

EFFECTS OF COOPERATIVE INSTRUCTIONAL STRATEGY ON MALE AND FEMALE SENIOR SECONDARY SCHOOL CHEMISTRY STUDENTS' ACADEMIC ACHIEVEMENT AND RETENTION IN ADAMAWA STATE, NIGERIA

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Abstract

This study investigated the effects of Cooperative Instructional Strategy on Senior Secondary School Chemistry Students' Academic Achievement and Retention in Adamawa State. Two research questions guided the study while two null hypotheses were formulated and tested at 0.05 level of significance. A pre-test, post-test, non-equivalent control group Quasi experimental research designed was employed for the study. The population of the study was 1,343 students, which consisted of all the Senior Secondary One (SS I) Chemistry students in Adamawa State. The study sampled 112 students selected using multi-stage sampling technique from two public senior secondary schools. The instrument used to generate data for the study was Chemistry Achievement Test (CAT). The instrument was validated by three experts. Kuder-Richardson (KR-20) reliability technique was used to test the reliability of the instrument. A reliability coefficient of 0.87 was obtained. Mean and standard deviation were used to answer the research questions, while the hypotheses were tested at 0.05 level of significance using Analysis of Covariance (ANCOVA). The findings of the study revealed among others, gender seems to have some effects on students' academic achievement in Chemistry; there is little or no difference in the mean retention scores of male and female students taught Chemistry with cooperative, individualize and lecture method and gender is not a significant factor affecting students' retention in Chemistry when taught under cooperative instructional strategies. The study recommended among others, that Chemistry teachers should adopt the use of instructional strategies such as cooperative instructional strategy to encourage social interaction, active engagement and self-motivation among learners.

Keywords: Cooperative instructional strategy, Academic achievement, Retention, Gender, Chemistry

Introduction

Science education has its focus on preparing individual with appropriate skills, abilities and competencies both mental and physical to live and contribute to the development of the society. Chemistry is an integral part of Science, Technology, Engineering and Mathematics (STEM) (Nneka, 2015). Chemistry is a natural science, which plays very crucial roles in scientific and economic development of nations. It is the study of the nature and properties of all forms of matter as well as substances that make up our environment and the various changes, which these substances undergo in different conditions (Umaru, 2015). Chemistry occupies a central position among the sciences due to its remarkable contribution in Medicine, Biochemistry, Microbiology, Pharmacy, Textile industry, Engineering, Petroleum and Agriculture to mention but a few (Jegede, 2010). The world is regarded as a chemical world because everything in the environment consists of one chemical substance or the other. In view of the foregoing, the importance of Chemistry as one of the potent tools for a nation's overall sustainable development can hardly be overemphasized. Consequently, Nigeria hopes to achieve technological and economic development and self-reliance for her citizens through science education.

Many researchers agreed that the conventional lecture method does not help students construct their own understanding and opined that the uninspiring teaching methods adopted by science teachers lead not only to low achievement in the science but also incapacitates students from developing required skills necessary for creative thinking (Igboanugo, 2013 & Nneka, 2015). The lecture method is a teaching method in which the teacher presents a verbal discourse on a particular subject, theme or concept to the learners, the teacher delivers preplanned lessons to the students with little or no instructional aides (Ogbonne & Offorma, 2013). Danmole (2011) noted that teachers need to employ different learning methods and strategies to ensure students understanding of scientific concepts. A shift is therefore advocated by researchers to methods that will enable the learner construct his/her own understanding (Samba *et al.*, 2012; and Samba & Lortim, 2014). Such methods have their roots in constructivism. This trend is learner centered and among these strategies are the cooperative and individualized instructional strategy.

Cooperative instructional strategy is a systematic pedagogical strategy that encourages small groups of students to work together for the achievement of common goals (Umaru, 2015). During cooperative instruction, students are grouped heterogeneously in four or five based on sex, academic abilities and tribe/state/race, among others, and work together in small group where each individual of the group interact with one another until the assigned task is successfully accomplished under the guidance of the teacher (Omoregbe & Ewansiba, 2013). Gender is one of the variables that may determine students' achievement when cooperative learning is adopted for classroom instruction. Gender is the grouping of people into feminine and masculine through interaction with caretaker and socialization in childhood (Ezenwosu & Nworgu, 2013). Jimoh, Idris and Olatunji (2016) corroborated by explaining that gender is the ascribed attributes that differentiate feminine from masculine. From the above, gender is the socially defined capabilities and attributes assigned to persons on the basis of their alleged sexual characteristics (Abul, 2007). There is a general belief in Nigeria that males are superior to females in terms of physical fitness, cognition, logical reasoning and even academic achievement.

According Ezenwosu and Nworgu, (2013), male students perform better in practical oriented subjects like physics, mathematics, statistics and accounting. Attesting to this, Chiansons, Kurumeh and Obidah (2010) observed that boys perform better than girls in circle geometry subjects while girls excel in languages. On the contrary, Ozofo (2001) found out that females achieve better than males in mathematics. Consequently, the above research evidences concerning gender difference on academic achievement may not be ignored by the researcher. Academic achievement is the degree of success attained by students after being exposed to one form of learning or the other. Jimoh, Idris and Olatunji (2016) opined that academic achievement is the level of success attained by student in school subjects. In the world of it is the degree of success reached in some general or specific area of study. Academic achievement is the success achieved by students in some general or specific area of study or fieldwork (Ezenwosu & Nworrugu, 2013). It is commonly measured using classroom exercise, assignment and continuous assessment as well as internal and external examination (Jimoh, Idris & Olatunji, 2016). Academic achievement can be used to indicate students' level of success in a particular task previously exposed to and it can also be used as indices for determining students' ability to effectively undertake another task (Jimoh, Idris & Olatunji, 2016). Research study by Umaru, Abdulwahid & Mustapha (2014) have shown that low academic achievement in Chemistry is due to poor understanding of the basic concept, lack of teaching aids and textbooks that reflect the students' environmental needs, low level and low quality of cognitive interactions with teachers, and language problems. All these compel students to memorize and regurgitate facts and principles (Ajaja & Eravwoke, 2010). Several researchers (Woods, 2007; Eablewood, Simsek, Yilar & Kucuk 2013; Odoh, 2013) have

therefore suggested that use of alternative contemporary teaching method, which reflect the constructivist approach to learning, may help to facilitate the teaching and learning of the subject, may lead to success, and increase students' interest in the subjects.

Retention is the ability to reproduce a learnt concept or skills when the need arises. For so long, researchers have been keen on knowing what can be done by teachers to enhance maximum retention of knowledge or skills long after they have been acquired whether in the classroom or outside the classroom (Agu & Samuel, 2018). Generally, it is believed that the more the human senses are brought into interaction during the learning process, the greater the retention capacity of the learner. This explains why the use of varied teaching methods is increasingly advocated in the education industry. The ability of students to retain knowledge and skills better after completing a course is becoming increasingly relevant and a focus on deep learning and represents a priority for educational research in general (Darlan & Carmicheal, 2012). In promoting greater achievement, some studies reported that co-operative learning also foster greater retention of learning as indicated by students' results (Sousa, 2006). Tran (2014) reported that a blend of 'telling' and 'showing' techniques results in greater retention of 65 percent. Based on the forgone, the present study intends to use cooperative strategy, in teaching some difficult concepts in Chemistry such as nature of matter and separating techniques to see or observe their effect.

Statement of the Problem

There has been a general outcry in most of our Secondary Schools from both students and teachers of Chemistry on ways of overcoming the difficulties in the subject (Olorundare, 2014). Students complain that the subject has formulas and structures which its nomenclatures do not follow a regular and specific pattern. They also claim that the calculations in the subject are so much with limited time to master them before writing their examinations (Olorundare, 2014). To make the situation worse, majority of the students say that the Chemistry teachers do not know how to teach the subject (Abungu, Okere & Wachanga, 2014).

On the part of the teachers, they claim that most of the students lack the interest to learn. It is obvious that teachers and students are involved in the teaching-learning process every week with the same unchanged story line 'difficult subject' (Adejo, 2015). The issue is the efficacy of the teaching methods used by teachers. It has been noted that teachers continue to use the traditional method instead of activity-oriented method on the students. The traditional method is not student centered and activity-oriented as required by the nature of science and its use may be the cause of students' poor academic achievement in Chemistry (Amin, 2016). In order to address these issues, it is therefore, important to study the impacts of innovative teaching method such as cooperative and individualized instructional strategy on students' academic achievement in Chemistry to determine which is more effective.

Research Questions

- (i) What are the mean achievement scores of male and female secondary school students taught Chemistry with cooperative instructional strategy and lecture method?
- (ii) What are the mean retention scores of male and female secondary school students taught Chemistry with cooperative instructional strategy and lecture method?

Research Hypotheses

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

H₀₁: There is no significant difference between the mean achievement scores of male and female Chemistry students taught using cooperative instructional strategy and those taught using lecture method.

Ho₂: There is no significant difference between the mean retention scores of male and female Chemistry students taught using cooperative instructional strategy and those taught using lecture method

Methodology

The quasi-experimental research design that employed a pretest-posttest, non-equivalent control group was used for the study. The non-equivalent control group was used because, it is natural to use intact classroom in a school for a quasi-experimental study than to start creating groups through random selection (Sambo, 2005). Symbolically the design for this study can be presented as follows:

$$\begin{array}{ccccccc} E & O_{E1} & \rightarrow & X_J & \rightarrow & O_{E2} & \rightarrow & O_{E3} \\ C & O_{C1} & \rightarrow & X_L & \rightarrow & O_{C2} & \rightarrow & O_{C3} \end{array}$$

Where E is the experimental group exposed to cooperative learning strategy, C is the control group exposed to lecture method of teaching; O_{E1} and O_{C1} are the pre-test for the experimental and control groups respectively; O_{E2} and O_{C2} are the post-test for the experimental and control groups respectively; O_{E3} and O_{C3} are the retention test for the experimental and control groups respectively, X_C is the treatment with cooperative instructional strategy and X_L is the treatment with lecture method. The experimental and the control groups were pre-tested to determine the entry behavior of the groups. The experimental group (E_1) was taught using the treatment (X_C) i.e. cooperative instruction strategy. The control group (C) was taught using the lecture method (X_L). All the groups were taught for four (4) weeks, after which the two groups were post-tested. Two weeks after the post-test, the retention test was administered.

A sample size of 112 Senior Secondary I Students were selected through multi-stage sampling technique. At first-stage, a simple random sampling technique (raffle draw) was used to select one Education Zone out of the five Education Zones in Adamawa State. The probability equal to one strategy was employed while selecting the zones. The second-stage was the use of simple random sampling to select one local government out of the four local government areas in Yola Educational Zone of Adamawa State. The third-stage was the use of purposive sampling technique to select two schools with adequate teaching facilities and qualified Biology teachers for the experimental activities. Simple random sampling technique was used to select one school and assigned for experimental treatment condition, while the other one for control group. The instrument used for data collection was Chemistry Achievement Test (CAT) constructed by the researcher based on the Chemistry topics of Nature of Matter and Separation Techniques taught which was part of SS I Chemistry curriculum. The validation of CAT was done by three specialists in the Department of Life Science Education, and Department of Organic Chemistry of Modibbo Adama University Yola. The Items of the CAT was trail tested on 40 students in Government Secondary school in Fufore local government area which is not part of this study to ascertain the internal consistency. Kuder-Richardson (KR-20) reliability technique was used to estimate the reliability of the CAT. The reliability coefficient obtained was 0.87.

The regular Chemistry class teachers were used for the study in both experimental (cooperative instructional strategy) and control group (lecture). Training was given to the Chemistry teacher who took the experimental group on the application of the cooperative instructional strategy, while the Chemistry teacher who took the control group used the lecture method. The teachers explained the features and practice of cooperative instructional strategy to the students. The experimental class teacher was given lesson prepared by the researcher while the researcher vetted the lesson plan prepared by the Chemistry teacher in the control group to ensure that the teachers did not deviate from the procedures of instructions

commonly used by Chemistry teachers. Chemistry Achievement Test (CAT) was used for both pre-tests before treatment, post-test after treatment and retention test two weeks after post-test. Mean and standard deviation was used for answering the research questions, and Analysis of Covariance (ANCOVA) was used for testing the hypotheses at 0.05 level of significance.

Results

Research Question One: What are the mean achievement scores of male and female secondary school students taught Chemistry with cooperative instructional strategy and lecture method?

Table 1: Mean achievement test scores of male and female secondary school students taught Chemistry with cooperative instructional strategy and lecture method

Gender	Cooperative				Lecture			
	N	Pre test	Post test	Mean gain	N	Pre test	Post test	Mean gain
Male	27	28.11	45.52	17.41	36	26.85	42.19	15.34
Female	22	30.23	46.86	16.63	27	27.16	42.32	15.16

Key: *N* = number of respondents

The result presented in Table 1 shows that for the students taught Chemistry with cooperative instructional strategy, the males had a pre-test achievement mean score of 28.11, post-test achievement scores of 45.52 and a mean gain of 17.41. For the females, the pre-test achievement mean score was 30.23, a post-test achievement mean score of 46.86 and a mean gain of 16.63 was obtained. For the lecture group, result shows that the male had a pre-test achievement score of 26.85, a post-test mean achievement score of 42.19 and a mean gain of 15.34. For the females, a pre-test achievement mean score of 27.16, a post-test achievement mean score of 42.32 and a mean gain of 15.16 was obtained. This shows that the male students taught Chemistry with cooperative instructional strategy have achieved higher than their female counterparts under the two learning groups.

Research Question Two: What are the mean retention scores of male and female secondary school students taught Chemistry with cooperative instructional strategy and lecture method?

Table 2: Mean and Standard deviation of retention test scores of male and female secondary school students taught Chemistry with cooperative instructional strategy and lecture method

Gender	Cooperative			Lecture		
	N	$\bar{x}$	SD	N	$\bar{x}$	SD
Male	27	49.88	1.91	36	43.85	2.08
Female	22	46.45	4.68	27	41.88	2.09

Key: $\bar{x}$ = mean, *N* = number of respondents, *SD* = Standard Deviation

Result in Table 2 shows that the males in cooperative group had a mean retention score of 49.88 with a standard deviation of 1.91 while the females had a mean retention score of 46.45 with a standard deviation of 4.68. For the lecture group, a mean retention score of 43.85 with a standard deviation of 2.08 was obtained for the male while for the females, a mean retention score of 41.88 with a standard deviation of 2.09 was obtained. Results showed that there is a little or no difference in the mean retention scores of male and female students taught Chemistry with cooperative and lecture method.

Testing of Hypotheses

Research Hypothesis One: There is no significant difference between the mean achievement scores of male and female Chemistry students taught with cooperative instructional strategy and those taught using lecture methods.

Table 3: Analysis of Covariance on significant difference between the mean achievement scores of male and female Chemistry students taught with cooperative and lecture method

Sourced	Type III Sum of Squares	df	Mean Square	F	Sig.	Decision
Corrected Model	486.249	6	81.042	12.291	.000	
Intercept	7149.921	1	7149.921	1084.364	.000	
Pre-test	9.413	1	9.413	1.428	.234	
Group	429.443	2	214.722	32.565	.000	
Sex	.201	1	.201	.031	.861	Accept
Group * Sex	54.310	2	27.155	4.118	.018	
Error	1160.483	176	6.594			
Total	356551.000	112				
Corrected Total	1646.732	111				

a. R Squared = .295 (Adjusted R Squared = .271)

The result in Table 3 shows that with respect to the academic achievement scores of male and female students taught Chemistry with cooperative instructional strategy and lecture, an F-ratio of .031 was obtained with associated probability value of 0.86. Since the associated probability value (0.86) is greater than 0.05 set as bench mark, the null hypothesis (H_{01}) which stated that there is no significant difference between the mean achievement scores of male and female Chemistry students taught with cooperative instructional strategy and those taught using lecture method was accepted. Thus, inference drawn in that, male and female students taught Chemistry with cooperative and lecture method did not differ significantly in their academic achievement. This result showed that gender is not a significant factor affecting students' academic achievement when taught Chemistry with cooperative and lecture method.

Hypothesis Two: There is no significant difference between the mean retention scores of male and female Chemistry students taught with cooperative instructional strategy and those taught using lecture method.

Table 4: Analysis of Covariance on significant difference between the mean retention scores of male and female Chemistry students taught with cooperative and lecture method

Sourced	Type III Sum of Squares	df	Mean Square	F	Sig.	Decision
Corrected Model	1050.091	6	175.015	41.465	.000	
Intercept	7388.863	1	7388.863	1750.586	.000	
Pre-test	.500	1	.500	119	.731	
Group	898.349	2	449.174	106.419	.000	
Sex	20.250	1	20.250	4.798	.030	
Group * Sex	114.146	2	57.073	13.522	.000	Accept
Error	742.860	176	4.221			
Total	388745.000	112				
Corrected Total	1792.951	111				

a. R Squared = .586 (Adjusted R Squared = .572)

The result in Table 4 shows that with respect to the retention scores of male and female students taught Chemistry through cooperative instructional strategy and lecture, an F-ratio of 4.798 was obtained with associated probability value of 0.30. Since the associated probability value (0.30) is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) which stated that there is no significant difference between the mean retention scores of male and female Chemistry students taught with cooperative instructional strategy and those taught with lecture method was accepted. Thus, inference drawn is that, male and female students taught Chemistry under cooperative and lecture method did not differ significantly in their retention ability. This result showed that gender is not a significant factor affecting students' retention when taught Chemistry under cooperative and lecture method.

Discussion

Results from Tables 1 and 3 confirms that gender does not have significant effect on the academic achievement. This implies that the gender gap is reducing. This is in line with the view of Clement, Ugustine, Odihi and Sunday (2017) who submitted that differences between boys and girls in the area of academic achievement in science are now very small. The findings of the study also showed that the reduction in gender gap is due to the teacher's effort in presenting well designed tasks to the students which in turn challenged the female students to give their best through the use of cooperative instruction strategy thus reducing the gender gap. This indicates that the use of the instructional strategy under study reduce the gender gap in favour of the female. This is not surprising because Wael (2014) observed that exposing students to appropriate activities reduces gender gap in science.

Tables 2 and 4 confirms that gender does not have significant effect on the academic retention. This is in line with the view of Jimmoh (2016) and Ezenwosu & Nwogu (2013) who submitted that differences between boys and girls in the area of academic retention in science are now very small. From the foregoing, it could be deduced from the findings of the study that female students developed a seemingly higher academic achievement because the classroom was student friendly and their little effort and successes were acknowledged. It could also be attributed to the fact that their views were recognized and respected which have boosted and developed their confidence in their ability to develop and apply cooperative instructional strategy in the learning of Chemistry. However, the gender influence on academic achievement of male and female students taught Chemistry using the individual instructional strategy was not significant.

Conclusion

Based on the findings of the study, the researcher drew the following conclusions:

- (i) the use of cooperative learning strategies in learning Chemistry concepts leads to increase in students' academic achievement more than the use of lecture method.
- (ii) the use of cooperative learning strategies in learning Chemistry concepts leads to increase in students' retention more than the use of lecture method.
- (iii) Gender is not a significant factor affecting students' retention in Chemistry when taught under cooperative instructional strategies.

Recommendations

Based on the findings of the study, the following recommendations are proffered:

- (i) Chemistry students should be taught with student-centred and activity-based methods of instruction, such as the cooperative instructional strategy, to encourage social interaction, active engagement and self-motivation among learners;

- (ii) Innovative teaching strategies should be incorporated into the Chemistry curriculum of teacher training tertiary institutions in Nigeria, in order to inculcate their use on teacher trainees;
- (iii) Teachers of secondary school chemistry in Nigeria should attend conferences, workshops and seminars regularly, where they would learn the requisite skills and knowledge to handle these innovative teaching strategies in their classrooms; and
- (iv) Government agencies and professional bodies such as the Nigerian Educational Research and Development Council (NERDC) and Science Teachers' Association of Nigeria (STAN) should sponsor and publish further research on the efficacies of these student-centered and activity-based teaching strategies in enhancing students' academic achievement in Chemistry and other Science subjects.

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