

Comparative Effects of Individualised and Cooperative Learning Instructional Strategies on Senior Secondary School Students' Academic Achievement in Organic Chemistry

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Abstract

This study compared the effects of Individualised Instructional Strategy (IIS) and Cooperative Learning Instructional Strategy (CLIS) on male and female senior secondary school students' academic achievement in Organic Chemistry. The study was guided by 2 research questions and 3 null hypotheses. The design was quasi-experimental. The population comprised 3,366 senior secondary class two (SS2) chemistry students. A sample of 602 students from 6 schools (339 males and 263 females) was drawn from the population using balloting technique. The experimental groups were taught with IIS and CLIS while the control groups were taught with Lecture method in each of the sampled schools. Both the experimental and control groups were taught Organic Chemistry by their regular chemistry teachers. The instruments used for the study were Chemistry Achievement Test on Organic Chemistry (CATOC), Cooperative Learning Instructional Manual and Learning Activity Package Manual, which were validated by three experts. The reliability of the CATOC was determined using K-R₂₀ with index of 0.82. The research questions were answered using mean with standard deviation while the null hypotheses were tested using Analysis of Covariance. The findings revealed that both IIS and CLIS significantly enhanced students' achievement in Organic Chemistry better than the Lecture method. However, the CLIS was more effective than the IIS. The researcher recommended among others, that chemistry students should be exposed to student-centred and activity-based teaching strategies such as the Individualised Instructional Strategy and Cooperative Learning Instructional Strategy, for enhanced students' academic achievement.

Keywords: achievement, organic chemistry, cooperative learning, gender, individualised instruction, learning activity package.

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Introduction

Chemistry is seen as a natural science, which plays very crucial roles inscientific and economic development of nations.It isthe 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. 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 (Jegade, 2007). Furthermore, Jantur in Njoku and Ezinwa (2014) pointed out that Chemistry is presumed to be the fulcrum on which all science and technology disciplines and careers hinge on for national development. Continuing, they maintained that Chemistry has the ability to explain matter from the elementary particles, and thus deal effectively with science concepts and principles regarding natural phenomena in the environment. Moreover, 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 and chemical education.

In spite of the importance and position Chemistry occupies as a fulcrum on which all other sciences hinge for industrial and national development, it has been plagued with gross under achievement by students, with little or no appreciable improvement over the years (Jegade, 2010; Olorundare, 2014; Oloyede, 2010; Omoregbe & Ewansiba, 2013; West African Examination Council, 2012-2015). These observed persistent students' poor academic performance in Chemistry could adversely affect the realization of the national goals for scientific and technological development. Research studies have shown that several factors contribute to this ugly trend. Such factors include, lack of qualified chemistry teachers; insufficient number of chemistry teachers; lack of instructional materials; over-loaded chemistry syllabus; abstractness and difficult nature of many chemistry concepts; poor teaching methods employed by most chemistry teachers; and lack of interest among chemistry students (Ezeano 2013; Jegede 2010; Njoku 2004). Meanwhile, Akale (1990) stated that the teacher and the teaching methods adopted are the most pronounced and important factors that generally influence students' academic achievement in science. Studies have shown that experienced and qualified teachers can utilise their skills and wealth of experience to manipulate all other factors to improve students' interest, participation and performance in the science subjects. However, Ugwu in Njoku and Ezinwa (2014) reported that most chemistry teachers do not utilize teaching methods which have been identified to be effective in enhancing students' achievement, as a result of initial inadequate and further pedagogical training of chemistry teachers in Nigeria. Most teachers therefore resort to the use of lecture method in chemistry instructions. Lecture method has been reported to encourage rote learning of facts and concepts. It makes the subject uninteresting and difficult, resulting invariably in poor students' academic achievement (Njoku & Ezinwa, 2014).

Moreover, in the teaching of Chemistry, teachers are expected to have a good level of competence and mastery of the subject matter, as well as teaching/instructional strategies. This will enhance effective teaching which will lead to students' enhanced understanding of the subject in the secondary schools. Teachers need to utilize teaching strategies that will not only develop the interest and attitude of the students in the subject, but will also foster the adjustment of their basic cognitive and social problems, and motivate them to learn the subject. The chemistry teachers should de-emphasize the use of teacher-centered and traditional "chalk-talk" approaches of teaching. They should rather embrace more innovative, student-centered and activity-based approaches of teaching, which have been reported to be more effective in realizing the objectives of chemistry education (Gillies 2004, Olatoye, Aderogba and Aanu 2011, Neboh 2012). Furthermore, innovative, student-centered and activity-based instructional strategies could be approached in several ways; it could be approached in form of individualized instructions, where students engage in activities of learning on individual bases. It could also be approached in cooperative manner, where students engage in activities of learning in small groups. This study examined the two approaches; individualized and

cooperative learning approaches of instructions, to determine their effectiveness in relation to the conventional lecture approach in enhancing students' academic achievement in Organic Chemistry.

Review of Literature

Individualized Instruction

Individualized instruction according to Olatoye, et al. (2011) is an instructional strategy in which the content, instructional materials, instructional media, and pace of learning are based upon the abilities and interests of each individual learner. Individualised instruction yields a huge net benefit by freeing teachers to focus upon the needs and problems of individual students, as the facilitator of learning. Individualized instruction is basically a constructivist's approach of learning in which the student is expected to build his or her learning and knowledge. Furthermore, Gibney (2000) emphasised that individualised instruction can be approached in several ways such as; programmed instruction, computer assisted instruction, independent study, Learning Activity Package, among others. These approaches have been investigated and found to be effective in enhancing students' academic achievement (Abu, 1998; Neboh, 2012). Moreover, Arseneau (1994) reported that individualised instructions give students the opportunity to engage actively in the teaching and learning process by engaging in hands-on activities. It helps in meeting differences in individual learning styles and rates. Individualised instructions provides the students the opportunity to grow in self-discipline, self motivation and also presents occasions for genuine interaction between the teacher and students, which is lacking in the traditional method of teaching. Among the different approaches to Individualised instructions, the researcher adopted the Learning Activity Package (LAP) for the purpose of this study.

Studies conducted by Neboh (2012) on the effect of Learning Activity Package (LAP) on male and female students' academic achievement in secondary school Biology in Enugu State, showed that students' academic achievement was greatly enhanced when taught with the Learning Activity Package. Similar studies conducted by Abu (1998) on the effects of Learning Activity Package and Lecture method on senior secondary students' achievement in Biology in Zaria, Kaduna State, Nigeria, showed that LAP enhanced students' achievement irrespective of their previous academic standings.

Cooperative Learning Instructional Strategy

Cooperative learning is a teaching strategy in which small teams, each with students of different levels of ability use a variety of learning activities to improve their understanding of a subject (Olatoye, Aderogba & Aanu 2011). Contributing, Wendy (2005) stated that Cooperative learning is the umbrella term for a variety of educational approaches involving joint intellectual effort by students, or students and teachers together. 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. Furthermore, Rossini and Jim (1997) and Johnson, Johnson, and Stane (2000) reported that, Cooperative learning is an instructional strategy that provides a learning environment that allows active participation of students in the learning process and makes it possible for the students to have control over what they learn, which may lead to improved academic achievement. Moreover, Armstrong in Oludipe and Awokoya (2010) added that Cooperative learning environment assumes that students seek information and understanding through active mental search with each group mirroring the make-up of the class in terms of ability, background and gender. Meanwhile, Gillies (2004) affirmed that students benefit academically and

socially from cooperative learning. Research studies have revealed that students by completing cooperative learning group tasks tend to have higher academic test scores, higher self-esteem and greater comprehension of the content and skills they studied (Johnson & Johnson 1989, Mobark 2014). Moreover, in a cooperative learning classroom, students' work together to attain group goals that may not be obtained by working alone. In this classroom structure, students discuss the subject matter, help one another learn, and provide encouragement for members of the group (Johnson, Johnson & Holubec, 1986). Contributing further, Johnson and Johnson (1989) added that Cooperative learning experiences promote more positive attitudes towards the instructional experiences than competitive or individualistic methodologies.

Furthermore, Springer, Stanne and Donovan (1999), conducted a meta-analysis study of the effects of cooperative learning on undergraduates in science, mathematics, engineering and technology (SMET). They reported that Cooperative learning was effective in promoting greater academic achievement, more favourable attitudes toward learning, and increased persistence through SMET courses and programs. Similar studies conducted by Anidu and Idoko (2010) compared the effects of Cooperative learning and Concept mapping instructional strategies on secondary students' achievement in Biology in Enugu State, Nigeria. The study revealed that students taught Biology using Cooperative learning instructional strategy had higher mean achievement score than those taught with Concept mapping instructional strategy. More so, Olatoye, et al. (2011) conducted a study on the effects of Cooperative and Individualized teaching methods on senior secondary school students' achievement in Organic Chemistry. Results of the study revealed that both Cooperative and Individualized methods significantly improved students' achievement in Organic Chemistry. However, Cooperative learning was significantly better than the Individualized method. In a similar research carried out by Christian and Pepple (2012) on the effects of Cooperative and Individualized learning strategies on students' achievement and retention in Chemistry in Rivers State, Nigeria. The results showed that Cooperative learning was more effective than the Individualised instruction and the conventional lecture method in enhancing students' achievement in Chemistry. This study investigated the effectiveness of the teaching strategies in enhancing students' academic achievement in topics in Organic Chemistry.

Influence of Gender on Students' Academic Achievement in Chemistry

Gender is the sum total of cultural values, attitudes, roles practices and characteristics based on sex. Sex is the innate biological differences between a man and a woman (Okeke 2008). Gender influence on students' academic achievement has been of concern to researchers, but no consistent result has been established. In a study conducted by Dhindsa and Chung (1999), female students had higher academic achievement in Chemistry than their male counterparts. In another study by Bosode (2010), the male students had higher academic achievement in Chemistry than their female counterparts. Furthermore, study conducted by Salta and Tzougraki (2004) showed no gender differences in students' academic achievement in Chemistry. These contradictory results on the influence of gender on students' academic achievement in Chemistry prompted this study, to ascertain the influence or otherwise of gender on students' academic achievement when taught with student-centred and activity-based teaching strategies in Organic Chemistry.

Purpose of the Study

The main purpose of this study is to compare the effects of Individualised Instructional Strategy (IIS), Cooperative Learning Instructional Strategy (CLIS) and Lecture method on senior secondary school students' academic achievement in Organic Chemistry. Specifically, this study sought to determine the;

1. Effects of teaching methods (IIS, CLIS and Lecture) on students' academic achievement in Organic Chemistry;
2. Difference in male and female students' academic achievement in Organic Chemistry when taught with IIS, CLIS and Lecture; and
3. Interaction effect of method and gender on students' academic achievement in Organic Chemistry.

Research Questions

In order to achieve the purpose of this study, the following research questions were formulated;

1. Do teaching methods (IIS, CLIS and Lecture) have any effect on students' academic achievement in Organic Chemistry?
2. Is there any significant difference in the academic achievement of male and female students taught Organic Chemistry with IIS, CLIS and Lecture?
3. What is the interaction effect of method and gender on students' academic achievement in Organic Chemistry?

Research Hypotheses

The following null hypotheses tested at 5% level of significance guided the study;

- H₀₁.** Teaching methods (IIS, CLIS and Lecture) have no significant effect on students' academic achievement in Organic Chemistry.
- H₀₂.** There is no significant difference in the academic achievement of male and female students taught Organic Chemistry with IIS, CLIS and Lecture.
- H₀₃.** There is no significant interaction effect of method and gender on students' academic achievement in Organic Chemistry.

Materials and Methods

Research Design

Quasi-experimental design was adopted for the study, precisely, the pre-test, post-test, non-equivalent, control group, quasi-experimental design. The design was chosen because intact classes were used.

Area of the study

The study was conducted in Ebonyi State, a State in the South East Geopolitical Zone of Nigeria. Ebonyi has three Educational Zones, viz.; Abakaliki, Afikpo and Onueke. Ebonyi State was chosen because of her status as one of the educationally disadvantaged States in Nigeria.

Population for the study

The population for the study comprised 3,366 Senior Secondary class two (SS2) Chemistry students in all the government co-educational secondary schools in Ebonyi State in the 2016 academic session.

Sample and sampling techniques

The sample was made up of 602 SS2 Chemistry students (339 males and 263 females). Two (2) schools were randomly selected from each of the 3 Educational zones of Ebonyi State, that is, 6 schools were used for this study. The following parameters guided the

choice of the schools; availability of 3 class streams; co-educational; more than 10 years study of Chemistry; and number of students in each class not more than 40.

Instrument for data collection

The main instruments used for the study were Learning Activity Package Manual (LAPM), Cooperative Learning Instructional Manual (CLIM) and Chemistry Achievement Test on Organic Chemistry (CATOC).

The LAPM was adapted from Ward and Williams (1976). It has seven basic components; the pre-test, performance objectives, concept, learning activities, self-test/evaluation, mastery/post-test, and enrichment opportunities. The CLIM was adapted from Slavin (1990). The LAPM and CLIM covered the following contents in Organic Chemistry; Structure and valency of carbon; Hydrocarbon; Homologous series; Saturated and Unsaturated hydrocarbons; Isomerism; and Aromatic hydrocarbons.

The CATOC comprised 25 multiple-choice test items drawn from the various Organic Chemistry units outlined above. The researcher developed the test items using a table of specification which determined number of test items for each topic along three categories of cognitive objective, namely: knowledge (remembering), comprehension (understanding) and application (thinking). Each test item had four response options A - D with only one option as the correct answer while others were distracters. In addition, item analysis was carried out for the initial forty (40) multiple choice items using scores obtained from the trial testing, at the end of which twenty five (25) items were finally selected. The criteria for selecting the twenty five (25) items were based on the recommendations of Obodo (2014) which include: possession of item difficulty index of 0.30 – 0.70; possession of positive item discrimination index of +0.30 and above; and possession of positive distractor index.

Validation of the instruments

The instruments were content and face validated by two experts in chemistry education and one expert in measurement and evaluation from Ebonyi State University. The instruments were revised based on the experts' suggestions. Specifically, the test items were adjusted according to the experts' comments before it was administered to the students as pre-test and post-test.

Reliability of the instrument

The reliability of the CATOC was determined through pilot-testing the instrument on 40 SS2 Chemistry students who were not part of the study subjects. Using Kuder-Richardson formula 20, reliability index of 0.82 was obtained, which confirmed that the instrument was reliable. This was in line with the established standard by Borich (2004) that any instrument with reliability index of 0.7 and above is adjudged reliable.

Procedure

The researcher organised a 5-day training workshop for the regular chemistry teachers of the sampled schools. The teachers received training on the use of LAP and CLIS in teaching Chemistry. They were told to teach the Control group using the Conventional (Lecture) method. Before treatment commenced, each teacher administered the CATOC to the students, as pre-test and recorded their scores. The pre-tests lasted for 50 minutes.

Experimental. In the experimental groups, the treatments were exposing the students to the LAP and CLIS for four (4) weeks. In the LAP four (4) experimental lessons were carried out on different topics in Organic Chemistry. The teacher distributed the LAP manual to the students. Each student

carried out the required activities as contained in the manual and progressed on the manual at their own pace. At the end of the four weeks treatment, post-test (which was a reshuffled version of the pre-test) was administered to the students and the scores recorded.

In the CLIS, the students were assigned to five-member learning teams. Each team was a microcosm of the entire class, comprising; high-, average-, and low-performing students (this was determined using their previous class performances); boys and girls, etc. Four experimental lessons were carried out on different topics in Organic Chemistry. The CLIS manuals were distributed to the students in their respective groups, after which the contents were presented to the whole class by the teacher, before the students studied the frames and carried out the required activities in their respective groups. Formative tests were administered to the students at the end of each topic. At the end of the treatment, a post-test (which was a reshuffled version of the pre-test) was administered.

Control. In the control group, after administering the pre-test, the students were taught four lessons using the Conventional (Lecture) method. The teachers delivered the lessons using chalk and chalkboard and ensured that students listened and copied notes. Assignments were given to the students. At the end of the exercise, the post-test was administered.

Methods of data analysis

The pre-test and post-test scores of the experimental and control groups were used for data analysis. The research questions were answered using the mean with standard deviation while the hypotheses were tested using Analysis of Covariance (ANCOVA) using the pre-test scores as covariates.

Results

Research question 1: Do teaching methods (IIS, CLIS and Lecture) have any effect on students' academic achievement in Organic Chemistry?

Table 1: Mean Achievement Scores and Standard deviations of Students

Experimental Conditions	Teaching method	Test Type	Mean (X)	Standard deviation (SD)	Gain score	No. of Subjects (N)
Experimental 1	IIS	Post-test	28.13	7.83	19.93	206
		Pre-test	8.20	2.85		
Experimental 2	CLIS	Post-test	29.06	8.53	20.91	205
		Pre-test	8.15	2.88		
Control	Lecture	Post-test	19.55	5.38	11.37	191
		Pre-test	8.18	2.69		
Total						602

As shown in Table 1, the mean scores of the students taught Organic Chemistry with IIS, CLIS and Lecture method are 8.20, 8.15 and 8.18 in the pre-tests. This shows that the 3 groups were similar at the beginning of the experiment. Furthermore, the table shows that the mean achievement score of those taught with IIS in the post-test is 28.13 with standard deviation of 7.83 and gain score of 19.93. Also, the mean achievement score of those taught with CLIS in the post-test is 29.06 with standard deviation of 8.53 and gain score of 20.91. On the other hand, the mean achievement score of those taught with the Lecture method in the post-test is 19.55 with standard deviation of 5.38 and gain score of 11.37. The differences in the mean achievement gain scores of the groups are 0.98 for IIS and CLIS; 8.56 for IIS and Lecture; and

9.54 for CLIS and Lecture method. Therefore, differences exist in the academic achievement of students taught with IIS, CLIS and Lecture method. Those students taught with IIS and CLIS had higher academic achievement than their counterparts taught with Lecture method. However, Table 1 did not show whether the observed differences in the mean achievement scores of the 3 groups in the post-test are significant. Hence, the results were subjected to inferential testing as shown in hypothesis 1 below.

Hypothesis 1: Teaching methods (IIS, CLIS and Lecture) have no significant effect on students' academic achievement in Organic Chemistry.

Table 2: Analysis of Covariance (ANCOVA) of Students' Overall Achievement Scores by Teaching Method and Gender

Source of Variation	Type III Sum of Squares	Df	Mean Square	F-cal	P-value	Decision
Corrected Model	1259.833	2	629.917	5.388	0.001	S
Intercept	127540.107	1	127540.107	3007.406	0.000	S
Method	1259.833	2	629.917	5.388	0.001	S
Gender	159.533	1	159.533	1.228	0.201	NS
Method X Gender	137.193	2	68.597	1.396	0.142	NS
Error	13804.607	599	60.018			
Total	133015.001	602				
Corrected Total	15270.417	601				

In table 2 above, the calculated F-value for the effect of teaching methods on students' achievement in Chemistry is 5.388 with P-value of 0.001 which is less than 0.05 set for the study. The null hypothesis is therefore rejected. This shows that the teaching methods have significant effect on students' achievement in Organic Chemistry. This further proves that there is significant difference in the students' mean scores among the three groups; IIS, CLIS and Lecture. It therefore becomes important to compare the three groups two-by-two to find out the group(s) that caused the difference. This was achieved using Scheffe's method of pair-wise comparison test as shown in table 3 below.

Table 3: Pair-Wise Comparison of the Achievement of the Three Groups Using Scheffe's Test

(I) Treatment	(J) Treatment	Mean Difference (I - J)	Std. Error	P-value
IIS	CLIS	2.500	1.277	0.247
	Lecture	- 4.500	1.285	0.044
CLIS	IIS	- 2.500	1.277	0.247
	Lecture	-7.000	1.273	0.003
Lecture	IIS	4.500	1.285	0.044
	CLIS	7.000	1.273	0.003

From Table 3 above, there is no significant mean difference between IIS and CLIS. However, there is significant difference between IIS and Lecture. There is also significant difference between CLIS and Lecture. This therefore means that, IIS and CLIS methods were significantly better than the Lecture method.

Research question 2: Is there any significant difference in the academic achievement of male and female students taught Organic Chemistry with IIS, CLIS and Lecture?

Table 4: Mean Achievement Scores and Standard Deviation of Male and Female Students

Experimental Conditions	Teaching Methods	Gender	Test type	Mean (X)	Standard deviation (SD)	Gain Score	No. of subjects (N)		
Experimental 1	IIS	Male	Post-test	27.36	8.00	19.26	122		
			Pre-test	8.10	2.54				
		Female	Post-test	27.69	7.67			19.64	84
			Pre-test	8.05	3.10				
Experimental 2	CLIS	Male	Post-test	28.24	8.07	20.04	107		
			Pre-test	8.20	2.49				
		Female	Post-test	27.25	9.00			19.10	98
			Pre-test	8.15	3.22				
Control	Lecture	Male	Post-test	18.58	3.72	10.40	110		
			Pre-test	8.18	2.89				
		Female	Post-test	18.88	5.17			10.67	81
			Pre-test	8.21	2.51				
Total							602		

Table 4 above shows the mean achievement scores of male and female students in the experimental and control groups. The table shows that in the experimental group 1 taught with IIS, the female students' mean achievement score is slightly higher than that of the male students by 0.39. Meanwhile, the table did not show whether the observed slight difference is significant. Also in the experimental group 2 taught with the CLIS, the male students' mean achievement score is slightly higher than that of the female students by 0.94. The table did not also show whether the difference is significant. More so, in the control group taught with Lecture method, the female students' mean achievement score is slightly higher than that of the male students by 0.27. The table did not equally show whether the difference is significant. In order to ascertain whether these observed differences are significant or can be attributed to error variance, the result is further subjected to inferential testing as hereunder shown.

Hypotheses 2: There is no significant difference in the academic achievement of male and female students taught Organic Chemistry with IIS, CLIS and Lecture.

From table 2 shown above, the calculated F-value for the main influence of gender on students' achievement in Organic Chemistry is 1.228 with P-value of 0.201 which is greater than 0.05 set for the study. The null hypothesis is therefore upheld. This means that there is no significant difference in the academic achievement of male and female students taught with IIS, CLIS and Lecture. Thus, the efficacy of the teaching methods according to this finding is not influenced by students' gender.

Research question 3: What is the interaction effect of method and gender on students' academic achievement in Organic Chemistry?

This research question will be answered using the corresponding research hypothesis as shown below.

Research hypothesis 3: There is no significant interaction effect of method and gender on students' academic achievement in Organic Chemistry.

In table 3 shown above, the calculated F-value for the interaction effect of method and gender on students' achievement in Organic Chemistry is 1.396 with P-value of 0.142 which is greater than 0.05 set for the study. The null hypothesis is therefore upheld. This means that there is no significant interaction effect of method and gender on students' academic achievement in Organic Chemistry. Hence, the two-way interaction of method and gender has no significant effect on students' achievement in Organic Chemistry. Moreover, since the main effect of method is significant but the interaction effect with gender is not, it then means that methods do not depend on gender to be effective.

Summary of findings

The results of data analysis have shown that;

1. There is significant main effect of method on students' achievement in Organic Chemistry. This shows that the three teaching methods were effective in enhancing students' academic achievement.
2. The IIS and CLIS methods were significantly better than the Lecture method in enhancing students' achievement in Organic Chemistry.
3. The CLIS was more effective than the IIS which was more effective than the Lecture in enhancing students' achievement in Organic Chemistry. The trend is; CLIS > Individualised Instruction > Lecture.
4. There is no significant difference in the mean achievement scores of male and female students in Organic Chemistry.
5. There is no significant interaction effect of method and gender on students' achievement in Organic Chemistry.

Discussion of findings

Results of data analysis has shown that the teaching methods (Individualised Instructional Strategy (IIS), Cooperative Learning Instructional Strategy (CLIS) and Lecture method) considered in this study were effective in enhancing students' achievement in Organic Chemistry. This finding agrees with the finding of Olatoye, Aderogba and Aanu (2011) that method has significant effect on students' achievement in Organic Chemistry. Meanwhile, further analysis of the results revealed that the IIS and CLIS were more effective in enhancing students' achievement than the Lecture method. This finding agrees with the findings of Abu (1998), Neboh (2008), Anidu and Idoko (2010), and Christian and Pepple (2012) who in their separate studies found that the IIS (specifically the Learning Activity Package) and the Cooperative Learning Instructional Strategy (CLIS) were more effective than the Lecture method in enhancing students' achievement in Science.

Moreover, the relative effectiveness of IIS and CLIS over the Lecture method in enhancing students' achievement could be attributed to the fact that both methods are student-centred and activity-based, which enable students to actively participate in teaching and learning, unlike the lecture method. Given the prevailing circumstances under which the teaching methods were employed in the classrooms, it is not surprising that the students taught with IIS and CLIS had higher academic achievement than those taught with the Lecture method.

Furthermore, this study found that the CLIS was more effective than the IIS in enhancing students' academic achievement. This agrees with Adekoya and Olatoye (2011) who

found the CLIS more effective than the Individualised method in enhancing students' achievement in Chemistry. Moreover, the effectiveness of CLIS over IIS could stem from the fact that students have the tendency to learn from their peers through cooperative interactions in the classroom, unlike individualised Instruction where the students carry out activities on individual bases.

Meanwhile, results of this study revealed no significant difference in the academic achievement of male and female students in Organic Chemistry taught with IIS, CLIS or Lecture methods. This shows that gender has no significant influence on students' achievement. This agrees with Okeke (2008); Udousoro (2003); Salta and Tzougraki (2004); and Oludipe (2012) who in their separate studies found no significant difference in the mean achievement scores of male and female students in Chemistry. However, the finding of this study disagrees with Lawal (2009); Okereke and Onwukwe (2011); and Ezeudu and Obi (2013) who found significant difference in the achievement of male and female students in Science. More so, the female students' mean achievement in the Individualised Instructional Strategy was found to be slightly higher than that of the male students, while the male students' mean achievement in CLIS, was higher than that of the female students. This can be attributed to the fact that, the students were exposed to different teaching environments; individualised and cooperative. It then shows that the female students achieved higher in an individualised learning environment, while the male students achieved higher in a cooperative learning environment. The observed differences, however, were not significant. This means that gender has no significant influence on the academic achievement of students in Chemistry when student-centred and activity-based teaching strategies are employed by the teachers.

This study further established that the interaction effect of method and gender on students' achievement in Chemistry was not significant. This finding is in agreement with the findings of Adekoya and Olatoye (2011) who found that the interaction effect of method and gender on students' achievement in Science was not significant. However, the finding disagrees with the finding of Ezeudu (1995) who found that the interaction effect of method and gender on students' achievement in Chemistry was significant. The fact that this study found no significant interaction effect of method and gender on students' achievement in Chemistry means that the methods do not depend on gender to be effective.

Conclusion

Research studies have shown that secondary school students' academic achievement in Chemistry have been consistently poor, despite all efforts being made by teachers to improve their intellectual skill and growth. These observed poor academic achievement have been attributed to among other things, the use of teaching methods/strategies which are not student-centred and activity-based by the chemistry teachers. Meanwhile, this study found that the IIS and CLIS were more effective than the Lecture method in enhancing students' academic achievement. Therefore, this study lends empirical support to the fact that students' academic achievement in Chemistry could be greatly improved when the teachers expose them to innovative, student-centred and activity-based teaching methods/strategies such as the Individualised Instructional Strategy and Cooperative Learning Instructional Strategy.

Recommendations

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

1. Chemistry students should be taught with student-centred and activity-based methods of instruction, such as the Individualised Instructional Strategy and Cooperative Learning Instructional Strategy, to encourage social interaction, active engagement and self-motivation among learners;
2. These innovative teaching strategies should be incorporated into the Chemistry curriculum of teacher training tertiary institutions in Nigeria, in order to popularize their use among the teacher trainees;
3. The 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
4. 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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