method in teaching Economics. A study by Adeoye and Abimbola (2016) on the effects of demonstration kit on senior school students' achievement in biology on their scoring levels revealed that the use of demonstration kit significantly improved the overall achievement of students at different scoring levels. A study by Ugwanyi, Nwankwo and Ugwoke (2016) on assessment of the efficacies of power point presentation and demonstration methods on the interest and achievement of students in physics showed that students exposed to power point presentation mode achieved higher than the students exposed to demonstration mode.

If chemistry teachers in Kogi State of Nigeria are not able or willing to utilise innovative instructional strategies but always prefer to use the lecture or demonstration strategy, chemistry educators are challenged to enrich the two strategies and make them student-centered and at the same time determine the relative effectiveness of the two instructional modes and the traditional strategy on students' achievement in chemistry. If the result is positive in favour of enriched instructional strategies, then chemistry teacher will be encouraged to utilise the enriched strategies in their classroom interaction pattern. The task is even more compelling when the literature reviewed above dealt mainly with the traditional demonstration and lecture strategies. Based on this, the present study was set to

determine the relative effectiveness of using enriched demonstration/lecture instructional strategies and traditional lecture strategy on students' academic achievement in chemistry.

The failure rate in the chemistry examinations, continue to dominate science education research efforts and some researchers revealed that female students are not achieving as high as their male counterparts in science subjects. For instance, Nwagbo and Onah (2017) revealed that male students performed better in both innovative and lecture methods than their female counterparts, while other researchers revealed that there is no significant difference in the performance of male and female students when innovative and lecture methods are used (Alfa, 2012; Achimugu and Onojah, 2017). Hence, this review shows that the influence of gender is inconclusive when students are taught science subject using innovative and lecture instructional strategies. This makes the study of gender as a factor a necessity in this study.

1 Purpose of the study

The purpose of the study was to determine the relative effectiveness of enriched demonstration, enriched lecture and traditional lecture instructional strategies on students' achievement in chemistry.

Specifically the study sought to:

1. Compare the mean achievement scores of students taught chemistry using enriched demonstration, enriched lecture, and traditional lecture instructional strategies.
2. Compare the mean achievement scores of male and female students taught chemistry with enriched demonstration, enriched lecture, and traditional lecture instructional strategies.
3. Determine the interaction effect between instructional strategies and gender on students' achievement in chemistry.

2 Research questions

The following research questions were posed to guide the study:

1. What are the mean achievement scores of students taught chemistry using enriched demonstration, enriched lecture, and traditional lecture strategies?
2. What are the mean achievement scores of male and female students taught chemistry using enriched demonstration, enriched lecture, and traditional lecture strategies?

3 Hypotheses

The following hypotheses were formulated and tested at 0.05 level of significance:

Ho_1: There is no significant difference between the achievement of students taught chemistry using enriched demonstration and enriched lecture instructional strategy and those taught using the traditional lecture strategy.

Ho_2: There is no significant difference between the achievement of male and female students taught chemistry using the enriched demonstration, enriched lecture and traditional lecture instructional strategies.

Ho_3: There is no significant interaction effect of the enriched instructional strategies and gender on the academic achievement of chemistry students.

4 Methods

The study adopted quasi-experimental design-pretest, post-test, non-equivalent control group design. The design was used because students were not randomly assigned to groups, instead intact classes were randomly selected and assigned to the experimental groups as well as the control group. The design can be sketched as follows:

GP1	:	Pt_1	X_1	Pt_2
GP2	:	Pt_1	X_2	Pt_2
GP3	:	Pt_1	C	Pt_2

GP1	=	Experimental group One
GP2	=	Experimental group Two
GP3	=	Control group
Pt_1	=	Pre-tests of all the group
Pt_2	=	Post-tests of all the group
X_1	=	Treatment group with enriched demonstration strategy
X2	=	Treatment group with enriched lecture strategy
C	=	Control group with traditional lecture strategy

The target population for the study comprised of all the 1,110 senior secondary one (SS 1) chemistry students in the 22 public and private senior secondary schools in Idah Local Government Area of Kogi State of Nigeria. The sample of the study was 166 SS1 chemistry students. A multi-stage sampling technique was used to select schools from the target population. Firstly, purposive sampling technique was used to select schools that had well equipped chemistry laboratories, qualified chemistry teachers, and had one arm of co-educational chemistry class since gender was a variable. The 12 schools that met the above criteria were subjected to the second stage of sampling involving selection of four schools for the study using simple random sampling technique. An intact class was assigned to each of the instructional strategies (two experimental groups and a control group). The instrument used for this study was the *Chemistry Achievement Test* (CAT). It was developed by the researcher and consisted of fifty (50) objective questions. Each question was scored two marks, making a total of 100% marks. The instrument was validated by the researcher. Bloom's taxonomy of educational objectives and the number of weeks used for instruction for each subtopic was used to construct the table of specification to take care of content validity. Three chemistry education experts and one measurement and evaluation expert were given the instrument to carry out the face validation exercise. Their comments and corrections were effected before the final form of the instrument. Also, the CAT difficulty and discrimination indices were determined to average mean of 0.68 and 0.64 respectively. The reliability of CAT was determined by trial testing on 40 students who were not part of the main study but who had characteristics similar to the students used for the study. The Kuder-Richardson formula (KR-20) was used to estimate its internal consistency which yielded a reliability index of 0.82 which was considered good enough.

Training was given to the four regular chemistry teachers on the enriched demonstration and lecture instructional strategies from the four schools selected for this study. The training lasted for one week. During the training session, the regular chemistry teachers of the enriched demonstration group were exposed to detailed experimental lesson plans on the students-led demonstration to ensure students' participation. While the regular chemistry teachers in the enriched lecture instructional strategy were exposed to a well-planned lesson containing questions and answers section to elicit students' active participation and interaction in the classroom. Pre-test was administered to students in both the enriched demonstration and lecture groups. After the experiment that lasted four weeks, post-test was administered to all the groups. Extraneous variable such as teacher variable, school variable, initial group differences, experimental bias, maturity and history that might affect the study were rigorously controlled. The data obtained was analysed by using mean, standard deviation and analysis of covariance (ANCOVA).

5 Results

The results were presented in line with the research questions and hypotheses that guided the study.

6 Research question one

What are the mean achievement scores of students taught chemistry using enriched demonstration strategy and enriched lecture strategies and those taught using traditional lecture strategy?

		Pre-test		Post-test		Mean Gain
Strategies	N	Mean	SD	Mean	SD	
Enriched Demonstration	59	47.92	7.44	71.74	6.89	23.82
Enriched Lecture	60	49.45	8.58	68.49	7.24	19.04
Traditional Lecture	57	48.57	9.11	56.76	8.89	8.19

Table 2: Mean and Standard Deviation Achievement Scores of Enriched Demonstration and Lecture Strategies.

The mean gain (23.82) of students taught chemistry using enriched demonstration strategy was greater than the mean gain score (19.04) of students taught chemistry using enriched lecture strategy. On the other hand, the mean gain of the enriched lecture (19.04) was greater than the mean gain of students taught chemistry using traditional lecture method (8.19). The data shows that the students in the two treatment groups who were exposed to the enriched demonstration and enriched lecture strategies achieved better than the control group who were exposed to the traditional lecture strategy.

7 Research question two

What are the mean achievement scores of male and female students taught Chemistry using enriched demonstration, enriched lecture and traditional lecture strategies?

			Pre-test		Post-test		Mean Gain
Strategies		N	Mean	SD	Mean	SD	
Enriched Demonstration	Male	34	47.43	7.86	70.86	6.96	23.43
	Female	25	48.62	7.22	72.12	6.74	23.50
Enriched Lecture	Male	36	50.10	8.68	69.10	6.97	19.00
	Female	24	48.76	8.46	67.88	7.45	19.12
Traditional Lecture	Male	34	47.60	8.97	56.82	8.75	8.21
	Female	23	49.54	9.22	57.70	8.99	8.16

Table 3: Mean and Standard Deviation Scores of Male and Female Students Taught Chemistry Using Enriched Demonstration, enriched Lecture and traditional lecture strategies.

The main gain (23.43) of male students taught with enriched demonstration strategy is slightly less than the mean gain (23.50) of their female counterparts taught by the same strategy. The mean gain (19.00) of the male students taught with enriched lecture strategy is also slightly less than the mean gain (19.12) of their female counterparts taught by the same strategy. While the mean gain (8.21) of male students exposed to traditional lecture strategy is slightly higher than mean gain (8.16) of their female counterparts exposed to the same strategy. The supportive hypothesis would indicate whether these observed mean differences are significant or not.

8 Hypotheses

The following hypotheses were formulated and tested at 0.05 level of significance.

Ho_1: There is no significant difference between the achievement of students taught chemistry using enriched demonstration and enriched lecture instructional strategy and those taught using the traditional lecture strategy.

Ho_2: There is no significant difference between the achievement of male and female students taught chemistry using the enriched demonstration, enriched lecture and traditional lecture instructional strategies.

Ho_3: There is no significant interaction effect of the enriched instructional strategies and gender on the academic achievement of chemistry students.

Source	Type III Sum of squares	Df	Mean square	F	Sig	Remarks
Corrected model	5045.5289	6	840.921	61.377	0.000	
Intercept	2167.840	1	2167.480	158.199	0.000	
Pretest	3943.257	1	3943.257	287.801	0.000	
Strategy	1259.586	2	629.793	45.957	0.000	Significant
Gender	5.293	1	5.293	0.386	0.349	Not significant
Strategy gender	87.434	2	43.767	3.194	0.158	
Error	2205.816	161	13.701			
Total	38302.250	166				
Corrected Total	8764.620	165				

Table 5: Analysis of Covariance (ANCOVA) of the Effect of Enriched Demonstration, enriched Lecture and Traditional Lecture Strategies of Students' Achievement in Chemistry

On instructional strategies, the results of ANCOVA presented in Table 5 shows that the calculated value of (45.957) for the effects of enriched demonstration, enriched lecture strategies and traditional lecture on the achievement of students' in chemistry had an associated probability of 0.000. Since the probability value of 0.000 is less than the 0.05 level of significance, the null hypothesis of no significant difference in the mean achievement scores of students taught chemistry using enriched demonstration, enriched lecture strategies and traditional was rejected. This implies that there was

significance difference in the mean achievement scores of students taught chemistry using enriched demonstration, enriched lecture and traditional lecture instructional strategies in favour of enriched demonstration and enriched lecture strategies.

On the influence of gender on students' achievement in chemistry using enriched demonstration, enriched lecture and traditional lecture instructional strategies, the result in Table 5 shows that the F-calculated value of (0.386) had associated probability value of 0.349 which is greater than 0.05 level of significance, indicating that the null hypothesis is not rejected. This means that there is no significance difference between the achievement of male and female students taught chemistry using enriched demonstration, enriched lecture and traditional strategies.

On interaction effect between strategies and gender on academic achievement of students in Chemistry, Table 5 shows $F_{(2:161)}$=3.194, P <0.05 had a calculated associated probability (P) value of 0.158 which is greater than 0.05 level of significance; the null hypothesis is not rejected. This means that there is no significant interaction effect of the enriched instructional strategies and gender on academic achievement of chemistry students.

9 Discussion of findings

The result of this study showed that students who were exposed to the use of enriched demonstration and enriched lecture strategies had a higher mean achievement scores than their counterparts exposed to traditional lecture strategy. Further analysis showed that there was significant difference in the mean achievement scores of students exposed to enriched demonstration and lecture strategies and those exposed to traditional lecture strategy in favour of enriched demonstration and enriched lecture strategies. Judging from the students' pre- and post-test mean scores, there is general improvement on the two enriched instructional modes of teaching. In comparative terms, the finding has confirmed the relative effectiveness of the use of enriched demonstration strategy over enriched lecture strategy. The study showed that students exposed to the enriched demonstration strategy actually made use of equipment, materials and other techniques of learning chemistry thereby stimulating in them the skills of observation, manipulation skills, critical thinking, and concept formulation. Thus, the activity-oriented nature of the enriched demonstration strategy made students in the group to record significant achievement scores compared to their counterparts in enriched lecture strategy. This result is in agreement with previous findings (Ibe and Nwosu 2003; Nwosu and Nwachukwu 2007; Alfa 2012; Atsua and Abdullahi 2015; Adeoye and Abimbola 2016) whose studies indicated that demonstration instructional strategy improve students' critical thinking and problem-solving skills and hence enhance students' academic achievement. Another interesting finding of this study is that students exposed to enriched lecture instructional strategy significantly performed better than students exposed to traditional lecture instructional strategy. This finding equally establishes the fact that students exposed to enriched lecture instructional strategy (which is student-centered) performed better than students exposed to traditional lecture strategy.

One of the educational implications of this finding is that chemistry educators should channel their energies and efforts toward reforming the traditional demonstration and lecture instructional strategies in order that they become more interactive, student-centered and activity-based by combining it with other teaching methods such as questioning and discussion strategies. This approach may be more helpful as every effort to sensitise chemistry teachers to use innovative instructional strategies such as concept mapping, cooperative learning, and discovery/inquiry have fallen on deaf ears as the teachers prefer to use demonstration and lecture modes of instruction than using innovative strategies. This study showed that there is no significant difference between male and female students in their academic achievement in chemistry when taught with the two enriched modes of instructional strategies. This finding is consistent with the findings of Ibe and Nwosu (2003), Asoegwu (2008), Atsua and Abdullahi (2015) who found no significant difference in the academic achievement of male and female

students exposed to the demonstration and lecture instructional strategies. This implies that demonstration instructional strategy is not gender sensitive.

Additionally, this study showed that there was no significant interaction effect between the instructional strategies and gender on the academic achievement of students in Chemistry. The finding of the study is in line with the finding of Igboegwu and Egbutu (2011) on the interaction effect of innovative instructional strategies and gender on students' achievement in chemistry. This implies that both male and female students should be equally encouraged to participate in the enriched demonstration and lecture instructional strategies of teaching and learning chemistry.

10 Conclusion

The study revealed that students that were taught chemistry using enriched demonstration strategy significantly performed better than those taught chemistry using enriched lecture strategy; while the enriched lecture strategy is superior to the traditional lecture strategy in enhancing students' achievement in chemistry. There was no significant difference in the academic achievement of male and female students taught chemistry using the three instructional lecture strategies. As well, there was no significant interaction effect between enriched instructional strategies and gender on students' academic achievement in chemistry. This implies that the enriched demonstration and lecture instructional strategies are gender friendly.

11 Recommendations

1. Teachers are encouraged to use enriched demonstration instructional strategy, since it is empirically established that it is better than enriched lecture strategy in enhancing students' achievement in chemistry.
2. However where the necessary equipment and materials are not available to carry out demonstration, chemistry teachers are encouraged to use enriched lecture strategy in place of traditional lecture instructional strategy.
3. Chemistry educators should focus their research efforts on enriching and reforming the traditional demonstration and lecture instructional strategies to make them more interactive, student-centered and activity-based, since it has been shown that these modes of teaching can enhance students' achievement when enriched.
4. Training workshops, seminars and conferences aimed at equipping chemistry teachers with basic skills on how to use enriched demonstration and lecture instructional strategies in teaching chemistry should be organised on regular basis.

Both male and female students should be given equal treatment when teaching with enriched instructional strategies.

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