

## Effects of Cooperative Learning and Analogy on Secondary School Student's Achievement and Interest in Chemistry

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**Abstract:** The purpose of this study was to investigate the effects of cooperative learning and analogy methods on secondary school student's achievement and interest in chemistry. The study which adopted a quasi-experimental design was conducted in four secondary schools in Okene Local Government Area of Kogi State, Nigeria. Out of these schools, two schools were exposed to the use of cooperative learning (experimental 1) while the remaining two used analogy method (experimental 2). One experiment was meant to control the other. The sample comprised 253 Senior Secondary School 2 (SSS2) chemistry students. Mean and standard deviation were used to answer the research questions while Analysis of Covariance (ANCOVA) was used in testing the hypothesis at  $p < 0.05$ . The result of the study revealed that both cooperative learning and analogy methods brought about significant shift in achievement and interest of SSS2 chemistry students.

**Key words:** Cooperative learning, analogy methods, students, chemistry, secondary, design

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### INTRODUCTION

For science and technology to successfully achieve the goals of development in Nigeria, there is need to engage creatively in science, especially, chemistry. No nation can make any meaningful progress in the information technology age, particularly in economic development without technology which has science as its foundations. This is because the level of science and technology of any nation has been widely accepted to be indicative of that nation's socio-economic and geo-political development. Science holds a great potential for mankind in terms of providing him with the means of reducing life's burden on Earth. Science plays profound roles in the life of individuals and the nation. Broadly, science can be defined as a body of knowledge which is acquired through observation and systematic experimentation (Ezeudu, 2011). Science is an important enterprise. It is a way of using human intelligence to achieve better understanding of nature and natural phenomena. Science is a systematized co-ordinated knowledge based upon the accurate observation of facts and the relation of these to the general principles of laws. According to Aniodoh, science enables man as an individual to take rational decision, create a just society and understand the environment. It helps to improve an individual's life expectancy and provides him means of tackling problems of existence such as disease and hunger. The researcher also emphasized that contributions of science could be seen in the area of our modern health,

automation, genetic engineering gene cloning, agriculture, transportation, building and construction. The positive overall impacts of science on the life of individuals and national economy explain why most countries including Nigeria are making huge investment in the field of science today.

Science is divided into two main branches viz. biological sciences and physical sciences. The biological sciences deal with living things while the physical sciences are concerned with properties of non-living matter. Chemistry being a physical science is one of the main branches of pure science. These branches of science are being taught by science educators using scientific processes and educational principles. Science education is the study of interrelationship between science as a discipline and application of educational principles to its understanding, teaching and learning (Gbamanja, 1991). Science education involves the teaching of science concepts, method of teaching and addressing misconceptions held by learners regarding science concepts. Okeke defined science education as an integrated field of study which considers both the subject matter of science discipline such as biology, chemistry, physics, agriculture, etc. as well as the process involved in the learning and teaching of science. In other words, science education implies exposing learners usually prospective teachers of science to scientific attitude as well as equipping them with professional skills of a science teacher. Science education is very important to the development of any nation. That is why every nation must

take it very seriously in all institutions of learning. Science education comprises three subjects namely: biology, chemistry and physics which are combined with education. Over the years there has been low enrolment of these courses, especially, chemistry in the tertiary institutions which can be attributed to the interest and achievement of students in these subjects in secondary schools (Kola, 2013). Nigeria, recognizing the need for science education in human and natural development, advocates for citizen's acquisition of scientific and technological education. Science education has been introduced in Nigerian schools from primary to tertiary level. However, the level of achievement in terms of acquisition of scientific skills is now the problem due to methods of teaching science subjects, especially, chemistry.

Chemistry deals with the composition, properties and the uses of matter. It probes into the principles governing the changes that matter undergoes (Osei, 2013). Chemistry forms a major part of the manpower needs of a nation-doctors, engineers, pharmacists agriculturists and science teachers. All at their secondary school level offered chemistry. Nigeria today is in need of such manpower in order to gain economic independence, technological know-how and other desirable social amenities and infrastructures. Today, people are aware of the fact that there is a subject known as chemistry and its importance is widely known. Hence, the increasing weight on the need for proper teaching of chemistry in our secondary schools. In spite of the importance of chemistry and the need to teach the subjects in schools there are a number of problems confronting the teaching and learning of the subject. Some of the problems include: shortage of qualified teachers, inappropriate teaching methods, inadequate teaching and learning facilities and lack of favourable attitude of the students to the subject. Learning chemistry involves two important aspects the theoretical and the practical aspects. The theoretical aspect deals with critical thinking, logical reasoning and ability to transfer knowledge from one concept to another. The practical aspect deals with performing activities which have indirectly or directly lead to the generation of ideas, concept and principles. Practical activities involve process of science which includes the formulation of hypothesis, testing of hypothesis, learning of concepts, exploration, fact finding and the application of basic skill and knowledge of chemistry.

The teaching and learning of chemistry is very important to man and for social development. Chemistry is taught in Nigerian secondary schools. The offering of chemistry in secondary schools starts from senior secondary school one. However, the students are taught basic science in their junior secondary school classes, part of which includes some aspects of basic chemistry which are elements and symbols, compounds, mixtures, atoms

and molecules. Though, the teaching of chemistry needs teachers with high morale, motivation and a mastery of knowledge, ability to understand learner's difficulties and capacity to facilitate learning, correct use of appropriate teaching methods are critical to the successful teaching and learning of chemistry. Students may learn names and definitions of chemical substances theoretically. But to master chemical reactions, they need to mix the chemicals and observe subsequent reactions. Knowledge of how teaching methods affect student's learning may help teachers to select methods that improve teaching quality, effectiveness and accountability to learners. It may also help them keep up with information technology and globalisation. The knowledge and application of chemistry have led to tremendous changes and development in society. The development in chemical industry, the provision of good food and drugs are traceable to the development in chemistry and other fields of knowledge that have chemistry as their foundation.

Over the years, curriculum planners have been trying to see how achievement of students offering chemistry as a subject can be affected positively through the teaching of the subject. The chemistry curriculum is aimed at satisfying the chemistry requirements of the senior secondary school programme in the new National Policy on Education (Federal Republic of Nigeria, 2009). The objectives of the curriculum are to develop interest in the subject of chemistry acquire basic theoretical and practical knowledge and skills develop interest in science, technology and mathematics acquire basic STM knowledge and skills develop reasonable level of competence in ICT applications that will engender entrepreneurial skills apply skills to meet societal needs of creating employment and wealth be positioned to take advantage of the numerous career opportunity offered by chemistry and be adequately prepared for further studies in chemistry.

In Nigerian secondary schools, many students always complain about the teaching of chemistry as a subject. Some see chemistry as being abstract. The academic achievement of students in chemistry is in a sorry state. West Africa Examination Council (WAEC) examiner's report has shown that in the result of May/June 2011 the Mean score in chemistry was 32 with standard deviation 18.39. In the year 2012, the mean score was 30 and a standard deviation of 13.39. This indicates that the achievement of students in 2012 was poorer than that of 2011. So, we often find a situation where by students do not want to offer the subject and those who do eventually get poor grades. One would say, therefore, that the teaching of chemistry, so far, in our secondary schools is causing a "psychological imbalance" on the part of the students, since, their performance does not qualify them to go for the courses of their choice in higher institutions.

Chemistry is seen as one of the core subjects in the science curriculum of secondary school education and various teaching methods have been put together to ensure effective teaching and achievement on the part of the teachers and students, respectively.

In this study, the focus will be on the methods of teaching chemistry in schools. A number of teaching methods can easily be identified (Nworgu, 2009). These include: lecture method, discussion method, problem-solving method, team teaching method, inquiry method, guided discovery method, demonstration method, project method, field trip method, analogy method, cooperative learning and constructivist-based method. The teaching of chemistry has been through didactic traditional approach (Nworgu, 2009). This is dominated by lecture method where the teacher gives out all the facts he/she wants the students to acquire and master without caring whether or not the students are actively participating in and contributing to the success of the lesson. The discussion method involves intelligent exchange of opinions between a whole class or a small group on a topic or an object. Inquiry method is termed "student centred" and some teachers advocate its use because it involves unstructured exploration by the students through their own process such as observing, measuring, classifying and from this investigation, generalization or conclusion can be made. Since, some of these methods have failed to bring about improvement in student's achievement in chemistry (Anonymous, 2012), the question now is how do we handle the teaching of chemistry in the present age for effective learning? An attempt to answer this question calls for the need to try other methods of teaching for student's better interest and achievement in the subject. Most of the conventional or traditional methods such as lecture method, team teaching method and discussion method encourage rote learning and memorization of concepts without actually exposing students to challenges that will make them to be actively engaged in learning process (Nworgu, 2009). The over reliance on these methods do not really encourage student's interest and achievement in chemistry (Sanni and Ochepe, 2002). In view of this, the present study investigated the effects of cooperative learning and analogy method on secondary school student's interest and achievement in chemistry.

Ezeudu (2011) defined cooperative learning as a teaching strategy in which the goals of the separate individuals are so, linked together that there is positive correlation among the group members for the attainment of their goal, i.e., an individual obtains his or her goals only, if the other members can obtain their goals. Hence, a person seeks an outcome that is beneficial to all those with whom he or she is cooperatively linked. Cooperative learning can also be defined as the instructional use of small groups, so that, students work together to maximize

their own and one another's learning. In cooperative learning situations, there is positive interdependence among student's goal attainments. Students perceive that they can reach their teaching-learning goals only, if the other students in their learning group also reach their goals (Johnson and Johnson, 1981). Cooperative learning is an innovative teaching-learning strategy. Cooperative efforts result in participants striving for mutual benefit, so that, all group members share a common fate, knowing that one's performance is mutually caused by oneself and colleagues and jointly celebrating when a group member is recognized for achievement. All the members of the group believe that they have common goal and they have the tendency to become absorbed in an experience.

There are different techniques in cooperative learning which are think-pair-share-round-table, sequential form simultaneous form and jigsaw. This study is using jigsaw technique in cooperative learning, since is a cooperative learning technique that requires everyone's cooperative effort to produce the final product. The name jigsaw comes from the method in which students are organized like pieces in a jigsaw to form different kind of groups where each student (piece) must be part of the jigsaw puzzle. Jigsaw technique helps students create their own learning. Teachers arrange students in groups. Each group member is assigned a different piece of information. Group members then join with members of other groups assigned the same piece of information, research and share ideas about the information. Eventually students return to their original groups to try to "piece together" a clear picture of the topic at hand. Analogy method is an innovative modern method of teaching. Analogies are important thinking tools used as a teaching strategy that helps the teacher to relate the old ideas he/she already has to new ones he/she is yet to know (Nworgu, 2009). It is the cognitive process of transferring information from a particular subject (the analogue or source) to another subject (the target). Analogue can be defined as an inference or an argument from one particular area to another particular area where at least one of the premises or the conclusion is general (Treagust, 2007). Analogy as a method of teaching is one of the constructivists based teaching approaches designed to provide a powerful means of bringing about change in student's interest and achievement in chemistry. This involves the use of familiar situation (analogue/source) to explain a similar unfamiliar phenomenon (target). Students must, therefore be familiar with analogue if it is to be fruitful. This fact was stressed by Treagust (2007) who said that in using analogies teachers must consider the knowledge base of the students. To be an effective tool in teaching science (especially, chemistry) in Nigeria secondary schools, analogy method must be able to prove its competence in bringing about higher levels of interest and achievement in chemistry concepts. This change will be seen in

student's attitude towards chemistry in secondary school. Analogies are essential in human cognition, reasoning, learning, communication and problem solving. They can have a profound and broad effect on how we view and understand our world. The effect of analogy on the achievement and interest of students in chemistry will be compared with cooperative learning. The researchers would want to know which of the two strategies produces more effects than the other.

Interest has been defined differently by different researchers. Interest is described as the attraction which forces or compels a child to respond to a particular stimulus (Obodo, 1999). This implies that any particular stimulus that is attractive or stimulating will make the learner develop interest in it. That is in a classroom situation, a student will be attentive during lesson, if he/she is very much interested in that particular lesson. Student's interest is closely associated with achievement and one's success in a subject is influenced by his/her interest in it, which might be due to the type of approach used in teaching the subject. Achievement is a term used to indicate the degree of success attained in some general or specific area. Achievement in a task is an act of attainment or accomplishment of a task. Achievement according to Obodo (1999) is defined as the extent or degree of attainment of students in tasks, courses or programmes to which they were sufficiently exposed. Some research attributed the poor achievement by students in science to the methods adopted by science teachers in teaching the subject (Obodo, 1999; Sanni and Ochepe, 2002). Interestingly as important as these courses are student's achievement has not been encouraging and this is worrisome and called for investigation (Anonymous, 2011). It therefore, becomes expedient to explore the efficacy of cooperative learning and analogy methods to check, if chemistry learning outcome could be improved as well as the interest and achievement of students in chemistry. Despite the fact that researchers attribute poor scientific achievement to poor teaching methods, majority of science educators are also of the view that gender is one of the determining factors of the student's poor achievement in science.

Gender refers to the many socially and culturally constructed characteristics, qualities, behaviours and roles which different societies ascribe to females and males (Nnamani and Audu, 2005). The issue of gender as it relates to academic achievement has attracted the attention of many national and international researchers. According to Mitchell and Hoff in the study of the relationship between gender and achievement there is a gender gap between male and female students who study science related subjects. The number seems to favour boys more than girls. Nwosu (2003) is of the opinion that cognitive ability and type of exposure may relate more strongly to the general achievement level in science than gender. The need for this study is to find out the effect of

some innovative methods of teaching such as cooperative learning and analogy method on the achievement and interest of students in chemistry. The major purpose of this study is to investigate the effects of cooperative learning and analogy on student's achievement and interest in chemistry. Specifically, this study seeks to find:

- The mean achievement scores of students taught chemistry using cooperative learning and those taught using analogy method
- The mean achievement scores of male and female students taught chemistry using cooperative learning and analogy method
- The mean interest scores of students taught chemistry using cooperative learning and analogy method
- The mean interest scores of male and female students taught chemistry using cooperative learning and analogy method
- The interaction effects of gender and instructional methods on student's achievement in chemistry
- The interaction effects of gender and instructional methods on student's interest in chemistry

#### **Research questions:**

- What are the mean achievement scores of students taught chemistry using cooperative learning and those taught using analogy method?
- What are the mean achievement scores of male and female students taught chemistry using cooperative learning and those taught using analogy method?
- What are the mean interest scores of students taught chemistry using cooperative learning and those taught using analogy method?
- What are the mean interest scores of male and female students taught chemistry using cooperative learning and analogy method?

#### **Hypothesis:**

- $H_{01}$ : There is no significant difference in the mean achievement scores of students taught chemistry using cooperative learning and analogy method
- $H_{02}$ : There is no significant difference in the mean achievement scores of male and female students in chemistry when taught using cooperative learning and analogy method
- $H_{03}$ : There is no significant difference in the mean interest scores of students taught chemistry using cooperative learning and analogy method
- $H_{04}$ : There is no significant difference in the mean interest scores of male and female students taught chemistry using cooperative learning and analogy method

- $H_{05}$ : There is no significant interaction effect between gender and instructional methods on student's mean achievement scores in chemistry
- $H_{06}$ : There is no significant interaction effect between gender and instructional methods on student's mean interest scores in chemistry

## **MATERIALS AND METHODS**

A quasi experimental design was used for this study. The non-randomized pretest-post-test control group design was adopted in which each of the two groups controlled the other. It is considered appropriate for this study because intact classes were used instead of randomly composed samples. According to Nworgu (2009), this design is often used in classroom experiment when experimental and control groups are naturally assembled in intact classes, so as not to disrupt the school setting. Consequently, intact classes were randomly assigned to experimental groups 1 ( $E_1$ ) and 2 ( $E_2$ ), respectively. The study was carried out in Okene Local Government Area, Kogi State. Okene local government is in Kogi central senatorial district of Kogi State. This area was considered for the study because from the researcher's experience in the marking of WAEC, NECO and transition examinations, the achievement of the students has not been satisfactory and having interacted with the chemistry teachers in the local government area observed that some of these teachers always give notes to the students without teaching them and those who teach use lecture method. The population of the study was 1046 students (720 males and 326 females). This comprises all Senior Secondary School Two (SSS2) chemistry students in Okene local government area. There are eighteen government secondary schools in Okene local government, two female schools and one male school in the zone. The remaining 15 are co-educational schools. The SSS two students were used for this study because this is the class that students in this local government area do the selection of their subject area and it is also in this class that one can really determine the interest of the students in science subjects, especially, chemistry. A sample of 253 students took part in the study (175 males and 107 females). Random sampling technique was used for sampling four schools from 15 co-educational schools. Since, gender is a variable of the study and the researchers wanted to find out the interaction effect of gender and instructional strategies, a purposive sampling was used. Two schools were randomly assigned to experimental group A and two to experimental group B. In each of the selected schools, one intact class was used giving a total of four classes in all. Two instruments were employed for data collection, namely, Chemistry achievement Test

(CAT) and Chemistry Interest Scale (CIS). Chemistry Achievement Test consists of 30 multiple-choice objective test items developed by the researchers from the content that was taught to both experimental groups. The topics that were taught with their weightings of the questions include: ionic theory-electrovalent (40%), covalent compounds (20%), electrolytes and non-electrolytes (20%) and electrolysis (20%). The interest scale was adapted from modified likert-type scale (Nworgu 2009). The chemistry interest scale is a twenty item interest scale. The instrument covered the four dimensions of interest. The dimensions are enjoyment in chemistry, leisure in chemistry normality in chemistry and career interest in chemistry. This was scored on a four point scale: Strongly Agree (SA), Agree (A), Disagree (D) and Strongly Disagree (SD). The CAT was subjected to both face and content validation while the interest scale was subjected to face and construct validity. They were given to three experts in the department of science education, University of Nigeria Nsukka and one chemistry teacher. The recommendations of these experts were incorporated into the instruments as appropriate. The reliability of the chemistry achievement test was done using a group of 20 SSS 2 chemistry students of another school different from the sampled school in Okene local government area of Kogi State. The instruments were administered to the students in order to determine the reliability index and the time to assign for the test. The copies of the scripts used in trial testing were scored by the researchers. The internal consistency of the achievement test was calculated using Kuder-Richardson (K-R) 20 and reliability coefficient of 0.83 was obtained. The chemistry interest scale internal consistency was calculated using Cronbach's alpha method and 0.84 reliability coefficient was obtained. Four research assistants were trained for this study. These were the chemistry teachers in the four schools. The research assistants were trained on the teaching methods and the contents to be covered. The researchers having prepared the lesson notes using cooperative learning and analogy methods that covered all the contents to be taught for 4 weeks explained to the teachers the steps involved. This lasted for a period of 1 week. Each of the four sampled classes was pre tested using CAT and CIS just before the treatment commenced. The pre-test was used to establish initial group equivalence. The regular chemistry teachers of the intact class groups carried out the actual teaching. The lesson plans are the major source of guide for both experimental groups. The experiment lasted for 5th week. The students were taught for 4 weeks after which the CAT and CIS were administered in the 5th week. Thus, the chemistry interest scale was administered immediately after the achievement test. In the interest scale, the students were required to tick a response that best describe their interest in Chemistry. After scoring the test,

the scripts were collated based on the variables of interest, achievement and gender. Mean and standard deviations were used to answer the research questions while Analysis of Covariance (ANCOVA) was used in testing the stated hypothesis, since, the research involves two variables. ANCOVA test is used in a pre- and post-test quasi-experimental research design when intact classes are used for treatment and control, respectively. The research related to human use has been complied with all the relevant national regulations, institutional policies and in accordance the tenets of the Helsinki Declaration and has been approved by the Research ethics committee at the Department of Science Education, University of Nigeria, Nsukka. This study was also conducted in adherence to the research ethics of the American Psychological Association. Informed consent was obtained from all individuals included in this study.

### RESULTS AND DISCUSSION

**Research question 1:** What are the mean achievement scores of students taught chemistry using cooperative learning and those taught using analogy. The result in Table 1 shows that the Experimental group ( $E_1$ ) taught chemistry using

Cooperative learning had a pre-test mean of 9.30 with a standard deviation of 3.47 and a post-test mean of 11.09 with a standard deviation of 3.37. The difference between the pre- and post-test means for the Experimental group ( $E_1$ ) was 1.79. The Experimental group ( $E_2$ ) taught chemistry using analogy had a pre-test mean of 7.51 with a standard deviation of 2.86 and a post-test mean of 10.75 with a standard deviation of 3.61. The difference between the pre- and post-test means for the Experimental group ( $E_2$ ) was 3.24. However, for each of the groups, the post-test means were greater than the pre-test means with the Experimental group ( $E_2$ ) having the higher mean gain. This is an indication that methods (cooperative learning and analogy) have some effects on student's achievement in chemistry.

**Hypothesis 1:** There is no significant difference in the mean achievement scores of students taught chemistry using cooperative learning and those taught using analogy.

The result in Table 2 shows that with respect to the achievement mean scores of students taught chemistry using cooperative learning and those taught using analogy an F-ratio of 0.169 was obtained with associated probability value of 0.681. Since, the associated probability value 0.681 is  $>0.05$  set as level of significance for testing the hypothesis, this means that the null Hypothesis ( $H_{01}$ ) which stated that there is no significant difference between the mean achievement scores of students in chemistry using cooperative learning and those taught using analogy is not rejected.

**Research question 2:** What are the mean achievement scores of male and female students taught chemistry using cooperative learning and those taught using analogy?

Result in Table 3 shows that the male taught chemistry using cooperative learning had a pre-test mean achievement score of 9.72 with a standard deviation of 3.33 and a post-test mean achievement score of 10.86 with a standard deviation of 3.59. The difference between the pre- and post-test mean achievement scores for the male group was 1.14. The female group had a pre-test mean achievement score of 8.31 with a standard deviation of 3.50 and a post-test mean achievement score of 11.49 with a standard deviation of 2.94. The difference between the pre- and post-test mean achievement scores for female group was 3.18. However, for each of the groups, the post-test means achievement scores were greater than the pre-test means. This is an indication that gender may have some influence on student's achievement in chemistry when taught using cooperative learning. Also, result of Experimental group ( $E_2$ ) in Table 3 shows that the male taught chemistry using analogy had a pre-test mean achievement score of 7.59 with a standard deviation of 2.76 and a post-test mean achievement score of 10.78 with a standard deviation of 3.60. The difference

Table 1: Mean and standard deviation of pre- and post-test achievement's score of students taught chemistry using cooperative learning and those taught using analogy

Variable methods	Pre-test			Post-test		
	N	$\bar{X}$	SD	$\bar{X}$	SD	Mean gain
Cooperative learning group ( $E_1$ )	107	9.30	3.47	11.09	3.37	1.79
Analogy group ( $E_2$ )	146	7.51	2.86	10.75	3.61	3.24

Table 2: Analysis of Covariance (ANCOVA) of student's achievement in chemistry

Sources	Type III sum of squares	df	Mean square	F-values	Sig.	Prob. level
Corrected model	91.284 <sup>a</sup>	4	22.821	1.879	0.115	0.05
Intercept	2678.964	1	2678.964	220.530	0.000	-
Pre-test achievement	71.797	1	71.797	5.910	0.016	-
Gender	8.474	1	8.474	0.698	0.404	-
Method	2.056	1	2.056	0.169	0.681	-
Gender*method	13.335	1	13.335	1.098	0.296	-
Error	3012.669	248	12.148	-	-	-
Total	33017.000	253	-	-	-	-
Corrected total	3103.953	252	-	-	-	-

<sup>a</sup> Significant values

Table 3: Mean and standard deviation of pre- and post-test achievement score of male and female student's taught chemistry using cooperative learning and those taught using analogy

Variable methods/Gender	Pre-test			Post-test		
	N	$\bar{X}$	SD	$\bar{X}$	SD	Mean gain
<b>Cooperative learning group (E<sub>1</sub>)</b>						
Male	74	9.72	3.33	10.86	3.59	1.14
Female	33	8.31	3.50	11.49	2.94	3.18
<b>Analogy group (E<sub>2</sub>)</b>						
Male	91	7.59	2.76	10.78	3.60	3.19
Female	55	7.16	2.74	10.71	3.67	3.55

Table 4: Mean and standard deviation of pre- and post-test interest scores of students taught using cooperative learning and those taught using analogy

Variable methods	Pre-test interest			Post-test interest		
	N	$\bar{X}$	SD	$\bar{X}$	SD	Mean gain
Cooperative learning group (E <sub>1</sub> )	107	30.53	8.70	54.04	4.26	23.51
Analogy group (E <sub>2</sub> )	146	39.81	8.61	55.74	6.91	15.93

between the pre- and post-test mean achievement scores for the male was 3.19. The female had a pre-test mean achievement score of 7.16 with a standard deviation of 2.74 and a post-test mean achievement score of 10.71 with a standard deviation of 3.67. The difference between the pre- and post-test means achievement scores for female group was 3.55. However, for each of the groups, the post-test means achievement scores were greater than the pre-test means. This is an indication that gender may have some influence on student's achievement in chemistry when taught using analogy.

**Hypothesis 2:** There is no significant difference in the mean achievement scores of male and female students in chemistry when taught using cooperative learning and analogy.

Table 2 shows that with respect to the mean achievement scores of male and female students taught chemistry using cooperative learning and those taught using analogy an F-ratio of 0.698 was obtained with associated probability value of 0.404. Since, the associated probability value 0.404 is  $>0.05$  set as level of significance for testing the hypothesis, this means that the null Hypothesis (H<sub>02</sub>) which stated that there is no significant difference between the mean achievement scores of male and female students taught chemistry using cooperative learning and those taught using analogy is not rejected.

**Research question 3:** What are the mean interest scores of students taught chemistry using cooperative learning and those taught using analogy?

Result in Table 4 shows that the Experimental group (E<sub>1</sub>) taught chemistry using cooperative learning had a pre-test mean interest of 30.53 with a standard deviation of 8.70 and a post-test mean interest of 54.04 with a standard deviation of 4.26. The difference between the pre- and post-test mean interest scores for the Experimental group (E<sub>1</sub>) was 23.51. The Experimental group (E<sub>2</sub>) taught chemistry using analogy had a pre-test

mean interest score of 39.81 with a standard deviation of 8.61 and a post-test interest mean of 55.74 with a standard deviation of 6.91. The difference between the pre- and post-test mean interest scores for the Experimental group (E<sub>2</sub>) was 15.93. However, for each of the groups, the post-test mean interest scores were greater than the pre-test mean interest scores with the Experimental group (E<sub>1</sub>) having the higher mean gain. This indicates that method (cooperative and analogy) have some effects on student's interest in chemistry.

**Hypothesis 3:** There is no significant difference in the mean interest scores of students taught chemistry using cooperative learning and those taught using analogy.

The result in Table 5 shows that with respect to the mean interest scores of students taught chemistry using cooperative learning and those taught using analogy an F-ratio of 2.121 was obtained with associated probability value of 0.147. Since, the associated probability value (0.147) is  $<0.05$  set as level of significance for testing the hypothesis, this means that the null Hypothesis (H<sub>03</sub>) which stated that there is no significant difference between the mean interest scores of students taught chemistry using cooperative learning and those taught using analogy is not rejected. Thus, there is no significant difference between the mean interest scores of male and female students taught chemistry using cooperative learning and analogy.

**Research question 4:** What are the mean interest scores of male and female students taught chemistry using cooperative learning and those taught using analogy?

Result in Table 6 shows that the male taught chemistry using cooperative learning had a pre-test mean interest score of 29.53 with a standard deviation of 8.97 and a post-test mean interest score of 53.78 with a standard deviation of 4.75. The difference between the pre- and post-test mean interest score for the male was 24.25. The female had a pre-test mean interest of 32.28 with a standard deviation of 8.01 and a post-test mean

Table 5: Analysis of Covariance (ANCOVA) of student's interest in chemistry

Sources	Type III sum of squares	df	Mean square	F-values	Sig.	Prob. level
Corrected model	2123.925 <sup>a</sup>	4	530.981	19.104	0.000	0.05
Intercept	25173.272	1	25173.272	905.700	0.000	-
Pre-test interest	1775.753	1	1775.753	63.889	0.000	-
Method	58.942	1	58.942	2.121	0.147	-
Gender	2.013	1	2.013	0.072	0.788	-
Method * Gender	7.255	1	7.255	0.261	0.610	-
Error	6892.976	248	27.794	-	-	-
Total	774892.000	253	-	-	-	-
Corrected total	9016.901	252	-	-	-	-

<sup>a</sup>Significant values

Table 6: Mean and standard deviation of pre- and post-test interest score of male and female student's taught chemistry using cooperative learning and those taught using analogy

Variable methods	Pre-test interest			Post-test interest		
	N	$\bar{X}$	SD	$\bar{X}$	SD	Mean gain
<b>Cooperative learning group (E<sub>1</sub>)</b>						
Male	74	29.53	8.97	53.78	4.75	24.25
Female	33	32.28	8.01	54.49	3.24	22.21
<b>Analogy group (E<sub>2</sub>)</b>						
Male	91	37.89	8.64	54.92	7.21	17.03
Female	55	42.89	7.66	57.05	6.22	14.16

interest score of 54.49 with a standard deviation of 3.24. The difference between the pre- and post-test interest mean for female group was 22.21. However, for each of the groups, the post-test means interest scores were greater than the pre-test interest means. This is an indication that gender has some influence on student's interest in chemistry when taught using cooperative learning. Also, result in Table 6 shows that the male taught chemistry using analogy had a pre-test mean interest score of 37.89 with a standard deviation of 2.76 and a post-test mean interest of 54.92 with a standard deviation of 7.21. The difference between the pre- and post-test means interest scores for the male was 17.03. The female had a pre-test mean interest score of 42.89 with a standard deviation of 7.66 and a post-test mean interest score of 57.05 with a standard deviation of 6.22. The difference between the pre- and post-test means interest scores for female was 14.16. However, for each of the groups, the post-test means interest scores were greater than the pre-test means interest scores. This is an indication that gender has some influence on student's interest in chemistry when taught using cooperative learning.

**Hypothesis 4:** There is no significant difference in the mean interest scores of male and female students taught chemistry using cooperative learning and analogy.

The result in Table 5 shows that with respect to the mean interest scores of male and female students taught chemistry using cooperative learning and analogy an F-ratio of 0.072 was obtained with associated probability value of 0.788. Since, the associated probability of 0.788 was >0.05 level of significance. The

null Hypothesis (H<sub>04</sub>) is not rejected. Thus, there is no significant difference between the mean interest scores of male and female students taught chemistry using cooperative learning and analogy. Although, there was an improvement in male and female student's interest in chemistry when taught using cooperative learning and analogy, gender did not show any significant difference.

**Hypothesis 5:** There is no significant interaction effect between gender and instructional strategies on student's mean achievement score in chemistry.

Table 2 shows that an F-ratio of 1.098 with associated probability value of 0.296 was obtained for interaction between gender and instructional strategies. Since, the associated probability (0.296) was >0.05 level of significance. The null Hypothesis (H<sub>05</sub>) is not rejected. Inference drawn is that the interaction effect of instructional strategies and gender on student's mean achievement scores in chemistry is not statistically significant. Although, there was an improvement in male and female student's achievement in chemistry when taught using cooperative learning and analogy, there was no interaction between gender and instructional strategies. This means that cooperative and analogy did not favour any particular group (i.e., male or female). Therefore, any difference in the achievement mean score on the basis of the two methods may be due to chance.

**Hypothesis 6:** There is no significant interaction effect between gender and instructional strategies on student's mean interest scores in chemistry.

Table 5 shows that an F-ratio of 0.261 with associated probability value of 0.610 was obtained for interaction between gender and instructional strategies on



student's mean interest scores in chemistry. Since, the associated probability (0.261) was  $>0.05$  level of significance. The null Hypothesis ( $H_{0c}$ ) is not rejected. Inference drawn is that the interaction effect of instructional strategies and gender on student's mean interest in chemistry is not statistically significant. Result shows that there was an improvement in male and female student's interest in chemistry when taught using cooperative learning and analogy, there was no interaction between gender and instructional strategies. This means that cooperative and analogy did not favour any particular group (i.e., male or female).

The major purpose of this study was to investigate the effects of cooperative learning and analogy on student's achievement and interest in chemistry. It was found that the mean achievement scores of the students taught with cooperative learning and analogy were high but that of students taught with cooperative learning was higher than the mean achievement score of students taught with analogy. The difference in scores was tested by the ANCOVA which showed that the difference is not significant. This shows that there is no significant difference to conclude that cooperative is better than analogy. This is in consonance with Anih (2007) who carried out a comparative study on the effect of lecture method and cooperative learning on achievement of students in general chemistry. The mean achievement scores of female taught chemistry using cooperative learning was higher than the mean achievement scores of the male taught chemistry using the same cooperative learning. In analogy the mean achievement scores of both male and female taught chemistry are almost the same. This showed that analogy method is gender friendly while the cooperative favoured the female students than their male counterparts. This result is in consonance with the findings by Ifeakor (2003), Nbina and Wagbara (2013) who carried out studies on the student's academic achievement in chemistry and integrated science, respectively and the result showed that there was no significant gender difference.

The difference in the level of interest was tested using ANCOVA, Table 5. The result indicated that there was no significant difference in the mean interest scores of the students taught chemistry with cooperative learning and analogy. This could be the fact that both are student's centered and also innovative methods. This finding is contrary to the investigation by Obodo (1999) on the effect of three teaching models on achievement, retention and interest of students. The researchers concluded that the models were not significant factors in terms of student's interest in the concept. But this finding is in agreement with the study by Asumagba who concluded from the study that interest of students enabled them to achieve superior academic gain in science courses.

In cooperative learning the female students showed higher interest than their male counterparts. In analogy,

the female students also showed more interest than their male counterparts. It was observed that the female students in each group showed better improvement than their male counterparts. This is in consonance with the study by Asumagba. The findings revealed that there was no significant difference in the interest of male and female students towards chemistry. This study is contrary to the study by Joseph that his investigation revealed a significant gender difference in the achievement of students in favour of male students. Cooperative learning favoured female students than their male counterparts while in analogy the mean achievement scores of both male and female are almost the same. The analogy is gender friendly than the cooperative learning. The level of significance for 2-tailed test was greater than the probability level of 5%.

The female students taught chemistry using cooperative learning showed more interest than their male counterparts after the treatment. In analogy group the female students also showed higher interest more than their male counterparts. It was noticed that the interest in analogy group is higher than that of cooperative learning. The level of significance for 2-tailed test was greater than the probability level of 5% this means that there is no interaction effect between gender and instructional strategies there by accepting the hypothesis.

## CONCLUSION

Students taught chemistry using both cooperative learning and analogy methods achieved higher results with no significant difference. Female students taught chemistry using cooperative learning achieved better than the male students while in analogy both male and female students had almost the same mean achievement scores. Students taught using analogy method had better interest in chemistry than those taught with cooperative learning but there was no significant difference. There is no significant interaction effect between gender and instructional strategies on student's mean achievement scores in chemistry. There is no significant interaction effect between gender and instructional strategies on student's mean interest scores in chemistry.

**Compliance with ethical standards:** The research related to human use has been complied with all the relevant national regulations, institutional policies and in accordance the tenets of the Helsinki Declaration and has been approved by the Research Ethics Committee at the Department of Science Education, University of Nigeria, Nsukka. This study was also conducted in adherence to the research ethics of the American Psychological Association. Informed consent was obtained from all individuals included in this study.

## RECOMMENDATIONS

The following recommendations have been proffered based on the findings of this study. Cooperative learning should be encouraged in corporation with analogy in Nigerian chemistry classrooms in particular and science classroom in general, since, both of them improve student's achievement.

Based on the findings, it is recommended that science teachers should adopt the cooperative learning with analogy teaching method in science classrooms, since, it would encourage both male and female students to perform well and reduce the gaps between the two groups. As a result of the indispensable nature of chemistry as one of the tools in scientific and technological advancement, students should be encouraged to take the study of chemistry seriously by exposing them to instructional methods such as cooperative learning and analogy that will stimulate and sustain their interest.

Effective use of cooperative learning and analogy methods of teaching should be included in the training programme of pre-service chemistry teachers. Universities and colleges of education should organize workshops on importance of cooperative learning and analogy methods and how to effectively implement them.

There should be effective counselling unit in every school to help students identify and maintain those factors that help in developing interest in their courses as interest relates to achievement in science. Government should provide materials like textbooks, well equipped laboratory and scientific equipment for use in cooperative learning and analogy methods. Time should be allotted by educational administrators for schools on the use of cooperative learning, since, it is time consuming, so that, much will be covered from the curriculum.

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