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Effectiveness of Cooperative Learning Strategies on Nigerian Junior Secondary Students' Academic Achievement in Basic Science

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Authors' contributions

This work was carried out in collaboration between B-AJB and ODI. B-AJB handled the theoretical literature review on cooperative learning strategies, and designed the study. ODI handled the empirical literature review on cooperative learning strategies, designed the science anxiety rating scale, and performed the statistical analysis of the data collected.

Research Article

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ABSTRACT

Aims: This study investigated the effectiveness of cooperative learning strategies on Nigerian Junior Secondary students' academic achievement in basic science.
Study Design: Quasi experimental pretest – posttest – delayed posttest control group design was used by the researchers to carry out the study.
Place and Duration of Study: CSIT department, faculty of education, Olabisi Onabanjo University, Ago-Iwoye and Basic science department, school of science, tai Solarin College of Education, Omu-Ijebu, South-west, Nigeria, between March 2009 and October 2010.
Methodology: The treatments were at two levels: cooperative learning strategies (learning together and jigsaw II) and conventional lecture method, which was the control group. The moderating variable was anxiety (high and low). Total number of one hundred and twenty students (120) obtained from the intact classes of the three selected Junior Secondary Schools in South-west Nigeria participated in the study. Achievement Test for Basic Science Students (ATBSS), and Basic Science Anxiety Scale (BSAS) were the main

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instruments used to collect data from students. Descriptive statistics and Analysis of Covariance (ANCOVA) were used to analyze the data collected. Also Multiple Classification Analysis (MCA) was used to determine the magnitude of the mean achievement scores of students exposed to the different treatment conditions.

Results: The results of this study indicated that there were significant main effects of treatment on all the dependent measures. There were also significant main effects of anxiety on the students' post and delayed-post academic achievement scores in basic science. Furthermore, there were significant interaction effects of treatment and anxiety on the academic achievement of students at the posttest and delayed-posttest levels.

Conclusion: This study revealed that students in the two cooperative learning strategy (Learning Together and Jigsaw II) groups had higher immediate and delayed academic achievement mean scores than the students in the conventional-lecture group. Learning together and Jigsaw II cooperative teaching strategies were found to be more effective in enhancing students' academic achievement and retention in basic science more than the conventional-lecture. When friendliness is established, students are motivated to learn and are more confident to ask questions from one another for better understanding of the tasks being learnt.

Keywords: Cooperative learning; students' achievement; retention; anxiety.

1. INTRODUCTION

Science education plays a vital role in the lives of individuals and the development of a nation scientifically and technologically (Alebiosu and Ifamuyiwa, 2008). It is widely and generally acknowledged that the gateway to the survival of a nation scientifically and technologically is scientific literacy which can only be achieved through science education. Towards revolutionizing Nigerian educational system, the 1969 Conference gave birth to the National Policy on Education which brought about significant changes to the Nigerian educational system (Alebiosu and Ifamuyiwa, 2008). For instance, in Nigeria, the National Policy on Education (2004) provided educational expenditure in science and technology. The Nigerian government, in a bid to enhance science and technological education, came up with 6-3-3-4 policy on education which stipulates that a child spends six years at the primary school level, three years at the Junior Secondary School level, three years at the Senior Secondary School level, and four years in Higher Institutions (Olarewaju, 1994). This system of education was reviewed in 2004 and came up with 9-3-4 system which stipulates that a child spends 9 years compulsorily right from primary school level to Junior Secondary School level, three years at the Senior Secondary School level, and four years in Tertiary Institutions.

All the above-mentioned systems of education in Nigeria are designed with special provisions for science and technology learning in schools. Moreso, Nigerian government also came up with a policy that 60 percent of the students seeking admission into the nation's Universities, Polytechnics, and Colleges of Education should be admitted for science oriented programmes, while 40 percent of the students should be considered for Arts and social science programmes (Ajibola, 2008). Educators understand that changes in student outcomes must be supported by parallel changes in curriculum and instruction. However, it is apparent that many of today's teachers are caught in the midst of a change for which they may not have been professionally prepared. Many teachers were educated in the

classrooms where the role of the student was to memorize information, conduct well-regulated experiments and were then tested on their ability to repeat these tasks or remember specific facts (Dogru and Kalender, 2007).

Basic science, formerly known as Integrated Science, is the first form of science a child encounters at the secondary school level; hence basic science prepares students at the Junior Secondary School level for the study of core science subjects at the Senior Secondary School level (Olarewaju, 1994). This implies that for a student to be able to study single science subjects at the Senior Secondary School level successfully, such student had to be well grounded in basic science at the Junior Secondary School level. In view of this, basic science is given great emphasis in the Junior Secondary School curriculum. The principal reasons why Nigerian Government started Basic Science teaching in Nigerian secondary schools are as follow:

1. It provides students at the Junior Secondary School level a sound basis for continuing science education either in single science subjects or further integrated science;
2. It enhances the scientific literacy of the citizenry;
3. It allows students to understand their environment in its totality rather than in fragments;
4. It allows the students to have general view of the world of science;
5. The processes of science serve as unifying factor for the various science subjects. It is necessary for the learner to know these processes through integrated approach of learning science (Federal Ministry of Education, 1981).

In an attempt to improve the standard of science teaching and learning, a lot of research studies had been carried out. Studies in Basic science education have reported that many students at the Junior Secondary School level have developed negative attitudes towards the subject (Akpan, 1996). Many of the students at this level, because of their dismal performance in the subject, are not benefiting much from the basic science curriculum (Afuwape, 2003; Afuwape and Olatoye, 2004; Balogun, 1992; Odetoyinbo, 2004; Olagunju, 1995; Olanrewaju, 1999; etc.). This, according to Afuwape and Olatoye (2004), has prevented many of them from offering core science subjects or performing better in the core science subjects at the Senior Secondary School level.

The Nigerian government's efforts towards making sure that Nigerian children show interest in science and science-oriented programmes (e.g. 60:40 ratio admission policies in favour of the science-oriented programmes, etc) cannot be said to have yielded much fruit. This is because many of the students at the Junior Secondary School level (J.S.S) are not showing interest in studying core science subjects (physics, chemistry, and biology) at the Senior Secondary School level. This has affected them in choosing science-oriented programmes at the Nation's tertiary institutions level. The problem stemmed from the conventional-lecture method being used by the basic science teachers at the J.S.S. level (Odetoyinbo, 2004). Several studies had been carried out in order to popularize appropriate teaching strategy for teaching and learning basic science, but many of the suggested strategies for teaching basic science did not include Jigsaw II and Learning Together cooperative learning strategies.

There are many cooperative teaching strategies in existence but the basic characteristics and components of cooperative teaching do not change in those strategies. Amongst the numerous cooperative teaching strategies, the following eleven, according to (Roger and Mary, 2000; David and Hartman, 2002; Alebiosu, 2003; Wendy, 2005; Sarah and Cassady,

2006), have received the most prominent attention. Learning together, Teams Games-Tournaments (TGT), Group Investigation, Constructive controversy, Numbered Heads Together, Jigsaw Procedure, Students Teams Achievement Divisions (STAD), Complex Instruction, Team Accelerated Instruction (TAI), Cooperative Learning Structures, Cooperative Integrated Reading and Composition (CIRC). The basic science, formerly Integrated Science, curriculum is child-centered and emphasis is laid more on learning science as a process than as a body of knowledge (Olarewaju, 1994). Hence, teachers should actively involve students in the teaching and learning of basic science. Learning together and jigsawII strategies of cooperative learning were specifically chosen because they allow more active involvement of students in the teaching and learning process than other cooperative learning teaching strategies which is in line with the design of basic science curriculum as stated earlier.

While empirical evidence supports the use of cooperative learning strategies with a variety of subject areas and age groups within and outside Nigeria, the extent to which these strategies are beneficial in basic science in Nigeria, to the best of researchers' knowledge, is unknown. Moreso, many of the research studies on the effects of cooperative learning teaching strategy, most especially in Nigeria, were limited to students' academic achievement; they did not examine the effect of cooperative learning strategies on students' retention of concepts taught. If the Jigsaw II and Learning-Together cooperative learning strategies of teaching are used to teach basic science concepts, what would be their effects on students' academic achievement and retention in basic science? In view of this, the effects of two cooperative learning strategies (Jigsaw II and Learning Together) on Nigerian Junior Secondary students' academic achievement and retention in basic science were investigated in this study. Moreso, the influence of anxiety on students' academic achievement was also examined.

1.1 Hypothesis

- Ho_1: There is no significant main effect of treatment on academic achievement of Students in basic science
- Ho_2: There is no significant main effect of anxiety on academic achievement of students in basic science
- Ho_3: There is no significant interaction effect of treatment and anxiety level on students'academic achievement in basic science.
- Ho_4: There is no significant main effect of treatment on students' retention of basic science concepts taught.
- H_5: There is no significant main effect of anxiety on students' retention of basic science concepts taught.
- H_6: There is no significant interaction effect of treatment and anxiety level on students' retention of basic science concepts taught.

1.2 Literature Survey

Cooperative learning is the umbrella term for a variety of educational approaches involving joint intellectual effort by students, or students and teachers together (Wendy, 2005). It requires a small number of students to work together on a common task, supporting and encouraging one another to improve their learning through interdependence and cooperation with one another (Larry and Hartman, 2002). The cooperative learning groupsusually comprises two to five students in a group that allows everyone to participate in a clearly

designed task (Sarah, 2006; Wendy, 2005). Students within small groups' cooperative learning are encouraged to share ideas and materials and divide the work when appropriate to complete the task. Small group competitive learning provides students with opportunity to explore and discuss topics with peers in a Bonds-on, interactive environment (Larry and Hartman, 2002). Gillies (2004) affirmed that students benefit academically and socially from cooperative small group learning.

The theoretical foundations of cooperative learning grew out of the work of social psychologist, Morton Deutsch, who specialized in the study of social interdependence (Kimberly et al., 2003). Deutsch studied the effects of different group structures on the process and outcomes of group efforts in a variety of social and work settings. There are two major theoretical perspectives related to cooperative learning-motivation and cognitive (Rossini and Jim, 1997). The motivational theories of cooperative learning emphasize the students' incentives to do academic work, while the cognitive theories emphasize the effects of working together. There are two cognitive theories that are directly applied to cooperative learning, the developmental and the elaboration theories (Slavin, 1987). The developmental theories assume that interaction among students around appropriate tasks increases their mastery of critical concepts (Damon, 1984). When students interact with other students, they have to explain and discuss each other's perspectives, which lead to greater understanding of the material to be learned. The struggle to resolve potential conflicts during collaborative activity results in the development of higher levels of understanding (Slavin, 1990). The elaboration theory suggests that one of the most effective means of learning is to explain the material to someone else. Cooperative learning activities enhance elaborative thinking and more frequent giving and receiving of explanations, which has the potential to increase depth of understanding, the quality of reasoning, and the accuracy of long term retention (Johnson et al., 1986).

Learning together strategy of cooperative learning was originally developed by David Johnson and Roger Johnson at the University of Minnesota (Harvard Education letter, 2000). Students work in four or five heterogeneous groups on a group assignment sheet. During discussion, if students ask the teacher a question, the teacher will refer such students to their groups to find answer. After the group discussion, a leader is chosen to present group's result to the entire class, and groups receive reward together. Scores are based on both individual performance and the success of the group, but individual do not compete with one another. The learning together strategy of cooperative learning provides a conceptual framework for teacher to plan and tailor cooperative learning strategy according to their circumstances, students' needs, and school contexts (Ghazi, 2003).

Jigsaw cooperative learning strategy was originally developed by Aronson and Colleagues in 1978 (Sarah and Cassidy, 2006). Jigsaw II requires students to work in group of five to six members. Each student in a group is given information to which no one else in the group has access, thus making each student "expert" on his or her section of the subject matter. After receiving their assignments, each team member reads a section. Next, members of different teams who have studied the same sections meet in "expert groups" to discuss their sections. Then the students return to their original teams and take turn teaching their team mates what they have learnt. All students in a group are expected to learn all the subject matter assigned to members of their group. After instruction in Jigsaw II, teachers test students individually and produce team scores based on each student's test performance.

The challenges of teaching science are to teach it in a way that enables pupils to learn science concepts while acquiring process skills and positive scientific attitudes. One of the

effective ways of accomplishing these objectives is through involving students in hands-on activities in the context of cooperative learning. Brad (2000) investigated the effectiveness of cooperative learning on students' academic performance in computer under cooperative and teacher-centered learning environments. He found that students in cooperative learning group exhibited higher level of academic performance. Chien (2002) also conducted an experiment on two vocational senior high classes to observe cooperative learning effect in the EFL classroom. Result indicated that students in cooperative EFL learning group performed better than their colleagues in the traditional EFL learning group. Chien's (2004) study was in agreement to her study in 2002. She created a measurement to gauge the effectiveness of cooperative learning. Her results showed that students in cooperative learning group improved in their posttest scores over time, which indicated that cooperative learning could improve English skills.

How cooperative learning affects student's achievement and problem solving skills was investigated by Effandi in 2003. This study of intact groups compared students' mathematics achievement and problem solving skills. The experimental group was instructed using cooperative learning methods, while the control section was instructed using the traditional lecture method. Results indicated that students in cooperative group instruction showed significantly better results in mathematics achievement and problem solving skills than their colleagues in the traditional group.

David et al. (2000) conducted a meta-analysis on the effectiveness of cooperative learning strategies. When the impact of cooperative learning lessons were compared with competitive learning, Learning Together (LT) promoted the greatest effect, followed by Academic Controversy (AC), Student-Team Achievement Divisions (STAD), Teams – Game - Tournaments (TGT), Group Investigation (GI), Jigsaw, Team Assisted Individualization (TAI), and Cooperative Integrated Reading and Composition (CIRC). When they compared the impact of cooperative learning lessons with individualistic learning, LT promotes the greatest effect, followed by AC, GI, TGT, TAI, STAD, Jigsaw, and CIRC. Moreso, of the 12 Learning Together methods that Slavin used, five (42%) were significantly positive. Thirteen of the Slavin's studies used the Jigsaw II method, 31% were significantly positive. Of the six studies on Group Investigation, three showed significantly positive results.

In the same vein, Wang (2001) explored the interactive network to develop a cooperative learning model which a mathematical-learning experiment and an empirical study could be based. The teachers set up websites as problem-situations for the students to solve through cooperative team work. The result of the study showed that cooperative learning strategy improved the students' grade in mathematics and motivated them towards learning mathematics. Chiu (2002) observed a teacher who implemented three cooperative learning methods (STAD, TGT, and LT) to solve the instructional problems she encountered when she taught junior high school students. The results revealed that cooperative learning strategy, used generally, had positive effect on the students in junior high school English.

Lai (2002) conducted a project with the methods of STAD, Jigsaw and Learning Together in an EFL junior high classroom. The findings showed that (a) students were motivated to study English harder and participated more in class by asking and responding to questions; and (b) students' communication skills were improved. In the same vein, Effandi (2003) compared students' mathematics achievement and problem-solving skill. The experimental section was instructed using the cooperative learning strategies and the control section was instructed using the traditional lecture method. Results indicated that students in the

cooperative group instruction had higher mean scores in mathematics and problem-solving skills than their colleagues in the control group.

Similarly, Ghazi (2003) investigated the effects of Learning Together method of cooperative learning in improving English as a foreign language reading achievement and academic self esteem. The Researcher employed pretest – posttest control group experimental design. The results indicated a statistically significant difference in favour of the Learning Together strategy on the variable of EFL reading achievement. Ren-shing's (2006) investigation confirmed the findings of Effandiand Ghazi. He investigated the differential effects (i.e. achievement in learning English, and attitude concerning English Language) on students between the traditional teaching method and the Jigsaw cooperative learning method. Data analysis indicated that students in Jigsaw cooperative learning group had higher mean scores than students who were taught using the conventional lecture method.

The findings of Fengfeng and Barbara (2007) conformed to that of Ren-shing (2006). They studied the effect of Teams-Games-Tournament (TGT) and no game playing condition on students' achievement in mathematics. Multivariate Analysis of Variance was used to analyze the data collected and results showed that cooperative game playing was more effective in promoting students' mathematics achievement than no game playing method. The findings of Samuel and John (2004) also confirm the effectiveness of cooperative learning methods. They investigated the effects of cooperative learning strategy on students' achievement in chemistry. Using a non-equivalent control group design, the study found that cooperative learning strategy facilitated students' chemistry learning more than regular methods. Pandian (2004) investigated the effects of cooperative computer-assisted learning and traditional (teacher-centered) learning methods on students' learning achievement in biology. Results of the analysis of covariance revealed that students in the cooperative computer-assisted group achieved better in biology test than their colleagues in the traditional group.

Samuel and John (2004) examined how the cooperative class experiment (CCE) teaching methods affect students' achievement in Chemistry. The study found that CCE method facilitated students' chemistry learning more than regular methods. The study of Andreas et al. (2006) confirmed the efficacy of cooperative learning in the teaching and learning process. They explored the effectiveness of cooperative learning approach, where students work together and elaborate concepts of physics. The results indicated that students in cooperative learning group performed better than their colleagues in the control group. Similarly, Burcinand Leman (2007) examined the effect of cooperative learning on ninth grade students' understanding of metallic bonding, the results of the students't-test indicated that the mean score of the students in cooperative learning group was significantly higher than the mean score of their colleagues in control group.

In fostering student learning outcomes, not all the studies on cooperative learning recommended the effective use of cooperative learning methods. Ghaith and Abd El-Malak (2004) examined the effect of cooperative Jigsaw II strategy on improving literal and higher order reading comprehension in English as a foreign language (EFL). The researcher employed a pretest-posttest control group experimental design. The results indicated no statistically significant differences between the students in the Jigsaw group and traditional competitive group on the dependent variables of overall reading comprehension and literal comprehension. The findings of Kurt and Somchai (2004) support the afore-mentioned research findings. They investigated the effect of cooperative learning in vocational studies. The traditional method was used as the control group. Analysis of co-variance was used to

analyze the data collected. The analysis of the result indicated that there was no significant difference between the achievement scores of students in cooperative learning group and traditional group.

Similarly, Gokce and Derin (2007) evaluated the effects of the Group Investigation method of cooperative learning and traditional method of instruction on students' academic achievement. The results indicated no statistically significant difference in academic achievement between the two groups. This implies that Group Investigation was not more effective than was the traditional whole class method. Both instructional methods produced student achievement results at almost the same level. Research study of Chin-Chau (1997) on the effect of goal structure provided an interesting result. The result of the study indicated that students in the cooperative and individualistic learning environments had higher mastery goal orientation and higher achievement scores in mathematics than the students in the competitive classroom environment. Cheng and Mao (1999) investigated the effects of cooperative learning instruction and that of traditional competitive methods on ninth grade students' earth science achievement in secondary schools. They found that there was no significant difference between the cooperative groups and traditional competitive groups on overall achievement, knowledge level, and comprehension-level test items.

Similarly, Lawrence (2006) examined achievement in individually competitive and cooperatively reward-structured environments in two high-school biology classrooms. He found that the two groups were not significantly different from each other on the pretest. While both cooperative and competitive techniques obtained significantly higher posttest scores, neither treatment was superior over the other in producing academic achievement. The study of Martin and Roland (2007) confirmed the finding of Lawrence (2006). They compared the effects of cooperative learning method of jigsaw and traditional direct instruction method on the cognitive achievement in physics. Analysis of the result revealed no significant differences between the two groups of instruction in students' cognitive achievement in physics.

2. METHODOLOGY

This study employed the 3 x 2 quasi-experimental design. This implies that the design included three instructional groups: experimental groups - Learning Together and Jigsaw II; and the conventional lecture method (control group); and Basic Science anxiety at two levels – high and low. The target population for this study was the Junior Secondary III (JSIII) students in three local government areas of Ogun state, South/West Nigeria. The sample for this study was the total number of students in the intact classes used in the selected co-educational Junior Secondary Schools. Selection of the schools was depended on the availability of basic science teachers, the distance of the schools to one another in order to remove contamination effect, and willingness of school principals and teachers to cooperate and participate in the study.

The basic science topics used during classroom teaching, using any of the teaching methods, were five topics in basic science selected from the third term scheme of work. This was necessary to make sure that students had not been exposed to those topics before the experiment. In order to collect data for the study, the following instruments were developed, validated and used:

i. The Cooperative Learning Guide (CLG).
ii. Achievement Test for Basic Science Student (ATBSS).

iii. Basic Science Anxiety Scale (BSAS).

The Cooperative Learning Guide for teachers provided a broad explanation of the significant characteristics peculiar to all cooperative learning strategies. The peculiar characteristics are as follows: group goal, positive interdependence, individual accountability, collaborative skills, and task specialization. The guide also discussed the sequential steps of the teacher's role in a typical cooperative learning class. The Cooperative Learning Guide for students consisted of a list of students' activities in a cooperative learning class. They were encouraged to regularly read the guide at their free time, at the commencement of the lesson, and at the end of every basic science lesson. Participating teachers in the experimental group were exposed to comprehensive training programmes so that they do not deviate from the instructional principles and procedures governing the experiment. During the training programme, the following steps were taken:

1. The teachers were intimated with the aims and objectives of the study.
2. The teachers were introduced to lectures on cooperative learning strategies.
3. The teachers were randomly assigned to each of the three models of instruction and were given the illustrations of the instructional strategies and the design for the study.
4. The teachers were made to organize and teach lessons based on their assigned roles.
5. The teachers were also trained on how to administer all data gathering instruments.
6. Teachers who successfully completed the training exercise were selected.

The students that were used as experimental subjects were exposed to orientation activities on cooperative learning techniques. Both the participating teachers and the researcher addressed the students in their classrooms. The students were taught the social skills and rules guiding the principles of cooperation. They were encouraged and motivated to interact among themselves.

To establish the validity of the Cooperative Learning Guides used, the instruments were given to experts in the field of Education and Psychology who are knowledgeable in cooperative learning techniques to comment on the adequacy of the teachers' and students' guides respectively. Experts in English Language education were also contacted for their comments in relation to diction and sentence construction in the guides. Consequently, the guides were trial tested on teachers and students of a selected Junior Secondary School to obtain useful comments.

Copies of the Achievement Test for Basic Science Students (ATBSS) were given to specialists in the field of science education to establish the content and face validity. They read through and input the necessary corrections in respect of the structure of each item, and the category under which each item would be placed. They also passed their comments and suggestions about the language to be used in the instrument. The instrument was also given to three English and Basic Science teachers from different Junior Secondary Schools in order to make the instrument readable and understandable to the target population. To determine the reliability of ATBSS, the achievement test was trial tested by administering it to forty students from an intact class of a co-educational Junior Secondary School different from the selected schools for the main study. Spearman - Brown co-efficient was used to determine the reliability co-efficient of the instrument, which was found to be 0.811.

The Basic science anxiety scale was the adapted 20-item science Anxiety Rating Scale by Murat BURSAL (2008). Two of the 20 items that were not relevant to basic science were discarded; hence the basic science rating scale contained 18 items. The instrument was to find students' level of anxiety for learning basic science at the Junior Secondary School level. There were two sections in the questionnaire; section A sought for demographic data of students, while section B consisted of 18 items which students responded to by expressing their level of agreement or otherwise on a 5-point Likert-type scale ranging of 1 = No anxiety, 2 = slightly low anxiety, 3 = not sure, 4 = slightly high anxiety, and 5 = High anxiety. To ascertain reliability of the instrument, it was trial tested by administering it to forty students from an intact class of a co-educational Junior Secondary School III (JSS III) different from the selected schools for the main study. The reliability of the instrument was determined by using Cronbach coefficient alpha which was found to be 0.968.

There were four phases of data collection. These were the pretest – first one week, treatment – six weeks, the posttest – one week, and the delayed posttest – last two weeks of the ten weeks. The essence of delayed posttest was to know whether students were able to retain the basic science concepts taught. Three periods of 40 minutes each were spent each week for the six weeks. There was no alteration on the time-table allocated for basic science by the school, i.e. the periods were in line with the schools' time-tables. During the lessons, the teacher presented a new topic, sub-topic, concepts and related concepts. He listed the instructional objectives and further linked previous knowledge with the new material explicitly explaining new concepts, sub-concepts, processes and models. At the implementation stage, teacher did the following:

i. They had their students seated and asked them to keep quiet as they moved into teams.
ii. Teachers made sure that they did not squeeze their faces while explaining the basic science concepts.

The data collected from the administration of the instruments were analyzed using the following statistical techniques:

i. Descriptive statistics, which involved the computation of the pretests, posttests, and the delayed posttests mean scores, standard deviation, and variance for each of the dependent variables.
ii. Analysis of Covariance (ANCOVA) computed for each dependent variable for the three instructional groups in order to test for possible post experimental differences in the dependent variables with respect to methods and anxiety. Multiple Classification Analysis (MCA) was used to determine the direction of the differences among the groups.

Computations for the afore-mentioned methods of data analysis were done using SPSS 15.00 statistical package.

3. RESULTS AND DISCUSSION

3.1 Hypothesis 1(Ho_1)

There is no significant main effect of treatment on academic achievement of students in basic science.

In Table 1, it is revealed that the treatment had significant effects on students'post-test academic achievement scores in basic science ($F_{2,\ 119}$ = 0.000, statistically significant). This is a pointer to the fact that there was significant main effect of treatment on students' post-test academic achievement in basic science. That is, the post-test academic achievement scores of the students exposed to the different treatment conditions were significantly different. Hence, the null hypothesis (Ho_1) was rejected.

3.2 Hypothesis 2 (Ho_2)

There is no significant main effect of anxiety on students' academic achievement in basic science.

Result from Table 1. in respect of the main effect of anxiety, revealed that there was significant main effect of anxiety on the students' post-test academic achievement scores in basic science ($F_{(1,119)}$ = 0.002,statistically significant). This is a pointer to the fact that there was significant difference in the post-test academic achievement mean scores in basic science of low and high anxiety students. Hence, the null hypothesis 2 was rejected.

3.3 Hypothesis 3 (Ho_3)

There is no significant interaction effect of treatment and anxiety level on students' academic achievement in basic science.

Table 1 also indicated that there was significant interaction effect of treatment and anxiety level on students' post-test academic achievement in basic science at the ($F_{2,\ 119}$ = .000, statistically significant). Hence, the 5th hypothesis was rejected.

Table 1. Summary of Analysis of Covariance of Students' Post-test Academic Achievement Scores According to Treatment and Anxiety

Source	Sum of Squares	Df	Mean Square	F	Sig.
Intercept	2228.095	1	2228.095	299.502	.000
Pretest	3.322	1	3.322	.447	.505
Method	3566.836	2	1783.418	239.728	.000*
Anxiety level	21.466	1	21.466	2.885	.002
Method*Anxiety level	126.426	2	63.213	8.497	.000*
Error	796.010	107	7.439		
Total	77410.000	120			
Corrected Total	7133.200	119			

**significant at p ≤ .05*

Result of the Multiple Classification Analysis (MCA), as presented in table 2, was used in order to determine the magnitude of the mean achievement scores of students exposed to the different treatment conditions. This result indicated that the jigsaw II teaching strategy had the greatest positive effect on the students' academic achievement in basic science, while the low anxiety students had the higher post test mean scores.

Table 2. Multiple classification analysis (MCA) of students' post-test achievement according to treatment and anxiety level

Grand mean = 24.659					
Variable + Category Teaching strategy	**N**	**Unadjusted Deviation**	**Eta**	**Adjusted for Indept+Covariates**	**Beta**
1. Jigsaw	45	5.12		6.28	
2. Learning Together	40	2.09		2.64	
3. Lecture	35	-10.28	.82	-9.26	.53
Anxiety Level					
1. Low	68	-0.25		0.51	
2. High	52	-1.41	.03	-0.51	.02
Multiple R Squared					.888
Multiple R					.942

Hypothesis 4 (Ho_4)

There is no significant main effect of treatment on students' retention of basic science concepts.

In Table 3, it is revealed that the treatment had significant effects on students' retention of basic science concepts taught ($F_{2, 119}$ = .000, statistically significant). This is a pointer to the fact that there was significant main effect of treatment on students' retention of basic science concepts taught. That is, the delayed posttest academic achievement scores of the students exposed to the different treatment conditions were significantly different. Hence, the null hypothesis (Ho_4) was rejected.

Hypothesis 5 (Ho_5)

There is no significant main effect of anxiety on students' retention of basic science concepts.

The result of the main effect of anxiety on the students' retention of basic science concepts taught, as revealed in table 3, indicated that there was significant main effect of anxiety on students' delayed post academic achievement scores in basic science ($F_{1, 119}$ = .000, statistically significant). Hence, the 5th hypothesis was rejected.

Hypothesis 6 (Ho_6)

There is no significant interaction effect of treatment and anxiety on students' retention of basic science concepts taught.

Result from table 3 also indicated that there was significant interaction effect of treatment and anxiety on students' retention of basic science concepts taught ($F_{2, 119}$ = .000, statistically significant). Hence, the 6^{th} hypothesis was rejected.

Table 3. Summary of analysis of covariance of students' delayed-post test academic achievement scores according to treatment, and anxiety

Source	Sum of Squares	Df	Mean Square	F	Sig.
Intercept	2149.087	1	2149.087	333.487	.000
Pretest	5.450	1	5.450	.846	.360
Method	5360.874	2	2680.437	415.939	.000*
Anxiety level	184.050	1	184.050	28.560	.000*
Method * Anxiety level	389.195	2	194.598	30.197	.000*
Error	689.540	107	6.444		
Total	75877.000	120			
Corrected Total	11612.592	119			

**Significant at p ≤ .05*

Result of the Multiple Classification Analysis (MCA), as presented in Table 4, was used in order to determine the magnitude of the mean achievement scores of students exposed to the different treatment conditions. The result of the multiple classification analysis in table 4 revealed that, with a grand mean of 23.929, the students exposed to the jigsaw teaching strategy recorded the highest adjusted delayed post-test mean achievement score of 30.279(23.929+6.35). The students exposed to the learning together strategy had the next higher adjusted delayed post-test mean achievement score of 27.029(23.929+3.10), while the students exposed to the conventional lecture strategy obtained the least adjusted post-test mean achievement score of 11.619(23.929-12.31). Hence, this result also indicated that the jigsaw II teaching strategy had the greatest positive effect on the students' delayed post academic achievement in basic science.

Result of the Multiple Classification Analysis (MCA) in Table 4 also revealed that, with a grand mean of 23.929, the low anxiety students recorded the highest adjusted delayed post-test mean achievement score of 24.709(23.929+0.78), while the high anxiety students recorded low adjusted delayed posttest mean achievement score of 21.609(23.929-2.32).

Table 4. Multiple classification analysis (MCA) of students' delayed-post test academic achievement according to treatment and anxiety level

Grand mean = 23.929					
Variable + Category Teaching strategy	**N**	**Unadjusted Deviation**	**Eta**	**Adjusted for Indept+Covariates**	**Beta**
1. Jigsaw	45	6.35		7.43	
2. Learning Together	40	3.10		3.93	
3. Lecture	35	-12.31	.78	-11.36	.61
Anxiety Level					
1. Low	68	0.78		1.48	
2. High	52	-2.32		-1.48	
			.46		.2
Multiple R Squared					.941
Multiple R					.970

Results from the aforementioned Tables 1 to 4 indicated that the three teaching methods used had effects on the academic achievement of students in their groups at the post test

level. There was significant difference in academic achievement of the students in the three treatment groups with jigsaw strategy having the highest positive effect followed by learning together strategy, while lecture method had lowest positive effect. This result implies that the two cooperative learning strategies of teaching promoted students' understanding of basic science concepts taught and improve their academic achievement more than the conventional lecture method. This result is in line with the findings of Burcin and Leman, 2007; Chang and Mao, 1999; Dennis and Valentina, 1997; Dimitrios et al., 2006; Joseph, 1998; Pandian, 2004; Samuel and John, 2004; Theodora, 2001, etc., who reported in their different studies that cooperative learning strategies facilitated students' learning more than conventional lecture method. However, the findings of this study contradict the findings of some other researchers who have reported no significant difference between the academic achievement of students in cooperative learning group and students in other groups - conventional lecture, competitive, and individualistic methods - (e.g. Chin-Chau, 1997; Cheng and Mao, 1999; Elaine and Susan, 2002; Lawrence, 2006; Martin and Roland, 2007; Rossini and Jim, 1997; Steven et al., 2001, etc).

Results along retention linerevealed that jigsaw and learning together strategies of cooperative learning aided students' retention of basic science concepts taught (the students' scores at the delayed – posttest level were a little bit higher than their scores at the posttest level, their scores did not reduce), while conventional - lecture method did not aid students' retention of basic science concepts (students' scores at the delayed – posttest level were lower than their scores at the posttest level). This result implies that the cooperative learning strategies brought about retention of basic science concepts taught when used to teach, this might be as a result of the active involvement of students in teaching and learning process. This result conforms to the findings of Ali, Seyed-Hussein et al. (2007); Barbara et al. (2006); Dougherty et al. (1995); Victoria and Choi-man (1995); Rossini and Jim (1997), etc.

Another objective of this study was to investigate the influence of students' level of anxiety for learning basic science on students' academic achievement at the post and delayed post test levels. Results of this study indicated that there was a difference in the post academic achievement means scores of low anxiety students and high anxiety students. Similarly, at the delayed post test level, there was significant difference in the mean scores of low and high anxiety students. This implied that anxiety might be the factor for the difference in students' post and delayed post academic achievement mean scores in basic science, as level of anxiety decreased; achievement scores increased, high anxiety led to decrease in academic achievement scores. This result is in line with the findings of Albero, Brown, Eliasonand Wind (1997), Schonwetter (1995), Teresa (2004), Oludipe (2010), etc.

Talking about the interaction effects of the variables on students' academic achievement, results of this study also revealed that there were significant interaction effects of treatment and anxiety on students' academic achievement at both the post test and delayed post test levels, this means that treatment interact with students' level of anxiety in determining students' academic achievement in basic science. The differences in post test and delayed post test mean scores of students in the two anxiety levels (low and high) in respect of learning together and jigsaw groups were very close. This suggests that students at all the anxiety levels gained academically when taught with the experimental strategies (learning together and jigsaw). The significant difference was contributed by the students of the conventional lecture strategy.

4. CONCLUSION

This study has very important contributions and high implication for the educational practices in Nigeria. This study revealed that students in the two cooperative learning strategy (Learning Together and Jigsaw II) groups had higher immediate and delayed academic achievement mean scores than the students in the conventional-lecture group. Learning together and Jigsaw II cooperative teaching strategies were found to be more effective in enhancing students' academic achievement and retention in basic science more than the conventional-lecture. When friendliness is established, students are motivated to learn and are more confident to ask questions from one another for better understanding of the tasks being learnt.

Based on the findings of this study, the following recommendations were made:

1. Basic science teachers should adopt learning together and jigsaw II cooperative teaching strategies and other various cooperative teaching strategies in order to enhance students' academic achievement and retention in basic science;
2. At the preservice level, the use and implementation of cooperative teaching strategies in the classrooms should be emphasized in the methodology courses being offered by the Student-teachers; and
3. At the in-service level, seminars and workshops should be organized by ministry officials, zonal educational authority, and local educational authority in order to educate practicing teachers on how to implement cooperative teaching strategy in schools at all levels.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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APPENDIX

Basic Science Rating Scale

Researchers: J. B. Bilesanmi-Awoderu & D.I. Oludipe

N.B. This is not a test, so your opinion will not be judged as right or wrong. Any information you give will be treated with confidentiality and will be used for research purposes.

Directions: For each item, place a check in the box under the column that describes how you feel it. Work quickly, but be sure to consider each item individually.

1. Background Information

Full name: ……
Number: ……
Male: [ ] Female: [ ]

Please indicate (X) on the number (1-5) to indicate how you feel about each statement below.

N.B.: No Anxiety = 1
Slightly low anxiety = 2
Not sure = 3
Slightly high Anxiety = 4
High Anxiety = 5

1.	Looking through the pages in a basic science text book	1	2	**3**	**4**	**5**
2.	Walking into a basic science class	1	2	**3**	**4**	**5**
3.	Buying a basic science text book	1	2	**3**	**4**	**5**
4.	Thinking about an upcoming basic science test one day before	1	2	**3**	**4**	**5**
5.	Watching a teacher work calculations on basic science on the chalkboard	1	2	**3**	**4**	**5**
6.	Picking up a basic science textbook to begin working on homework assignment	1	2	**3**	**4**	**5**
7.	Being given “quiz” test in a basic science class	1	2	**3**	**4**	**5**
8.	Solving question on basic science topics	1	2	**3**	**4**	**5**
9.	Getting ready to study for basic science test	1	2	**3**	**4**	**5**
10.	Being given a homework assignment of many difficult problems which is due in the next class	1	2	**3**	**4**	**5**
11.	Listening to a lesson in a basic science class	1	2	**3**	**4**	**5**
12.	Waiting to get a basic science test returned in which I expected to do well	1	2	**3**	**4**	**5**
13.	Working on a basic science problem	1	2	**3**	**4**	**5**

14.	Taking an examination in basic science	1	2	**3**	**4**	**5**
15.	Starting a new chapter in a basic science book	1	2	**3**	**4**	**5**
16.	Listening to another student explain a basic science topic	1	2	**3**	**4**	**5**
17.	Walking on school premises and thinking about a basic science topic	1	2	**3**	**4**	**5**
18.	Raising your hand in a basic science class to ask question	1	2	**3**	**4**	**5**
19.	Thinking about an upcoming examination one day before	1	2	**3**	**4**	**5**