



Comparative effect of Jigsaw II Cooperative, Concept mapping and Expository Learning Strategies on Chemistry Students' Academic Achievement in Secondary Schools in Ikot Abasi Local Government Area

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Abstract

This study investigated the comparative effect of Jigsaw II Cooperative, Concept mapping and expository learning strategies on Chemistry students' academic achievement in secondary schools in Ikot Abasi Local Government Area. Four research questions and four null hypotheses were formulated to give direction to the study. The study adopted a quasi-experimental non-randomized pre-test, post-test design. The population of the study consisted of all the 1430 students of 2024/2025 academic session in the eleven (11) co-educational Secondary Schools in Ikot Abasi Local Government Area of Akwa Ibom State. The study sample comprised 150 students in the three intact classes of the SSS I students selected using simple random sampling technique. Researcher-made instrument titled: Chemistry Achievement Test on Chemical Bonding (CATCB) were used for data collection. The instrument was face valued by three experts. The reliability coefficients of the instruments, determined using Kuder-Richardson formula 21 reliability statistics, were 0.79 for CATCB. The data obtained from all the tests were analyzed using mean, standard deviation, and Analysis of Covariance (ANCOVA). The result showed that there was a significant difference in the mean academic achievement scores of students in the concept taught using Jigsaw II Cooperative learning strategy, Concept mapping learning strategy and expository learning strategy, that there was no significant influence of gender on the students' mean academic achievement scores. It was concluded that Jigsaw II Cooperative learning strategy and Concept mapping learning strategy enhanced Chemistry students' academic achievement in the concept of chemical bonding. Recommendations were made among others, that Chemistry teachers should make effective use of Jigsaw II Cooperative in teaching concepts in chemistry.

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Keywords: Chemistry, Jigsaw II Cooperative learning strategy, Concept mapping learning strategy, Expository learning strategies, students' academic achievement

Introduction

Chemistry is a science that systematically studies the composition, properties and activities of organic and inorganic substances and the various elementary forms of matter. Chemistry, by its nature, is the central science because diverse subjects share essential links with it. It is one of the core subjects offered in senior secondary schools. The teaching of Chemistry should develop in the students manipulative and experimental skills to make them competent and confident in conducting experiments. In some countries, many students, from the secondary school to the university, struggle to understand Chemistry, and many do not succeed (Reid, 2018) ^[9]. Research has shown that many students do not correctly understand fundamental concepts in Chemistry (Kamisah and Nur, 2023).

The situation is much the same in Nigeria. For example, the West African Examination Council Chief Examiner's Report in 2023 said less than 70 percent of the students, both male and female, passed Chemistry at credit level. Chemistry has been regarded as a difficult subject for students by many researchers, teachers and science educators (Kamisah and Nur, 2023) because of the abstract nature of many chemical concepts, inappropriate teaching strategies, lack of teaching aids and the difficulty in the language of Chemistry. Both science educators and cognitive researchers agree that efforts to understand and improve science education should be focused on learning strategies.

Learning strategies are techniques that students use to acquire, process, and retain information more effectively. They are deliberate, goal-directed actions or thoughts that help learners understand and remember new concepts, solve problems, or complete academic tasks successfully. These strategies may include organizing information, summarizing key points, rehearsing content, using mnemonic devices, self-questioning, and employing visual aids such as mind maps or diagrams. Learning strategies also encompass meta-cognitive skills like planning, monitoring, and evaluating one's learning process (Joe, 2022) ^[5]. Ajoma (2019) ^[2] sees learning strategies as the professional techniques teachers adopt regularly in instructional exercises to enable them to impart relevant knowledge and skills to the learners. There are various strategies available to a trained teacher to enhance the delivery of knowledge and skills to the learners. The various strategies have different effects on the academic achievement of the students. These include the Problem-solving models, the cooperative learning models, the inquiry learning models, the discovery learning models and the collaborative models, among others. This present study focused on how Jigsaw II Cooperative and Concept mapping strategies could enhance academic achievement of students in Chemistry.

Jigsaw II Cooperative learning strategy is an effective way to teaching. It is one the cooperative learning strategies where students break learning materials into manageable learning pieces (small pictures) and then integrate all the learning materials into meaningful whole (bigger picture). It is based on the perspective that one students will first become "an expert" in a small part of the whole learning materials and then teach other students about this part of the material. It is a method of organizing classroom activity that makes students dependent on each other to succeed. It breaks classes into groups and breaks assignments into pieces that the group assemble to complete the jigsaw puzzle. Jigsaw II Cooperative strategy encourages listening, engagements and empathy by giving each member of group an essential part to play in activity carried out (Akpan and Essien, 2018) ^[3]. As earlier stated, this study also consider concept mapping teaching strategy.

Concept mapping as a learning strategy provides a suitable environment, where students learn individually and in groups to collaborate and support each other (Oakley, 2024) ^[8]. Concept mapping is a strategy of visually organization of structure of information, concepts, and their relationship. Concept maps are used as a tool for meaningful learning, to document conceptual change, develop critical thinking skills, emphasize hierarchical relationships, move away from rote memorization, as a compensation for different learning styles and improve students' achievement (Hay, 2017) ^[4]. It is against this background that this study is carried out to ascertain if concept mapping still enhance academic

achievement.

Academic achievement is the action of accomplishing an academic task successfully. Its purpose is to find out the stand of a student at a given moment (Reid, 2018) ^[9]. It has to do with testing the knowledge acquired by the students which help the teacher and the students to evaluate and predict the degree of learning attained. It is useful in testing the retention of information and skill. Achievement is a determinant of the efficacy and efficiency of a given instruction (Joe, 2022) ^[5]. Interest is considered to be the feeling of an individual towards a particular object or an activity. It means that a child will develop an interest in an object or activity that is found to be attractive or stimulating. Therefore, in a classroom situation, the learner will be attentive during a lesson only if the instruction is appealing to the learner (Ajoma, 2019). Apart from students' academic achievement as the result of learning strategies adopted in teaching and learning process, the retention of the taught concepts by the students is also paramount. Although teaching strategies has been identified as one of the issues influencing achievement in science education, the problem might be linked to characteristics of learners such as gender.

Gender difference is another factor commonly associated with students' academic achievements. In the context of this study, the term is an analytic concept that describes sociological roles, cultural responsibilities and expectations of men and women in a given society or cultural setting. Studies on gender as it affects students' academic achievement and retention in Chemistry appear inconclusive. Some studies report significant influence of gender on the achievement of students while other studies indicate no significant influence of gender on achievement of students. This has underscored the need of the present study to find out if there is any significant difference between the mean achievement scores of the male and female Chemistry students taught chemistry concepts using Jigsaw II Cooperative and Concept mapping strategies.

Empirically, Sentongoet *al.*, (2023) ^[10] studied the effect of using Jigsaw II Cooperative, concept mapping and expository teaching strategies in teaching chemical bonding with Ugandan Learners. The objectives of the study were to examine the effect of using jigsaw II Cooperative and concept mapping in addition to hands-on (manual) laboratory activities when teaching chemical bonding and to compare the results with those of learners who were taught using hands-on (manual) laboratory activities only. The study employed a quasi-experimental design involving two groups: one whole class was assigned the Experimental Group (EG) and the other the Control group (CG). The study was conducted in a co-educational school with a population of 2200 learners The sample size was 250 learning selected using simple random sampling technique. Data were collected using an achievement test. The reliability coefficient of the instrument determined using Cronbach Alpha was 0.81. Data from achievement tests were analysed using descriptive and inferential statistics. The results indicated that learners had little knowledge about chemical bonding. The EG performed better than the CG in the post-test (ANCOVA, $p < 0.05$). The previous study was conducted in Ugandan while the present study was conducted in Ikot Abasi Local Government Area, Akwa Ibom State.

Ajayi and Ogbaba (2021) ^[11] examined the effect of gender on students' achievement in stoichiometry using hands-on activities. A sample of 292 students from eight purposively

selected secondary schools out of a population of 8,381 SS II students from zone C of Benue State, Nigeria was used for the study. The study adopted a quasi-experimental research design. Stoichiometry Achievement Test (SAT) was used for data collection. Reliability coefficient of 0.92 was established using Pearson correlation moment coefficient. Two research questions and two hypotheses guided the study. The research questions were answered using mean and standard deviation while the hypotheses were tested at 0.05 level of significance using Analysis of covariance (ANCOVA). The study revealed that there is no significant difference in the mean achievement scores between male and female students taught stoichiometry using hands-on activities; ($F(1, 145) = 4.160, p > 0.05$). It also found no significant interaction effect between methods and gender on the mean achievement scores of students in stoichiometry; ($F(1, 291) = 0.11, p > 0.05$). The previous was conducted in Benue State while the present study was conducted in Ikot Abasi Local Government Area, Akwa Ibom State.

From the above reviews, since the studies were conducted in other regions in Nigeria, therefore, the researchers were motivated to carry out a study to investigate the comparative effect of Jigsaw II Cooperative learning strategy and Concept mapping learning strategy on Chemistry students' academic achievement in the concept of chemical bonding.

Statement of the Problem

Chemistry has been regarded as a difficult subject for students by many researchers, teachers and science educators because of the abstract nature of many chemistry concepts, poor computational ability, inappropriate teaching strategies, lack of teaching aids and the difficulty in the language of Chemistry. Both science educators and cognitive researchers agree that efforts to understand and improve science education should be focused on fundamental teaching strategies. Also, there must be effective teaching strategies. Teaching and learning outcomes may increase greatly, depending on teacher's ability to use innovative teaching strategies. Innovative teaching strategies are those strategies developed by educators that outline logical steps that when followed produce an optimal solution to given problems. However, the innovative teaching strategies of concern to this study are Jigsaw II Cooperative and Concept mapping. It is the belief of this researcher that teaching Chemistry concepts using Jigsaw II Cooperative and Concept mapping would lead to students' improved performance in the subject. Hence, the present study seeks to investigate the relative effectiveness of these models in facilitating students' concept attainment in chemical bonding. The problem of this study, therefore, is: how effective would Jigsaw II Cooperative and Concept mapping be in facilitating students' achievement in chemistry in Public secondary schools in Ikot Abasi LGA.

Purpose of the Study

The study seeks to investigate the comparative effect of Jigsaw II Cooperative learning strategy and Concept mapping learning strategy on Chemistry students' academic achievement in the concept of chemical bonding. Specifically, the study sought to:

1. Determine the difference in the mean academic achievement scores of students taught the concept of chemical bonding using Jigsaw II Cooperative, concept mapping and expository learning strategies.

2. Investigate the mean academic achievement scores of male and female chemistry students taught chemical bonding using Jigsaw Cooperative learning strategy.
3. Examine the mean academic achievement scores of male and female chemistry students taught chemical bonding using Concept mapping strategy.

Research Questions

The following research questions were posed for the study:

1. What difference exist among the mean academic achievement scores of students taught the concept of chemical bonding using Jigsaw II Cooperative, concept mapping and expository teaching strategies?
2. What difference exist between the mean academic achievement scores of male and female chemistry students taught chemical bonding using Jigsaw Cooperative learning strategy?
3. What is the difference between the mean academic achievement scores of male and female chemistry students taught chemical bonding using concept mapping strategy?

Hypotheses

The following null hypotheses were raised for the study:

1. There is no significant difference among the mean academic achievement scores of students taught the concept of chemical bonding using Jigsaw II Cooperative, concept mapping and expository learning strategies.
2. There no significant difference between the mean academic achievement scores of male and female chemistry students taught chemical bonding using Jigsaw II Cooperative learning strategy.
3. There is no significant difference between the mean academic achievement scores of male and female chemistry students taught chemical bonding using Jigsaw II Cooperative learning strategy.

Research Methods

Quasi- experimental research design involving pretest and posttest was adopted for this study. Non randomization of the subjects into groups was employed for biasness freedom (Kpolovie, 2018) ^[7]. The study was conducted in secondary schools in Ikot Abasi Local Government Area of Akwa Ibom State. The population for this study consisted of 1430 Senior Secondary One (SSI) chemistry students registered in the 11 public secondary schools located at Ikot Abasi Local Government Area (Akwa Ibom State Secondary Education Board, 2025). The sample size for this study consisted of one hundred and fifty (150) SSI Chemistry students drawn from two randomly selected secondary schools. This study adopted simple random sampling technique. Simple random sampling was adopted for this study because it ensures that every student in the population had an equal and independent chance of being selected. This technique reduces the risk of bias in the selection process and increases the likelihood that the sample accurately represents the larger population of SSI Chemistry students.

A researcher made instrument titled: Chemistry Achievement Test on Chemical Bonding (CATCB) was used for data collection in this study. The CATCB consisted of 50 multiple choice (A-D) test items. The instrument had two (2) sections (A & B). Section A contained items on the demographic variables of the students and Section B contained items on the

concept of Chemical bonding. The CATCB consists of 50 multi-choice items with three distracters and one correct option lettered A-D. Each correct answer was scored two (2) points and wrong answer was scored zero. The researcher also prepared lessons plans that were used in teaching the students the concept of chemical bonding using the different learning strategies.

The instrument was face validated by one secondary school chemistry teacher with at least 8 years of teaching experience and two other experts. One expert each in the field of Test and measurement in the Department of Psychological Foundations of Education and Chemistry Education in the Department of Science Education in the University of Uyo. The validates were required to check for the appropriateness of the items in terms of the language used, content coverage and class level. The researcher was appropriately guided, with all comments and suggestion in-cooperated in the final form of the instrument. The content validity of the Chemistry Achievement Test on Chemical Bonding (CATCB) was ensured using the test blue print designed by Bloom (knowledge, comprehension, application, analysis, synthesis and evaluation). In order to ascertain the reliability of the instrument, copies of the CATCB were administered to a trial test group of 30 senior secondary one (SS1) students in a school within the population which was not part of the sample. Data generated was subjected to Kuder-Richardson's formula – 20. Kuder-Richardson's formular – 20 was chosen because the test items were multiple choices, which takes

care of variance and proportion of correct and incorrect responses in the items. The reliability coefficient of .079 was obtained. This coefficient showed that the instrument was reliable.

After appropriate permission have been granted by the principals of sampled schools, the instrument for data collection for this study was administered as pretest to the students before experimental treatments. The two experimental groups was taught using jigsaw II Cooperative and concept mapping differently for four (4) weeks, 60minutes per period while the control group was taught the same topic using expository strategy. The actual teaching was done for four weeks while the posttest was administered immediately after complete teachings. The scores from the posttest test was recorded and used to provide information on students' academic achievement across treatment groups. Mean and Standard deviation statistical tools were used to answer the research questions while Analysis of covariance (ANCOVA) statistical tool was used to test the formulated null hypotheses at .05 alpha level of significance.

Results

Answering of Research Questions

Research Question 1: What difference exist among the mean academic achievement scores of students taught the concept of chemical bonding using Jigsaw II Cooperative, concept mapping and expository teaching strategies?

Table 1: Mean (\bar{X}) and standard deviation of students' pre-test and post-test scores classified by treatment groups

Treatment Groups	n	Pre-test	Post-test	Mean Gain Score
		\bar{x} sd	\bar{x} sd	
Jigsaw II Cooperative	51	19.41 4.20	71.86 9.59	52.45
Concept mapping	49	20.20 4.44	70.82 5.43	50.62
Expository strategy	50	19.40 4.24	23.70 5.03	4.30

The result in Table 1 shows that the mean gain score of students in the Jigsaw class is 52.45 while the mean gain score of students in concept mapping class is 50.62. The result however shows a mean gain of 4.30 for students in the expository class. This shows that students taught using Jigsaw strategy achieved better than other groups. However, the margin between Jigsaw and concept mapping is marginal (close) while Jigsaw and concept mapping were far better

learning strategies when compared to expository learning strategy.

Research Question Two:

What difference exist between the mean academic achievement scores of male and female chemistry students taught chemical bonding using Jigsaw II Cooperative strategy?

Table 2: Mean and Standard deviation scores of male and female students' pretest and posttest scores in Chemical bonding when taught using Jigsaw II Cooperative strategy

Pretest Posttest						
Gender	n	\bar{x}	SD	\bar{x}	SD	Mean Gain scores
Male	20	19.75	4.44	71.75	9.63	52.00
Female	31	19.19	4.10	71.94	9.72	52.72

Results in Table 2 shows that female students with mean gain scores of 52.00 achieved academically slightly the same as male students with difference of 52.72 when taught the concept of chemical bonding using jigsaw II Cooperative strategy.

Research Question Three

What difference exist between the mean academic achievement scores of male and female chemistry students taught chemical bonding using concept mapping strategy?

Table 3: Mean and Standard deviation scores of male and female students' pretest and posttest scores in Chemical bonding when taught using concept mapping strategy.

Pretest		Posttest	
Gender	n	\bar{x}	SD
Male	27	20.56	4.67
Female	22	19.77	4.22
		70.56	5.43
		50.00	51.37

Results in Table 3 shows that male students with mean gain scores of 50.00 achieved academically slightly the same as female students with difference of 51.37 when taught the concept of chemical bonding using concept mapping strategy.

Testing of Null Hypotheses

Hypothesis One: There is no significant difference among the mean academic achievement scores of students taught the concept of chemical bonding using Jigsaw II Cooperative, concept mapping and expository teaching strategies.

Table 4: Summary of Analysis of Covariance (ANCOVA) of the students' post-test scores classified by treatment groups

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Decision at .05 alpha level
Corrected Model	75791.607 ^a	3	25263.869	514.028	.000	S
Intercept	23183.293	1	23183.293	471.696	.000	S
Pretestscores	80.160	1	80.160	1.631	.204	NS
GROUP	75783.557	2	37891.778	770.960	.001	S
Error	7175.727	146	49.149			
Total	544450.000	150				
Corrected Total	82967.333	149				

a. R Squared = .914 (Adjusted R Squared = .912), S= Significant at .05 alpha level, NS= Not significant at .05 alpha level

In Table 4, the calculated F-ratio for the effect of instructional strategies at df 2, 149 is 770.960, while its corresponding calculated level of significance is .001 alpha. This level of significance is less than .05 in which the decision is based, indicating that there was a significant difference in the

academic achievement of students in the concepts taught using Jigsaw II Cooperative, concept mapping and expository teaching strategies. With this observation, null hypothesis 1 was rejected. The direction of significance was determined using Scheffe post hoc test in Table 5.

Table 5: Scheffe Post Hoc tests for Post-test classified by treatment groups

GROUP	N	Subset	
		1	2
Expository teaching strategy	50	23.7000	
Concept mapping	49		70.8163
Jigsaw II Cooperative	51		71.8627
Sig.		1.000	.758

The mean difference is significant at the 0.05 level.

The results in Table 5 show that students taught using Jigsaw II Cooperative achieved significantly better performance compared with those taught using concept mapping and expository teaching strategies. Those in the expository strategy group had the least performance.

Hypothesis Two: There no significant difference between the mean academic achievement scores of male and female chemistry students taught chemical bonding using Jigsaw II Cooperative learning strategy.

Table 6: Summary of Analysis of Covariance (ANCOVA) of male and female students' post-test scores classified by Jigsaw II Cooperative strategy group and gender with pre-test scores as covariate

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Decision at .05 alpha level
Corrected Model	82.084 ^a	2	41.042	.436	.649	NS
Intercept	13380.881	1	13380.881	142.225	.000	S
Pretest1	81.666	1	81.666	.868	.356	NS
GENDER1	.003	1	.003	.006	.995	NS
Error	4515.955	48	94.082			
Total	267975.000	51				
Corrected Total	4598.039	50				

a. R Squared = .018 (Adjusted R Squared = -.023), S= Significant at .05 alpha level, NS= Not significant at .05 alpha level

In Table 6, the calculated F-ratio for the main effect of gender at df 1, 50 was .006 while its significant level is .995. This significant level is greater than .05 alpha in which the decision is based, indicating that the influence of gender on

the students' academic achievement was not statistically significant when taught using Jigsaw II Cooperative learning strategy. With this observation, null hypothesis 2 was retained.

Hypothesis Three: There no significant difference between the mean academic achievement scores of male and female

chemistry students taught chemical bonding using concept mapping strategy.

Table 7: Summary of Analysis of Covariance (ANCOVA) of male and female students' post-test scores classified by concept mapping strategy group and gender with pre-test scores as covariate

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Decision at .05 alpha level
Corrected Model	20.005 ^a	2	10.003	.329	.721	NS
Intercept	10276.256	1	10276.256	338.291	.000	S
Pretest2	15.916	1	15.916	.524	.473	NS
GENDER2	5.605	1	5.605	.185	.670	NS
Error	1397.342	46	30.377			
Total	247150.000	49				
Corrected Total	1417.347	48				

a. R Squared = .014 (Adjusted R Squared = -.029), NS= Not significant at .05 alpha level, S= Significant at .05 alpha level

In Table 7, the calculated F-ratio for the main effect of gender at df 1, 50 was .185 while its significant level is .670. This significant level is greater than .05 alpha in which the decision is based, indicating that the influence of gender on the students' academic achievement was not statistically significant when taught using concept mapping strategy. With this observation, null hypothesis 3 was retained.

Discussion of Findings

Jigsaw II Cooperative, concept mapping and expository teaching strategies and Students' Academic Achievement

The findings revealed that students taught using Jigsaw strategy achieved better than other groups. It was showed that there is a significant difference among the academic achievement scores of students taught the concept of chemical bonding using Jigsaw II Cooperative, concept mapping and expository teaching strategies. The result also revealed that students taught using Jigsaw II Cooperative achieved significantly better performance compared with those taught using concept mapping and expository teaching strategies. The students taught using expository teaching strategy had the least performance. This result could be attributed to the fact that during jigsaw II Cooperative and concept mapping learning, students break learning materials into manageable learning pieces (small pictures) and then integrate all the learning materials into meaningful whole (bigger picture). The result of this finding is in line with the findings by Sentongoet *al.*, (2023) ^[10] who showed that learners exposed to jigsaw II Cooperative learning strategy are highly motivated, pay much attention to detail and learn better. It has also been noted that the students interact easily with jigsaw II Cooperative learning strategy.

Gender, Jigsaw II Cooperative and Students' Academic Achievement

The finding revealed that female students achieved academically slightly the same as male students when taught the concept of chemical bonding using jigsaw II Cooperative strategy. It was also revealed that there is no significant difference between the academic achievement scores of male and female students taught the concept of chemical bonding using Jigsaw II Cooperative. This result could be attributed to the fact that both male and female students were exposed to the same treatment and on that note, they expect to perform equally. This means that the learning strategy seem to be

interested to both male and female students. The result of this finding agreed with the findings by Ajayi and Ogbeba (2021) ^[1] who reported that there is no significant difference among the academic achievement of students taught the concept of chemical bonding using Jigsaw II Cooperative and expository teaching strategies.

Gender, Concept mapping and Students' Academic Achievement

The finding revealed that male students achieved academically slightly the same as female students when taught the concept of chemical bonding using concept mapping strategy. The findings also showed that there is no significant difference between the academic achievement scores of male and female students taught the concept of chemical bonding using concept mapping. This result could be attributed to the fact that both male and female students were exposed to the same treatment and on that note, they expect to perform equally. This means that the learning strategy seem to be interested to both male and female students. The result of this finding agreed with the findings by Ajayi and Ogbeba (2021) ^[1] who reported that there is no significant difference among the academic achievement of students taught the concept of chemical bonding using concept mapping and expository teaching strategies.

Conclusion

Based on the findings of the study, it is hereby concluded that of the three learning strategies (Jigsaw II Cooperative, Concept mapping and expository) investigated, Jigsaw II Cooperative is the most effective in facilitating students' achievement in chemistry. Also gender had no statistically significant influence on students' academic achievement in chemistry.

Recommendations

Based on the findings and the conclusions reached, the following recommendations are made:

1. Chemistry teachers should make effective use of Jigsaw II Cooperative in teaching concepts in chemistry.
2. Curriculum planners should ensure the incorporation of Jigsaw II Cooperative in the teaching and learning of chemistry.
3. Government in conjunction with professional bodies like STAN should endeavour to organize and sponsor regular

- workshops to train science teachers on the use of Jigsaw II Cooperative in teaching science concepts.

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