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The Effects of Two Teachers' Instructional Methods on Students' Learning Outcomes in Chemistry in Selected Senior Secondary School in Kaduna Metropolis, Nigeria

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Abstract
The study investigated the effect of teachers' instructional methods on students learning outcomes in selected senior secondary school in Kaduna, Nigeria Two instructional methods (Demonstration and Lecture) were used on target population of one thousand nine hundred and eleven (1,911) **senior secondary** (S.S. II) Science Students. The sample consist of 100 Students randomly drawn from two co-educational senior secondary schools within Kaduna North LGA. The students were divided in to two groups: The experimental group and the control group of 50 students each based on a categorization test to ascertain the equivalence of the group. The pretest-posttest quasi-experimental control group design was adapted. The students in the experimental group were exposed to Demonstration Method, while those in the Control group were exposed to the lecture instructional strategy for a period of three weeks. The instrument developed and validated for data collection was Chemical Bonding Performance Test (CBPT). Four research questions were stated and four null hypotheses were tested. The data collected were analyzed using mean, standard deviation, t-test and ANOVA at 0.05 level of significance. The major findings from the study shows that there is significant difference in learning outcome on students exposed to demonstration and lecture strategies used to teach chemistry ($t_{cal} = 0.774 > t_{crit} = 0.443$ and $F_{cal} = 0.771 > F_{crit} = 0.710$ at $P<0.05$) and there is no significant difference in the academic performance of both male and female students exposed to demonstration instruction in teaching chemistry ($t_{cal} = 0.177 < t_{crit} = 0.861$ and $F_{cal} = 0.728 < F_{crit} = 0.781$ at $P<0.05$) . Findings from present study suggest that Chemistry teachers should incorporate demonstration method for teaching at senior secondary school level so as to enhance academic performance and also Curriculum planners should recommend and ensure demonstration method is used for teaching chemistry at senior secondary school among others.
Keywords: Chemistry, learning outcome, gender, demonstration and lecture instructional strategies

1. Introduction

Science has been accorded a prime position worldwide within the context of science education, Chemistry has been identified as a very important science subject and its importance in scientific and technological development of any nation has been widely reported [1]. It was as a result of the recognition given to Chemistry in the development of individual and the nation that has made it a core-subject among the natural sciences and other science-related courses in the Nigerian educational system [2]. It has been a pre-requisite subject for offering most science oriented courses in the tertiary institution.

Teaching methods are the means for helping students to study effectively. Teaching methods concern the tactics teachers use to meet teaching objectives, including instructional organization and techniques, subject matter, and the use of teaching tools and materials. Ameh and Dantani [3] observed that methodology is very vital in any teaching-learning situation and the method adopted by the teacher may promote or hinder learning. It may sharpen mental activities which are the bases of social power or may discourage initiatives and curiosity thus making self-reliance and survival difficult.

Teachings should be involved in "formulating the goals and objectives for teaching procedures that will best achieve those objectives, carrying out procedures, evaluating the successes and failures"[4]. Teaching method is a product of the combination of strategies, tactics and techniques [4].

Shymansky and Kyle [5] were of the view that instructional strategy includes the materials, media, setting and behaviour the teacher uses to create an environment to produce an effect. As a result, the achievement of the instructional goals and the choice of suitable teaching strategies are not separate. Erdem [6] emphasizes four features of teaching strategies. First, teaching strategies should improve a student's predisposition to learning by increasing the desire for studying and understanding new situation. Second teaching strategies should be structured to help learners rapidly capture the information distributed through the instruction, and develop learner's abilities in assimilating and using knowledge possessed. Third, teaching strategies should be sequenced in the most effective manner so that students can comprehend new knowledge by applying their prior experiences. Finally, teaching strategies should be designed to allow students to genuinely engage in their learning.

Different teaching strategies will lead to varied instructional outcomes and an instructor can choose for himself or herself strategies which are appropriate to his or her intension in teaching. A particular strategy may be better than another one for a given purpose. Yet a single strategy may not be applicable for all students and all types of subject matter. Consequently, the selection of strategies should be in accord with an individual population of students and the particular subject matter [6].

The choice of strategies and tactics relies upon the selected learning activities and thus "the key to (teaching) method is to bring about the desired learning in students by selecting the proper strategies and tactics and consequently the proper content and techniques" [4]. According to Nbina and Obamamu [7] teachers should match how to teach with what and to whom to teach, in developing a variety of methods for facilitating student achievement of determined outcomes. Agboola and Oloyede [8] also emphasizes that for effective instruction, a science teacher must able to use several science teaching methods and to implement them where they are applicable and most effective.

The traditional lecture approach often consists of a teacher centered methodology in a face to face capacity [9] . Given the prevalence of this prescribed mode of instruction, there has been a shift in students attending classes with the intention of gaining new and meaningful knowledge. However, the incentive in attending lectures now is to get the current information needed to pass the assessment [10]. In these types of lecture environments, the formal style of lecturing alone has not proven to be effective.

However, researchers have instead found that combining traditional methods of lecturing with learner centered methodologies can be a more productive approach. When instructors allow for a brief traditional lecture followed by discussions, group work, or application, students demonstrate a better understanding of the material [11]. Knight and Wood [12] additionally sought to replace some lecture time with "interactive engagement and cooperative work". Indeed, as instructors have labored to accommodate learners, the structure of lectures has taken on more innovative techniques. Chemistry as a science subject is bulky in nature. The subject teachers usually adopt lecture method in teaching in order to cover the syllabus within the stipulated time and this do not give room for proper understanding of the subject.

According to Achounye [13] demonstration approach is a practical method of teaching. It involves showing, doing and telling something. The onus is therefore on the teacher to display the steps in the process and explain them accurately and clearly, while students are expected to practice by repeating the things the teacher has done. This method have been noted for bridging the gap between theory and practice [14]. It controls the rate of breakages and accidents as students watch the teacher do it before attempting to do the same and enable the teacher to teach manipulative and operational skills.

Students' persistent poor performance has been partly ascribed to inadequate teaching and instructional methods adopted by science teachers[3]. Ifemuyinwa, [14] reported the deplorable performance of secondary school students in science subjects and identified persistent use of the traditional mode of instruction as one of the major short-coming affecting the learning and higher achievement in science subjects. The situation is further exacerbated by the abysmal performance recorded in NECO/WAEC Annual report for 2010-2014 [16,17] for chemistry and other allied sciences. This therefore calls for the adoption of activity-based strategy that will not only be stimulating and motivating to the learners but should also have the potential of improving learning outcomes significantly.

It is in view of the foregoing, that this study was initiated to examine the acquisition of chemistry knowledge in the classroom using two instructional strategies: lecture and demonstration methods with the aim of determining the effect of each method on the learning outcomes of students in Senior Secondary School Year two (SS II) in Kaduna North Local Government Area of Kaduna state, Nigeria.

2 Purpose of the study

The purpose of the study is to investigate the effect of two instructional methods on senior secondary school students' learning outcomes in chemistry in Kaduna North Local Government Area of Kaduna State using the following methods of instruction. Specifically the study set to investigate:

i. the difference in the academic achievement of students exposed to lecture method and those exposed to demonstration.
ii. the difference in the academic achievement between male students taught demonstration method and exposed to lecture method .
iii. the difference in the academic achievement between female students taught demonstration method.
iv. the difference in the academic achievement of male and female students taught using lecture method and those taught by demonstration method.

3 Research questions

The following research questions were formulated to guide the study

i. What is the difference in the learning outcome of students exposed to lecture method and those exposed to demonstration?
ii. What is the difference in the learning outcome of male students taught using lecture method and those taught using demonstration method?
iii. What is the difference in the learning outcome of female students taught using lecture method and those taught using demonstration method?
iv. What is the difference in the learning outcome between male and female students taught using demonstration method?

4 Null hypotheses

The following null hypotheses were formulated at 5% level of significance

H_o1: There is no significant difference in learning outcome of Chemistry students exposed to lecture and demonstration methods.

H_o2: There is no significant difference in achievement of male Chemistry students exposed to lecture method and those taught using demonstration method.

H_o3: There is no significant difference in achievement of female Chemistry students exposed to lecture method and those taught using demonstration method.

H_o4: There is no significant difference in learning outcome between male and female Chemistry students taught using demonstration method.

5 Methodology

5.1 Area and Population of the study

The population of the study comprised SS II science students in the 15 public senior secondary schools that offered Chemistry in Kaduna North Local Government Area of Kaduna State. SS II students were chosen because they are more stable in terms of statistical sampling than SS I and SS III. The population comprised of single-sex and co-educational schools. There were seven male schools, four female schools and four co-educational schools in the population.

The total number of students in the population was 1911 comprising of 1108 males and 803 females. The age range of the students was between 16 and 20 years, and most of them attended public primary schools located at various wards of the local government area of study. It is from this population that the sample for the study was chosen.

5.2 Sample and sampling techniques

One hundred students served as sample for the study. Since gender is one of the variables in the research, purposive sampling procedure was adopted to ensure subjects chosen that is, both male and female had similar background, experience and environmental exposure. Four co-educational schools were chosen for the research to ensure that both male and female students were exposed to the same mode of instructions under the same condition. Therefore only the 9 co-educational schools were chosen out of 17 schools in the population. 20% of students from the sample in each school were used for the study which is in accordance with the central limit theorem by Tuckman in Muhammed [18] who recommended a minimum of 30 subjects as sample for experimental research.

5.3 Instrumentation

One instrument was used for the study. This was the Chemical Bonding Performance Test (CBPT). It was developed with the aim of testing students understanding of chemical bonding. The test was adopted from West African Examination Council (WAEC) past questions papers for the duration period of 2010 – 2015 Chemistry examinations because the content of the questions consist of the major areas to be covered in the research such as forces within molecules, the ionic bond, covalent bond, overlaps of atomic orbitals, bond polarity: dipoles, metallic bond and intermolecular forces. Also, the instrument consist of twenty-five (25) multiple choice test item.

5.3.1 Pilot Study

The Chemical Bonding Performance Test (CBPT) was subjected to pilot testing testing using a sample of 45 SSII students at Government Technical College, Malali was used to test the instrument.

The purpose of the pilot study according to Olorukooba [19] is to:

(a) Find out the weaknesses of the design and effect corrections where applicable before the main study.
(b) Workability of the design of the study, in a field setting.
(c) Determine the appropriate time duration for the subjects to write the tests.
(d) Establish the characteristcs of the instrument such as the item analysis, item difficulty, and facility indices.

(e) Provide further information such as the reliability of the instrument for the research.
(f) Test the workability of the hypotheses formulated for the study based on data generated from a smaller but identical sample selected for the main study.
(g) Establish the difficulty and discrimination level of the items.

5.4 Validity and Reliability of research instrument

Before the questions were administered, they were subjected to content and face validity by scrutiny of specialists in chemistry and curriculum, to determine the appropriateness or otherwise of the questions for the purpose of the research. In this way, an attempt was made to validate the instrument to ensure that it measures what it is suppose to measure.

The degree of error or precision in which an instrument measures what it is supposed to measure is called its reliability [20]. A test is said to be reliable if repeated measurements using the test gives more or less the same results. The data obtained from the pilot study was used to calculate the reliability of the instruments.

Chemical Bonding Performance Test (CBPT) was used to ascertain its reliability using Statistical Package for Social Sciences (SPSS), the reliability coefficient of the instrument was computed to be 0.654. This indicated that the test was reliable and as such it will measure what it was suppose to measure.

5.5 Method of data collection

The procedure for data collection is described as follows:
Before the commencement of the treatment, a pretest was administered to both the experimental and control groups.

The scores of the pretest was analyzed to determine if there is any difference in the performance of the students in the experimental and control groups.

The study was conducted for a period of three weeks during which the topic Chemical bonding was taught which was broken down into sub-topics as follows: forces within molecules, the ionic bond, covalent bond, overlaps of atomic orbital, bond polarity: dipoles, metallic bond and intermolecular forces. The researcher worked in conjunction with Chemistry teacher in these schools. A pre-test was administered to the whole students that constituted the population for the study before being divided into groups where treatments are given and post-test was also administered to all students as well.

The researcher also mapped out lesson plans and notes that indicated the topics taught and the procedures taken for a period of three weeks.

In the first group (i.e. Experimental group) which consists of fifty students, the students were exposed to demonstration method of teaching and the second group (i.e. Control group), the students were subjected to the lecture method of teaching which consist of fifty students as well.

5.6 Method of data analysis

Scores from the experimental and control groups formed the data for the study. Data collected were analysed using the mean, variance, standard deviation (S.D), ANOVA statistical tool and t-test statistic at 0.05 level of significance using WINKS SDA version 7.0.6.

6 Results

The results obtained from the data analysis are presented in Tables 1 to 8 and were used to test the stated hypotheses.

The students used for the study in both experimental and control groups were subjected to pre-test which was marked and recorded.

Table 1: Comparison mean academic achievement scores of the pre-test for the Experimental and Control group

Groups	N	$\overline{X}$	S.D p- value	*Df*	t-value
Experimental	50	38.82	14.15034	49	-6.913
			0.000		
Control	50	54.82	13.38243		

Not significant at $p \leq 0.05$; $df = 49$

The scores obtained were compared using the t-test statistics and are presented in Table 1, it is evident that there is no significant difference between the experimental and control group in their pre-test mean scores.

This means that the students of both groups were equal in terms of their prior knowledge on the selected topics at the start of the study.

H_o1: *There is no significant difference in learning outcome of Chemistry students exposed to lecture and demonstration methods.*

The answer to research hypotheses one is summarised in Table 2 and 3.

Table 2: t-test statistics for comparison of the post-test mean scores of the Experimental and Control group

Group	N	Mean	Std. Error	Std. D	Df	t-value	p-value	Remark
Experimental	50	54.06	1.3194	9.3294				Rejected
Control	50	52.80	1.1468	8.1090	49	0.774	0.443	

Not significant at $p \leq 0.05$; Df = 49

Table 3: ANOVA statistic for comparison of the post-test mean scores of the Experimental and Control group

Variations	Sum of squares	Df	Mean square	F- Value	P-value	Remark
Between Groups	1239.544	17	72.914			Rejected
Within Groups	3025.276	32	94.540	0.771	0.710	
Total	4264.82	49				

To test this hypothesis, Chemical Bonding Performance Test (CBPT) post mean scores of both the experimental and control groups were compared using the t-test statistics. The result of the t-test is as shown in Table 2 and it was found that calculated value (0.774) is greater than the tabulated value (0.443), therefore we reject the null hypothesis. Also, the hypothesis was tested using ANOVA statistics and the result was presented in Table 3 above, the values shows that the F-value (0.771) is greater than P-value (0.710), which also suggest we reject null hypothesis.

The result obtained from both t-tests and ANOVA tests show that there is significance difference between the two group's in terms of their learning outcome in the post test. This means experimental group had higher score than the control group, and also shows that student exposed to demonstration method perform better than students exposed to lecture method the null hypothesis is therefore rejected.

H_o2: *There is no significant difference in achievement of male Chemistry students exposed to lecture method and those taught using demonstration method*

The answer to research hypotheses two is summarised in Table 4

Table 4 : t-test statistics for comparison of the post-test mean scores of male in the Experimental and Control group.

Group	N	Mean	Std. Error	Std. D	Df	t-value	p-value	Remark
Experimental	25	56.16	2.2477	11.2386				Rejected
Control	25	53.44	2.2287	11.1433	24	0.814	0.424	

Not significant at $p \leq 0.05$; Df = 25

Table 5 : ANOVA statistics for comparison of the post-test mean scores of male in the Experimental and Control group.

Variations	Sum of squares	Df	Mean square	F-value	P-value	Remark
Between groups	2100.16	12	175.013	2.255	0.087	Rejected
Within groups	931.200	12	77.600			
Total	3031.36	24				

The hypothesis was tested by using the Chemical Bonding Performance Test (CBPT) post-test mean scores of male in the experimental and control group. The mean were compared using t-test statistics and result presented in Table 4 and it was found that calculated value (0.814) is greater than the tabulated value (0.424), therefore we reject the null hypothesis. Also, the hypothesis was tested using ANOVA statistics and the result was presented in Table 5 above, the values shows that the F-value (2.255) is greater than P-value (0.087), which also suggest we reject null hypothesis.

It can be deduced from the tables 4 and 5 that there is significant differences in the post-test means scores between the boys within the lecture and demonstration method. This means the boys of the experimental group are better than those of the control group. The hypothesis is therefore rejected.

From the above result, one can conclude that demonstration method was more effective than lecture method in teaching Chemistry. This shows that the demonstration method facilitated the students understanding of the subject and thus better performance compared to the lecture method.

H_o3: *There is no significant difference in achievement of female Chemistry students exposed to lecture method and those taught using demonstration method*

The answer to research hypotheses three is summarised in Table 6 and 7.

Table 6: t-test statistics comparison of the post-test mean scores of female in the Experimental and Control group.

Group	N	Mean	Std. Error	Std. D	Df	t-value	p-value	Remark
Experimental	20	55.20	2.1121	9.4457				Rejected
Control	20	52.20	2.3029	10.2987	19	0.886	0.386	

Not significant at $p \leq 0.05$; Df = 25

Table 7: ANOVA statistics comparison of the post-test mean scores of female in the Experimental and Control group.

Variations	Sum of squares	Df	Mean square	F- Value	P-value	Remark
Between Groups	1057.200	10	105.72	1.491	0.280	Rejected
Within Groups	638.00	9	70.889			
Total	1695.200	19				

The hypothesis was tested by using the Chemical Bonding Performance Test (CBPT) post-test mean scores of female in the experimental and control group. The mean were compared using t-test statistics and result presented in Table 6 and it was found that calculated value (0.886) is greater than the tabulated value (0.386), therefore we reject the null hypothesis. Also, the hypothesis was tested using ANOVA statistics and the result was presented in Table 7 above, the values shows that the F-value (1.491) is greater than P-value (0.280), which also suggest we reject null hypothesis.

It can be deduced from the tables 6 and 7 that there is significant differences in the post-test means scores between the girls within the lecture and demonstration method. This means female exposed to demonstration involving manipulation perform better than those taught using lecture method. The hypothesis is therefore rejected.

H_o4: *There is no significant difference in academic achievement between male and female Chemistry taught using demonstration method.*

The answer to research hypotheses four is summarised in Table 8 and 9.

Table 8: t-test statistics comparison of the post-test mean scores of female in the Experimental and Control group.

Group	N	Mean	Std. Error	Std. D	Df	t-value	p-value	Remark
Experimental	25	52.52	2.5253	12.6264				Accepted
Control	25	51.96	2.4823	12.4113	24	0.177	0.861	

Not significant at $p \leq 0.05$; Df = 24

Table 9: ANOVA statistics comparison of the post-test mean scores of female in the Experimental and Control group.

Variations	Sum of squares	Df	Mean square	F-value	P-value	Remark
Between groups	2097.073	15	139.805	0.728	0.781	Accepted
Within groups	1729.167	9	192.130			
Total	3826.24	24				

To determine whether the performance of the boys and girls differed following the respective treatments, the post-test mean achievement scores were subjected to t-test.The result is as shown in Table 8 and 9. From the results obtained, it can be seen that there is no significant difference in the post-test mean achievement scores between males and females taught using demonstration method. Based on this result, the null hypothesis is accepted. The implication of this is that demonstration method tends to promote homogeneity of performance between boys and girls. In other words, demonstration method is not gender bias in learning outcomes.

7 Discussion

The results of this study has added yet another empirical evidence to the library of data on the efficacy of the demonstration instructional strategy in the teaching and learning of chemistry. The experimental group produced higher mean achievement scores than the control group taught chemistry bonding using the traditional methods. The importance of deeper learning as a means of developing learners' capacity to apply knowledge gained during the learning process was reflected in this study since the students taught through the demonstration method produced enhanced learning outcomes. Students' active participation, their interaction in groups and the teacher's role as facilitator of thought provoking questions might have enhanced students' achievement in

chemical bonding tests. Findings from this study is consisted with those of earlier investigators and activity-based proponents [3,8,14,21,22,23,24].

As to the effect of gender, findings from present study suggest that irrespective of the sex, status of the student, demonstration teaching method has positive effects in enhancing learning outcomes.. This discovery therefore showed that both male and female students when exposed to the treatment of demonstration teaching method perform well in their academic mean scores implying that both male and female derive almost equal benefit from being taught using the demonstration teaching method. This is particularly instructive because a number of teacher instructional strategy tends to be gender bias in favour or against a particular sex. For example, Shaibu and Mari [25] and Lawal[26]explained that female subjects were significantly better than their male counterparts and that there was a significant difference between the male and female subjects in their ability to solve quantitative problems. Jegede[27] and Omwrhiren [28] observed that male subjects were significantly better than their female counterparts. However, Muhammad [18] and Opara and Waswa[23] in their separate studies saw no significant difference in achievement between gender. This implies that theuse of demonstration. method is good for both boys and girls. Odubunmi and Onafowokan(2003), observed no difference in performance based on gender when the subjects were taught using Hands-on experience method of teaching basic science at junior secondary school level. Bichi [20], revealed that there was no significant difference in the performance of both male and female students in the study on Effects of problem solving strategy and enriching curriculum on senior secondary school students achievement in evolution concepts using problem solving instructional method.

The findings of this study have implications for chemistry and science teaching in Nigeria secondary schools. The persistent failure of students in chemistry could be arrested if teachers were better equipped with effective strategies such as the demonstration instructional strategy. The researchers advocates that teachers should not only be seen as agents of knowledge transmission but also that of alienating or transferring ownership of learning to their students. Classroom lessons and environment should be organized in such a way as to elicit learners' potential to think creatively, participate actively and reflectively.

8 Conclusion

This study reaffirms the previous studies which suggest that, the demonstration instructional method of teaching enhances the learning outcomes of senior secondary school students towards chemical bonding. Therefore the demonstration instructional method is viable and has potential to enhance senior secondary school students' academic achievement in chemistry. The teaching of chemical bonding, using the demonstration instructional method was found to be independent of gender . This means that, both boys and girls showed enhanced learning outcome in the use of demonstration instructional strategy. In summarizing our findings, we conclude that these results apply to public secondary schools in Kaduna metropolis. We cannot say whether these relationships apply to other institutions of secondary education. No doubt our results remains open and certainly suggest avenues for further research and it would be desirable to examine these relationships using data from more than one institution. Nonetheless, we have found demonstration instructional strategy a significant predictor of learning outcome in chemistry.

9 Recommendation

In view of the findings arising from present study, we recommend that:

1. Chemistry teachers should incorporate demonstration method for teaching at senior secondary school level so as to enhance academic performance
2. Curriculum planners should recommend and ensure that the demonstration method is used for teaching chemistry at senior secondary school level.
3. The demonstration teaching method should be applied to both male and female in view of its gender friendly nature.
3. Teachers should sponsored by the government and other educationally friendly stakeholders to attend workshops and seminars on the appropriate and effective use of the demonstration teaching method in the realization of enhanced learning outcome in chemistry among senior secondary school students Kaduna state.
4. The Ministry of Education as an agency of Government should provide all the needed instructional and infrastructural facilities for the effective application of demonstration teaching method in Chemistry in the senior classes in Kaduna metropolis .
5. More topics in chemistry at this level of instruction should be tested using the teachers' instructional method in order climes so as to compare findings.

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