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Jigsaw, Think-Pair-Share and Coop-Coop Cooperative Instructional Strategies and Retention of Students' Knowledge in Carbohydrate

Comfort Daiko[1], Emmanuel E. Achor[2*], Gladys U. Jack[3]

[1] Department of Basic Science, College of Agriculture, Jalingo, Nigeria

[2] Department of Science and Mathematics Education, Benue State University, Makurdi, Nigeria

[3] Department of Science Education, Taraba State University, Jalingo, Nigeria.

Abstract

Purpose: This paper aims to compare the effects of Jigsaw, Think-pair-share, and Coop-Coop Cooperative Instructional Strategies on the retention of students' knowledge in Carbohydrate in Jalingo metropolis, Taraba State, Nigeria. **Methodology:** The study employed a quasi-experimental non-randomized pre-test, post-test design. The study population comprised 1936 students in all 41 public secondary schools in Jalingo metropolis, Taraba State, Nigeria. The sample consisted of 322 students (males = 184, females = 138) drawn from the population. An Achievement Test in Carbohydrate (ATC), consisting of 50 multiple-choice questions, was used to collect data for the study. The reliability index of the ATC was estimated using Kuder-Richardson (K-20) and yielded a value of .86. Both descriptive statistics, including Mean and standard deviation, and inferential statistics, such as Analysis of Covariance, were adopted for the analysis. **Findings:** Findings revealed that students taught carbohydrates using Jigsaw retained knowledge more than their counterparts taught using think-pair-share and coop-coop cooperative instructional strategies. **Significance:** There was no significant difference between the mean retention scores of male and female students taught carbohydrates using Jigsaw, Think-pair-share, and Coop–Coop Cooperative Instructional Strategies. The interaction effects between instructional strategies and gender on retention were not statistically significant. Among other recommendations, it was suggested that there is a need for an urgent workshop to address the use of Jigsaw to teach organic concepts and operations to enable chemistry teachers to deploy it appropriately.

Keywords: carbohydrate, chemistry, coop-coop cooperative strategy, jigsaw strategy, retention of students' knowledge, think-pair-share strategy.

* Corresponding author: *Emmanuel E. Achor, nuelachor@yahoo.com*

Introduction

Chemistry has played a major role in global environmental issues, particularly in the areas of pollution, toxic substances, and non-biodegradable materials that are harmful to the environment and living things (Owoyemi, 2018). Chemistry is one of the core subjects in senior secondary schools in Nigeria. Its inclusion justifies the recognition of its role in our day-to-day activities. The functional role of Chemistry, as one of the science subjects, in both national and global development remains very important (Umanah & Udo, 2015).

Chemistry, as a subject, offers learners opportunities to develop their skills in scientific methods and the ability to unravel the world in which humans live. This has given chemistry unparalleled popularity among other science subjects. It is essential, therefore, that Chemistry be given priority attention in secondary schools.

The Secondary School Chemistry curriculum has a component of life Chemistry called Carbohydrate Chemistry. Carbohydrate an aspect of organic chemistry plays a significant role in the overall development of nations and so it is necessary to lay a solid foundation in the learners to help them appreciate its relevance. Organic chemistry has practical applications in food and pharmaceutical industries, medicine, tissue engineering and agriculture (Besada et al, 2014). Carbohydrates are organic compounds comprising of carbon, hydrogen and oxygen.

It is on note that the teaching and learning of carbohydrates Chemistry have been burdened with challenges that prevent the optimum achievement of the objectives of Chemistry for national development. It is a well-documented fact in science education literature that many students in many countries of the world, at all levels struggle to learn carbohydrates Chemistry (Jegede, 2012; Njoku, 2005; Oloyede, 2010). Consequently, these students perceive carbohydrates Chemistry as a difficult aspect of Chemistry. This perception is reflected in their performance in the subject in external examinations such as the West African Secondary School Certificate Examination (WASSCE) and National Examination Council (NECO) which has remained persistently poor.

It is no gainsaying that in a typical Nigerian science classroom, the traditional lecture method still predominates. This method is teacher-centred, and the learners are not actively engaged in meaningful hands-on, heads-on and hearts-on activities. The learners only remain passive listeners struggling to memorise the concepts taught without actually understanding them. The resultant effect is poor learning, poor perception of the concepts taught and poor academic achievement. The carbohydrates contents of Chemistry need to be properly taught using appropriate learner-friendly, interactive strategies.

There are varieties of student-friendly cooperative teaching strategies from which a teacher can select for facilitating learning and students' achievement in carbohydrate Chemistry (Olatoye et al, 2009). These include Jigsaw, Think-Pair-Share, Think-Pair-Solo, Numbered Heads Together, Coop-Coop, Pantomime-A-Tale, Round-Robin brainstorming, Teams-Games-Tournaments and Student Teams Achievement Division to mention a few. The study, therefore, investigated the relative effectiveness of three variants of this strategy: Jigsaw, Think-Pair-Share and Coop-Coop Cooperative strategies in facilitating students' interest, achievement and retention of carbohydrate Chemistry in Jalingo Education Zone of Taraba State, Nigeria.

Jigsaw instructional strategy was developed by Elliot on grounds that cooperation will help individuals to develop, and each can reach a goal so long as every other individuals in the group get to their goals. In Jigsaw cooperative teaching strategy, the classes are broken into groups of 4-6 members and

assigned tasks which are only parts of the lesson to be taught for the groups (home groups) to work on. From every `home group` each student is assigned a portion of study material. `Home groups` members will disengage from the group and then join other teams to form `expert groups`. In the `expert groups` the students undertake intensive study of their material to ensure understanding and prepare it for peer tutoring. Thereafter, each student returns to his/her respective home group to teach the assigned material to the rest of the group and also learns other parts of the material from the group (Lestik & Plous, 2012). For instance, carbohydrate as a concept might be divided into the definition of carbohydrate, sources of carbohydrate, reactions of carbohydrate, properties of carbohydrate. From the exposure, students learn to learn from their teammates. They are encouraged to support and manifest interest in one another's work, thus jigsaw cooperative learning brings children together irrespective of their abilities.

Think-pair-share is another cooperative instructional strategy used by teachers in mediating classroom interactions. The think-pair-share cooperative instructional strategy gives students opportunity to adopt higher-level thinking. The strategy gives students opportunity to reflect about a question, raise and review their hypothesis as well as enhancing their reasoning (Hmelo-Silver, 2013). The strategy was developed by Frank Lyman as cited in Glomo-Narzoles (2012) to provide the teacher flexibility of cooperative learning. This strategy is a multi-dimensional discussion that has three stages of thinking, meaning students are given time to think individually after posing a question; pair as students discuss the ideas among themselves and within the pair to produce a final answer and finally share, that is, each pair share their new and upgraded answer with other members of the class.

Think-pair-share and other collaborative learning techniques are different on the grounds that each student is given time to think quickly and they also work in small groups (pairs). According to Ifamuyiwa and Onakoya (2013), think-pair-share strategy unites the cognitive and social angles of learning; and encourages the development of thinking and the creation of knowledge. This strategy is a kind of informal group learning strategy which assists teachers in making students dynamic learners participating actively in classroom discussion and interaction. The process of think-pair-share commences with the teachers giving out the problem or asking an open-ended question to which there may be a variety of answers. The teacher proceeds to give learners time to think and directs them to reflect about the question and how to answer it. While on think time, learners work together with their partners; sharing ideas with other pairs or with the whole class.

Another instructional strategy that is of interest in the present study is the Coop-Coop Cooperative Learning which was developed by Kagan (1989). In this structure, the instructor guides the process at each phase. The instructor begins by explaining the topic and thereafter breaks it into distinct relevant sub-topics. Thereafter, the students are organized into 5-6 membered teams. The students may be allowed to form teams themselves. The teams discuss the instructor's assigned topics and pick one in which they like. The instructor approves the topic to the teams. Alternatively the teams will be permitted to create topics following the instructor's list as a starting point. However, if allowed, the instructor will insist that all relevant sub-topics are taken by the teams. Each team sub-divides its topic into smaller topics for every team member. The team topic must be fully addressed.

The instructor would like to keep approval rights for each team's micro-topic list. Micro-topics are independently prepared. This is accompanied by presentations by the team to the entire class. Micro-topic preparation may include library and/or database research, surveys, experiments, papers, videos, plays, or scenarios. After team presentations to the whole class, the teacher gives feedback to teams and necessary corrections and additional information on the topics presented. This is followed by testing the

students on the subject matter and award grades. The present study investigated the efficacy of Jigsaw, Think-Pair-Share and Coop-Coop Cooperative instructional strategies in advancing interest in carbohydrate Chemistry.

Retention is the capacity to call to remembrance content of materials. According to Achor et al (2009), retention is the ability to preserve or keep knowledge of learnt materials and to be able to remember and recall it when required. An individual also can retain and playback their experiences and what has been learnt after a particular learning approach. The human mind gains the items of knowledge through feeling and perception. The assimilated materials need to be preserved or stored in the human mind in form of images for knowledge enhancement. Whenever an interesting situation shows, acquired images are revived or reproduced to allow for occurrence of memory (Ellah & Achor, 2018). It thus means that what quadratic, simultaneous and quadratic simultaneous equations are and how to solve them algebraically are presented to the students such that it touches their consciousness. It further goes to imply that any pedagogical strategy adopted to improve students' performance in Mathematics may also improve their retentive ability in the subject. Ajayi (2017) in their separate studies found that there is a significant difference between the retention mean scores of the students in the experimental and control groups. The significant difference could be linked to students' gender.

Gender is another factor commonly associated with students' interest and academic achievement in the sciences. Gender, as a concept is a socio-cultural construct that differentiates the roles of males and females in a given society; the physical, biological, mental and behavioural attributes about and to differentiate between the male and female population. Gender issue in science education has attracted the attention of many researchers. Studies on gender as it affects students' academic performance in Chemistry are inconclusive, hence, needs further investigations. Some researchers consider science learning as male restricted and that girls tend to be strongly conditioned by the low-perception of their competencies and skills. This, often results to resistance and lack of self-confidence in most girls or desire by boys to be in control (Cuomo et al, 2017).

The interaction effect between strategies and gender has gained researchers' attention in in last decade in science education. For instance, Ugwuanyi (2012) in a study found that gender significantly interacts with instructional treatment. The interaction could be due to gender or strategies. However, Miriogu (2012) and Musa (2017) found no interaction effect of gender and treatments on physics achievement. Given these inconsistencies in research findings, further studies on the interaction effect of gender and cognitive-based instruction on performance become imperative.

Statement of the Problem

Students' persistent poor performance in Chemistry in external examinations conducted by the West African Examinations Council (WAEC) and National Examinations Council (NECO) over the years is worrisome. The observed state of students' underachievement in Chemistry in WAEC and NECO has caused serious concern to Chemistry teachers, educational planners and parents.

It is also worthy of note that Chemistry is abstract, hence, needs to be properly taught using appropriate learner-friendly, interactive approaches to captivate and sustain the learner's interest during classroom interactions. To address the issue of inadequate involvement of the learners in teaching-learning situations Chemistry educators have recommended the use of student-friendly cooperative teaching approaches which include Jigsaw, Think-Pair-Share, Think-Pair-Solo, Numbered Heads Together, Coop-

Coop, Pantomime-A-Tale, Round-Robin Brainstorming, Teams-Games-Tournaments and Student Teams Achievement Division. The question then is, which of these cooperative teaching strategies enhances students' retention of knowledge more in the concept of carbohydrates in organic Chemistry considering their gender? There is a relative paucity of empirical studies in this area, hence, is difficult to assess the effectiveness of cooperative strategies in Chemistry, particularly in carbohydrates. This study seeks to fill the gap by investigating the relative effectiveness of jigsaw, think-pair-share, and coop-coop cooperative instructional strategies on students' retention of knowledge in carbohydrate Chemistry in Jalingo area of Taraba State, Nigeria.

Objectives of Study

This study investigated the effect of Jigsaw, Think-Pair-Share, and Coop-Coop Cooperative instructional strategies on students' retention of knowledge in carbohydrate Chemistry in Jalingo Educational Zone of Taraba State, Nigeria. The specific objectives of the study are to:

1. Find retention scores of students in carbohydrate when taught using Jigsaw, Think-Pair-Share and Coop-Coop Cooperative instructional strategies.
2. Determine the difference in the retention scores of male and female students in carbohydrate Chemistry when taught using Jigsaw instructional strategy.
3. Ascertain the difference in the retention scores of male and female students in carbohydrate Chemistry when taught using Think-Pair-Share instructional strategy.
4. Ascertain the difference in the retention scores of male and female students in carbohydrate Chemistry when taught using Coop-Coop Cooperative instructional strategy.
5. Determine the interaction effect of instructional strategies and gender on the retention of students in carbohydrate Chemistry.

Method

Design, Sample and Sampling

A quasi-experimental, non-randomized, pre-test, post-test design was employed for the study. The quasi-experimental design seeks to demonstrate the cause-effect output of a given study. The design is considered appropriate because it is the most powerful and valid design which can be used to identify confidently the cause of any given effect (Agogo & Achor, 2019). The choice of the design is informed by the fact that subjects cannot be randomized and therefore intact classes are used. A limitation of this design is that the students in each study group are not equivalent in knowledge level and this called for need to correct its effect by choice of appropriate statistic for analysis. The factors involved vary at the following levels: treatment - 3 levels, interest - 2 levels, and gender - 2 levels, thus a 3 x 2 x 2 factorial design.

The study population is made up 1,934 SS2 students in all the 41 public mix-sex secondary schools in Jalingo metropolis of Taraba State during the 2019/2020 academic session (Taraba State Post Primary School Management Board [TSPPSMB], 2020). The choice of SS2 students is because carbohydrates are taught at this level. It follows that students do not have any prior knowledge of the concept to be investigated.

The study sample comprises 322 SS2 Chemistry students in six intact classes selected from six

secondary schools in the study area. In the first stage, purposive sampling was used in selecting only co-educational public schools and schools that have presented candidates for the Senior secondary certificate Examination (SSCE) in Chemistry at least for five years. The second stage, sampling random sample was used to select two schools from the six and assigned of Jigsaw Cooperative group experimental group I, Think-Pare-Share (Experimental group II) and coop-coop cooperative groups (Experimental group III), respectively. A pre-test was administered to SSII Chemistry Students in intact classes to determine equivalent achievement. The sample for the investigation was SSII male and female students that offer Chemistry. The numbers of students in the experimental groups were unequal because intact classes with different students' populations are involved in the study.

Instrumentation, Validation and Reliability

The only instrument was developed by the researcher for data collection: Achievement Test in Carbohydrates (ATC). In the same vein, twelve instructional packages (lesson plans) were prepared for the teaching. Four lesson plans for teaching in each experimental group, that is, experimental groups Jigsaw, Think-Pair-Share and coop-coop respectively.

The achievement test in carbohydrates Chemistry is a 50-item 4-option multiple-choice test with options (A-D) designed to measure the students' pre-test, post-test and retention achievement in the concept taught. The students were required to choose the correct answers from the options A-D listed against each question. The items in the ATC were selected from topics in carbohydrates listed in the Chemistry Curriculum in Taraba State based on Bloom's taxonomy of educational objectives in the cognitive domain. The multiple-choice items consisted of four options lettered A-D, one of the options is the key. Two marks will be given for correct answers to a question and no mark is given for correct answers or a choice of more than one answer for a question. The sample students are expected to answer the question in each of the tests. A total of 100 marks is the maximum obtainable marks in each of the instruments. The table of specifications of the questions reveal that most were on application, knowledge, comprehension and synthesis.

The instrument and 12 instructional packages, namely, ATC and Lesson plans respectively, were given to four lecturers, three from science education, one from Faculty of Science, Department of Chemistry for face validation. All the validators are from Taraba State University, Jalingo. The experts were asked to scrutinize the items for appropriateness to achieve the purpose of the study. They were also requested to look out for relevance of the contents and statements clarity. The observations of the validators were used in modification of the instruments for trial data collection. The content validation covered 60 items using table of specification. The 60 items covered the topic of carbohydrates taught to the students as intact classes.

To determine the internal consistency of the instrument, 40 copies of the ATC were administered on a sample of 40 SSII Chemistry students in Jalingo town of Jalingo Educational zone of Taraba State. The school is not part of the schools for the main study using Kuder-Richardson (K-R-20), the score obtained by the student in achievement test in carbohydrates Chemistry (ATC) were used to the reliability coefficient. The items reliability index was found to be .87. This value of the coefficient that was obtained indicates that the instrument is reliable and suitable for the main study. Further, the psychometric analysis was used to estimate the difficulty index, discrimination index and the distraction power of each item based on the results items with difficulty indices below 25 and above 70 were dropped for being too difficult and too simple respectively. Those with discrimination indices below 25 and above 70 were also dropped for

lacking the potentiality to discriminate between the slow and fast learners. These reduced the items in ATC to 50 in the final form of the instrument. More so, the selection of items was also based on the recommendation that for an acceptable choice item to meet the statistically acceptable criteria, any item that has both difficulty index (DF.1) p. value between .35 and .90 and discrimination index (D.1)>= .20 should be selected (Geddes, 2014).

Experimental Procedure

Before treatment, the six chemistry teachers with B. Ed or B. Sc (Ed) were trained as research assistants on experimental grouping and the use of the strategy in each of the groups. The prepared lessons were used by research assistants to teach the assigned groups. Those trained for experimental group Jigsaw handled experimental group Jigsaw. Those trained for think-Pair-Share and coop-coop handled experimental group, think-Pair-Share and coop-coop. the training lasted for one week.

After selecting the sample schools and assigning them to the three treatment groups, the researcher obtained permission from the principals of the three selected schools and also sought the cooperation of the SS2 Chemistry teachers during the exercise. The research assistants were briefed for one week on how to teach their respective groups using the validated lesson notes developed by the researcher for the study. The use of the research assistants is to control for the treatment effect. At the end of the briefing session, the researcher assessed the research assistants' level of compliance and offered help where necessary.

This is followed by the administration of the Achievement Test in Carbohydrates to all the students in all the treatment groups as pre-test by the research assistants under the strict supervision of the researcher. Thereafter, the lesson notes prepared by the researcher were used by the research assistants in teaching the concepts to their respective groups for four weeks. The students in treatment Group 1 were taught using the Jigsaw cooperative teaching strategy; those in treatment Group two were taught using Think-Pair-Share cooperative teaching strategy; while those in treatment Group three were taught using Coop-coop cooperative teaching strategy. The teachings in all the groups were done during the normal class periods for Chemistry and in an intact class setting. This was done to avoid disrupting the school programme, and treatment effect. At the end of the treatment session, the reshuffled version of the Achievement Test in Carbohydrates (ATC) and Student Interest in Chemistry Scale (SICS) was administered to all the treatment groups as post-test and subsequent retention test under the supervision of the researcher. Test scripts from both the pre-test and post-test were collected immediately at the end of each test by the research assistants who submitted the same to the researcher for marking and scoring.

Results and Discussion

The pre-test and post-test data in carbohydrates Chemistry were analysed using mean and standard deviation to answer the research questions, while ANCOVA was used in testing the null hypotheses formulated. The choice of ANCOVA was informed by the fact that the subjects were not randomly selected and therefore were not equivalent in their knowledge level. ANCOVA therefore corrected the initial difference as pre-test results were used to co-vary with the post test results. All the hypotheses were tested at a .05 level of significance. ANCOVA statistic took care of the initial difference in knowledge among the students sampled. The Analysis of Covariance was used to ensure that initial group differences are addressed. Results from data analysis and interpretation are presented in this section.

Research Question One

What are the mean retention scores of students in carbohydrates when taught using Jigsaw, Think-Pair-Share and Coop-Coop Cooperative instructional strategies?

Table 1: *Mean Retention Scores of Students in Carbohydrate when taught using Jigsaw, Think-Pair-Share and Coop-Coop Cooperative Instructional Strategies*

Instructional Strategy		Pre ATC	Retention	Mean Gain
Jigsaw	Mean	13.03	19.72	6.69
	N	108	108	
	Std. Deviation	4.98	7.30	
Think-Pair-Share Strategy	Mean	14.83	15.64	.81
	N	107	107	
	Std. Deviation	3.12	4.55	
Coop-Coop Cooperative Strategy	Mean	12.60	14.31	1.71
	N	107	107	
	Std. Deviation	4.65	4.19	

Table 1 displays the mean retention scores of students in carbohydrates when taught using Jigsaw, Think-Pair-Share and Coop-Coop Cooperative instructional strategies. It can be seen from the table that 108 students were taught carbohydrates using the Jigsaw instructional strategy, 107 students were taught carbohydrates using Think-Pair-Share strategy and 107 students were taught carbohydrate using Coop-Coop Cooperative strategy. The table reveals that the mean retention scores of students in carbohydrates when taught using Jigsaw strategy is 13.03 with a standard deviation of 4.98 during pre-test and 19.72 with a standard deviation of 7.30 in post-test. The mean retention scores of students in carbohydrates when taught using Think-Pair-Share strategy is 14.98 with a standard deviation of 3.12 during pre-test and 15.64 with a standard deviation of 4.55 in post-test. The mean retention scores of students in carbohydrates when taught using Coop-Coop Cooperative strategy is 12.60 with a standard deviation of 4.65 during pre-test and 14.31 with a standard deviation of 4.19 in post-test. The table further shows that the mean gain for Jigsaw strategy is 6.69, while that of Think-Pair-Share strategy is 17.69 and Coop-Coop Cooperative strategy is 10.60.

Research Question Two

What is the difference in the mean retention scores of male and female students in carbohydrate Chemistry when taught using Jigsaw instructional strategy?

Table 2: *Mean Retention Scores of Male and Female Students in Carbohydrate Chemistry when taught using Jigsaw Instructional Strategy*

Gender		PreATC	Retention	Mean Gain
Female	Mean	12.74	19.37	6.63
	N	46	46	

Gender		PreATC	Retention	Mean Gain
	Std. Deviation	4.53	6.67	
	Mean	13.24	19.98	6.74
Male	N	62	62	
	Std. Deviation	5.31	7.78	
Mean difference				.11

It is revealed in Table 2 that the difference in the mean retention scores of male and female students in carbohydrate Chemistry when taught using Jigsaw strategy. The table shows that 46 female students and 62 male students were taught carbohydrate Chemistry using the Jigsaw strategy. The table reveals that the mean retention scores of female students taught carbohydrate Chemistry using the Jigsaw strategy is 12.74 with a standard deviation of 4.53 during pre-test and 19.37 with a standard deviation of 6.67 in the post-test. The mean retention scores of male students taught carbohydrate Chemistry using the Jigsaw strategy is 13.24 with a standard deviation of 5.31 during pre-test and 19.98 with a standard deviation of 7.78 in post-test, Table 2 further shows that the mean gain of female students that were taught carbohydrate Chemistry using Jigsaw strategy is 6.63 and those of male students taught carbohydrate Chemistry using Jigsaw instructional strategy is 6.74. The difference in the mean retention scores of male and female students in carbohydrate Chemistry when taught using the Jigsaw strategy is .11 in favour of male students.

Research Question Three

What is the difference in the mean retention scores of male and female students in carbohydrate Chemistry when taught using the Think-Pair-Share instructional strategy?

Table 3: *Mean Retention Scores of Male and Female Students in Carbohydrate Chemistry when taught using Think-Pair-Share Instructional Strategy*

Gender		PreATC	Retention	Mean Gain
	Mean	14.89	15.63	.74
Female	N	46	46	
	Std. Deviation	3.27	4.72	
	Mean	14.79	15.66	.87
Male	N	61	61	
	Std. Deviation	3.03	4.46	
Mean difference				.13

From Table 3, it is shown that the difference in the mean retention scores of male and female students in carbohydrate Chemistry when taught using the Think-Pair-Share instructional strategy. The table shows that 46 female students and 61 male students were taught carbohydrate Chemistry using the Think-Pair-Share strategy. The table reveals that the mean retention scores of female students taught carbohydrate Chemistry using Think-Pair-Share strategy is 14.89 with a standard deviation of 3.27 during pre-test and 15.63 with a standard deviation of 4.72 in post-test. The mean retention scores of male

students taught carbohydrate Chemistry using Think-Pair-Share strategy is 14.79 with a standard deviation of 3.03 during pre-test and 15.66 with a standard deviation of 4.46 in post-test, Table 3 further shows that the mean gain of female students that were taught carbohydrate Chemistry using Think-Pair-Share strategy is .74 and those of male students taught carbohydrate Chemistry using Think-Pair-Share strategy is .87. The difference in the mean retention scores of male and female students in carbohydrate Chemistry when taught using the Think-Pair-Share strategy is .13 in favour of male students.

Research Question Four

What is the difference in the mean retention scores of male and female students in carbohydrate Chemistry when taught using Coop-Coop Cooperative instructional strategy?

Table 4: *Mean Retention Scores of Male and Female Students in Carbohydrate Chemistry when taught using Coop-Coop Cooperative Instructional Strategy*

Gender		PreATC	Retention	Mean Gain
	Mean	13.26	14.52	1.26
Female	N	46	46	
	Std. Deviation	4.89	3.74	
	Mean	12.10	14.15	2.05
Male	N	61	61	
	Std. Deviation	4.44	4.53	
Mean difference				.79

Table 4 displays the difference in the mean score of male and female students in carbohydrate Chemistry when taught using Coop-Coop Cooperative instructional strategy. The table shows that 46 female students and 61 male students were taught carbohydrate Chemistry using Coop-Coop Cooperative strategy. The table reveals that the mean score of female students taught carbohydrate Chemistry using Coop-Coop Cooperative strategy is 13.26 with a standard deviation of 4.89 during pre-test and 14.52 with a standard deviation of 3.74 in post-test. The mean score of male students taught carbohydrate Chemistry using Coop-Coop Cooperative strategy is 12.10 with a standard deviation of 4.44 during pre-test and 14.15 with a standard deviation of 4.53 in post-test. Table 4 further shows that the mean gain of female students that were taught carbohydrate Chemistry using Coop-Coop Cooperative strategy is 1.26 and those of male students taught carbohydrate Chemistry using the same strategy is 2.05. The difference in the mean scores of male and female students in carbohydrate Chemistry when taught using Coop-Coop Cooperative strategy is .79 in favour of male students.

Research Question Five

What is the interaction effect of instructional strategies and gender on the retention of students in carbohydrate Chemistry?

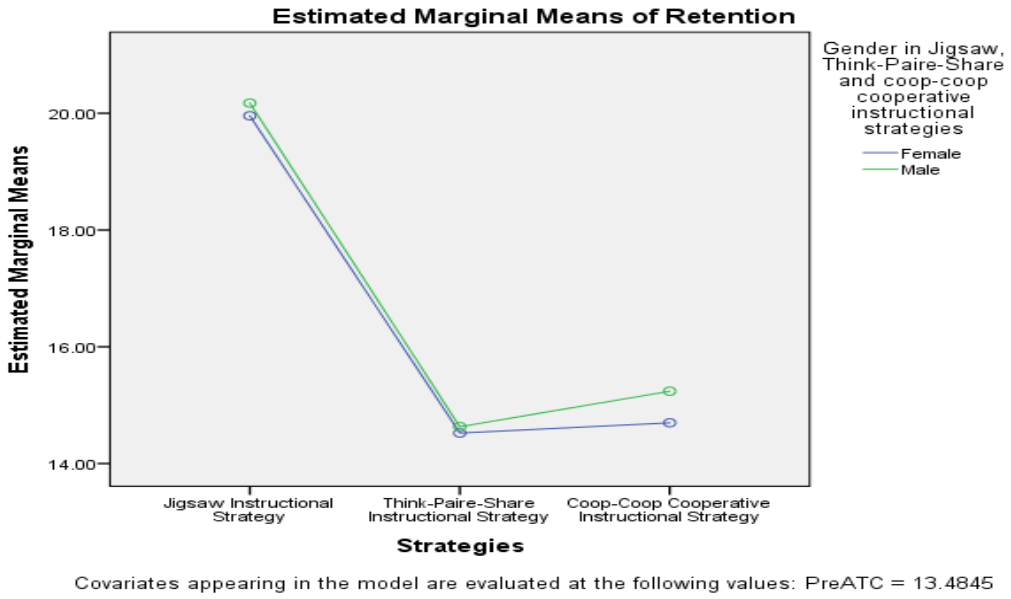

Figure 1: *Interaction Effect of Instructional Strategies and Gender on the Retention of Students in Carbohydrate Chemistry*

In Figure 1, the profile plot/graph reveals the interaction effect of instructional strategies and gender on the retention of students in carbohydrate Chemistry. The interaction pattern shows that the plots for males and females intersect at the Think-Pair-Share instructional strategy. The plot further shows that the interaction effect of instructional strategies and gender on the retention of students in carbohydrate Chemistry deviate at Jigsaw and Coop-Coop Cooperative instructional strategies.

Hypothesis One

There is no significant difference in the mean retention scores of students in carbohydrates when taught using Jigsaw, Think-Pair-Share and Coop-Coop Cooperative instructional strategies.

Table 5: *ANCOVA of Retention Scores of Students in Carbohydrate when taught Using Jigsaw, Think-Pair-Share and Coop-Coop Cooperative Instructional Strategies*

Dependent Variable: Retention

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	5394.424[a]	3	1798.141	93.946	.000	.470
Intercept	1064.248	1	1064.248	55.603	.000	.149
PreATC	3682.421	1	3682.421	192.392	.000	.377
Strategies	**1998.692**	**2**	**999.346**	**52.212**	**.000**	**.247**
Error	6086.572	318	19.140			
Total	99873.000	322				
Corrected Total	11480.997	321				

a. R Squared = .470 (Adjusted R Squared = .465)

It is seen from Table 5 that F(2, 318) = 52.212; p = .000 < .05. Since p is less than .05, the null hypothesis is rejected. This shows that there is a significant difference in the mean retention scores of students in carbohydrates when taught using Jigsaw, Think-Pair-Share and Coop-Coop Cooperative instructional strategies. Thus, based on evidence from data analysis there is a significant difference in the mean retention scores of students in carbohydrates when taught using Jigsaw, Think-Pair-Share and Coop-Coop Cooperative strategies. The partial Eta square of .247 was obtained for the strategies meaning that 24.7% of mean retention scores of students in carbohydrate can be attributed to the strategies employed.

Table 6: *Comparisons of Retention Scores of Students in Carbohydrate when taught Using Jigsaw, Think-Pair-Share and Coop-Coop Cooperative Instructional Strategies*

(I) Strategies	(J) Strategies	Mean Difference (I-J)	Std. Error	Sig.
Jigsaw Instructional Strategy	Think-Pair-Share Instructional Strategy	5.493	.605	.000
	Coop-Coop Cooperative Instructional Strategy	5.077	.597	.000
Think-Pair-Share Instructional Strategy	Coop-Coop Cooperative Instructional Strategy	-.417	.611	.872

Table 6 displays the bivariate comparisons of the Instructional Strategies of teaching carbohydrates and their effect on the mean retention scores of students at P = .000 < .05 for Jigsaw Instructional Strategy and Think-Pair-Share Instructional Strategy. Again, comparisons of the Instructional Strategies of teaching carbohydrates and their effect on the mean retention scores of students at P = .000 < .05 for Jigsaw Instructional Strategy and Coop-Coop Cooperative Instructional Strategy. However, comparisons of the Instructional Strategies of teaching carbohydrates and their effect on the mean retention scores of students at P = .872 > .05 for Think-Pair-Share Instructional Strategy and Coop-Coop Cooperative Instructional Strategy. Therefore, the rejected null hypothesis is confirmed and upheld. This implies that there is a significant difference in the mean retention scores of students in carbohydrates when taught using Jigsaw, Think-Pair-Share and Coop-Coop Cooperative instructional strategies.

Hypothesis Two

There is no significant difference in the mean retention scores of male and female students in carbohydrate Chemistry when taught using Jigsaw instructional strategy.

Table 7: *ANCOVA of Retention Scores of Male and Female Students in Carbohydrate Chemistry when taught Using Jigsaw Instructional Strategy*

Dependent Variable: Retention JS

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected model	2986.934[a]	2	1493.467	57.594	.000	.523
Intercept	473.873	1	473.873	18.275	.000	.148
Pre-ATCJS	2976.969	1	2976.969	114.804	.000	.522
Gender JS	**.172**	**1**	**.172**	**.007**	**.935**	**.000**
Error	2722.732	105	25.931			
Total	47718.000	108				
Corrected Total	5709.667	107				

a. R Squared = .523 (Adjusted R Squared = .514)

It can be seen from Table 7 that F(1,105) = .007; p = .935> .05. Thus, the null hypothesis is not rejected. This explains that there is no significant difference in the mean retention scores of male and female students in carbohydrate Chemistry when taught using Jigsaw instructional strategy. Based on evidence from data analysis there is no significant difference in the mean retention scores of male and female students in carbohydrate Chemistry when taught using Jigsaw instructional strategy. The partial Eta squared of .000 is obtained for gender meaning that no percentage could be attributed to retention scores of male and female students in carbohydrate Chemistry.

Hypothesis Three

There is no significant difference in the mean retention scores of male and female students in carbohydrate Chemistry when taught using the Think-Pair-Share instructional strategy.

Table 8: *ANCOVA of Retention Scores of Male and Female Students in Carbohydrate Chemistry when taught Using Think-Pair-Share Instructional Strategy*

Dependent Variable: Retention TP

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	368.985[a]	2	184.492	10.499	.000	.168
Intercept	205.040	1	205.040	11.668	.001	.101
Pre-ATCTP	368.968	1	368.968	20.997	.000	.168
Gender TP	**.202**	**1**	**.202**	**.011**	**.915**	**.000**
Error	1827.520	104	17.572			
Total	28386.000	107				
Corrected Total	2196.505	106				

a. R Squared = .168 (Adjusted R Squared = .152)

Table 8 reveals that F(1,104) = .011; p = .915> .05. Thus, the null hypothesis is not rejected. This implies that there is no significant difference in the mean retention scores of male and female students in carbohydrate Chemistry when taught using the Think-Pair-Share instructional strategy. Thus, based on

evidence from data analysis there is no significant difference in the mean retention scores of male and female students in carbohydrate Chemistry when taught using the Think-Pair-Share instructional strategy. The partial Eta squared of .000 is obtained for gender. This implies that the Think-Pair-Share instructional strategy does not account for the retention scores of male and female students in carbohydrate Chemistry.

Hypothesis Four

There is no significant difference in the mean retention scores of male and female students in carbohydrate Chemistry when taught using Coop-Coop Cooperative instructional strategy.

Table 9: *ANCOVA of Retention Scores of Male and Female Students in Carbohydrate Chemistry when taught using Coop-Coop Cooperative Instructional Strategy*

Dependent Variable: Retention CC

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected model	694.797[a]	2	347.398	30.932	.000	.373
Intercept	664.870	1	664.870	59.199	.000	.363
Pre-ATCCC	691.125	1	691.125	61.537	.000	.372
Gender CC	**1.863**	**1**	**1.863**	**.166**	**.685**	**.002**
Error	1168.026	104	11.231			
Total	23769.000	107				
Corrected Total	1862.822	106				

a. R Squared = .373 (Adjusted R Squared = .361)

Table 9 displays that F(1,104) = .166; p = .685> .05. Therefore, the null hypothesis is not rejected. By implication, there is no significant difference in the mean retention scores of male and female students in carbohydrate Chemistry when taught using Coop-Coop Cooperative instructional strategy. The partial Eta square of .002 obtained for gender means that only .2% of mean retention scores of male and female students in carbohydrate Chemistry can be accounted for by Coop-Coop Cooperative strategy.

Hypothesis Five

There is no significant interaction effect of instructional strategies and gender on the retention of students in carbohydrate Chemistry.

Table 10: *Interaction Effect of Instructional Strategies and Gender on the Retention of Students in Carbohydrate Chemistry*

Dependent Variable: Retention

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	5403.629[a]	6	900.605	46.680	.000	.471
Intercept	1034.730	1	1034.730	53.632	.000	.145
Pre-ATC	3677.972	1	3677.972	190.635	.000	.377
Strategies	1958.851	2	979.426	50.765	.000	.244
Gender	6.579	1	6.579	.341	.560	.001
Strategies * Gender	**2.649**	**2**	**1.324**	**.069**	**.934**	**.000**
Error	6077.367	315	19.293			
Total	99873.000	322				
Corrected Total	11480.997	321				

a. R Squared = .471 (Adjusted R Squared = .461)

It can be seen from Table 10 that F(2, 315) = .069; p = .934 > .05. Again since p is greater than .05, the null hypothesis is not rejected. This means that there is no significant interaction effect of instructional strategies and gender on the retention of students in carbohydrate Chemistry. Thus, there is no significant interaction effect of instructional strategies and gender on the retention of students in carbohydrate Chemistry. The partial Eta square of .000 obtained for the interaction effect means that the interaction effect of instructional strategies and gender do not account for the retention of students' knowledge in carbohydrate Chemistry.

Findings revealed that significant difference exists in the mean retention scores of students taught carbohydrates using Jigsaw, Think-Pair-Share and Coop-Coop Cooperative instructional strategies. This means that Jigsaw, Think-Pair-Share and Coop-Coop Cooperative instructional strategies enhance students' retention in carbohydrate Chemistry. The finding agrees with that of Ogbonne (2012) who found that students in the treatment group had higher retention in statistics content taught more than those in the control group. The finding also agrees with that of Yakubu (2016) that there is a significant difference in retention between students taught climate change using Field-based Teaching Strategy and those taught using lecture method. The finding also agrees with that of Ugan (2019), that pupils taught using ethnomathematics strategy retained mathematical concepts higher than those taught with the conventional teaching strategy.

The use of Jigsaw, Think-Pair-Share and Coop-Coop Cooperative instructional strategies in the present study show evidence of putting new knowledge to use and applying the knowledge in a new situation to solve a new problem. The use of the Jigsaw cooperative teaching strategy provides the teacher with the opportunity of assembling students into groups of 4-6 members and assigning tasks that

are only parts of the lesson to be taught for the groups to work on. The instructional strategy further allows each student from every home group to be assigned a portion of the material. Then the home group members separate from their group and join other teams to form another expert groups. In the expert groups the students study intensively their particular material to ensure that they understand it well and prepare it for peer tutoring. This may be responsible for the significant difference found in the mean retention scores of students taught carbohydrates using Jigsaw, Think-Pair-Share and Coop-Coop Cooperative instructional strategies.

Finding on the use of Jigsaw strategy and gender revealed that no significant difference exists between the mean retention scores of male and female students taught carbohydrate Chemistry. By implication the use of the Jigsaw strategy is not gender sensitive concerning students' retention capacity. The finding agrees with that of Yakubu (2016) that there is no significant difference in retention of male and female students in the treatment group which implies that the strategy is gender-friendly.

Gender stereotyping permeates students' retention ability in Chemistry class when Jigsaw instructional strategy was used to teach carbohydrate Chemistry. The mean retention scores of male and female students taught carbohydrate Chemistry using Jigsaw strategy were found not significantly different. Males and females tend to be strongly conditioned by the self-perception of their competencies and skills. This often results in resistance and lack of self-confidence which is typical in girls. The use of the Jigsaw strategy has the potential of boosting their self-confidence as finding has shown that the instructional strategy is gender-friendly.

Finding on the use of Think-Pair-Share strategy and gender revealed that significant difference does not exist in the mean retention scores of male and female students taught carbohydrate. Accordingly the use of the Think-Pair-Share strategy is not gender sensitive with regards to students' retention capacity. The finding agrees with that of Ugan (2019) that retention of male and female Primary Pupils taught mathematics concepts using ethnomathematics strategy is not signficant.

The mean retention scores of male and female students taught carbohydrate Chemistry using Think-Pair-Share instructional strategy is found not significantly different. Retention could be improved through the organization of materials in some meaningful fashion. The use of the Think-Pair-Share instructional strategy enhanced the meaningful organization of materials as the finding has shown that the instructional strategy is gender-friendly.

Finding on the use of Coop-Coop Cooperative instructional strategy and gender revealed that there is no significant difference in the mean retention scores of male and female students taught carbohydrate Chemistry using Coop-Coop Cooperative instructional strategy. This implies that the use of Coop-Coop Cooperative instructional strategy is not gendered-sensitive concerning students' retention capacity. The finding agrees with that of Ogbonne (2012) that there was no significant difference in the level of retention of male and female students in statistics due to the use of the Kumon teaching strategy.

The mean retention scores of male and female students taught carbohydrate Chemistry using Coop-Coop Cooperative instructional strategy was found not significantly different. The inability to recall what had been learnt and that activities in the classroom can be used as stimuli for retention. The use of Coop-Coop Cooperative instructional strategy is expected to enhance the ability to recall what has been learnt as finding has shown that the instructional strategy is gender-friendly.

The finding on the interaction effect of strategies and gender revealed that there is no significant interaction effect of instructional strategies and gender on the retention of students in carbohydrate Chemistry. The non-significant interaction effect of instructional strategies and gender on retention of students

may have come from the non-gender sensitivity of the instructional strategies. The findings agree with that of Ajai (2011) that there is no significant interaction effect of method and gender on students' retention.

The present study attributed the causes of the non-significant interaction effect of strategies and gender on students' retention to the non-sensitive nature of the instructional strategies to gender. The reason to a large extent is that the students in their cooperative groups can discuss prior knowledge and ask questions related to the specific problem or issue, takes time to individually research or reflect on newly acquired information and areas that require further exploration, meet in small groups and spend time to discuss the problem and present new information that may have been obtained during individual research. After such a meeting, students individually reflect on the information they had received during group meetings, thoughts regarding the problem or issues in question are compared. Then the group again meets to critically analyze individual and group thoughts and hold discussions to synthesize the information and draw some form of conclusions about a given problem.

Conclusion and Recommendation

This study concludes that the students taught carbohydrates using jigsaw cooperative strategy retained more knowledge than their counterparts taught using Think-pair-share and coop-coop cooperative strategies. The three cooperative instructional strategies have been found out to be gender friendly with regards to retention of knowledge. There is no interaction effect between instructional strategies and gender on students' retention of knowledge in carbohydrates. Thus the research findings recognize instructional strategy as the main obstacle in teaching and understanding carbohydrates and chemistry generally. It is recommended that:

1. There is a need for an emergency workshop to address chemical concepts and operations in Jigsaw to enable teachers of chemistry to employ the appropriate strategy (Jigsaw). The workshop can be divided into two: Chemistry teachers to know or to have an idea of chemical concepts, formulae, operations etc. The second workshop should concentrate on the technical knowledge of using Jigsaw and chemistry terminologies. The current prevailing teaching/ learning approach (lecture) should be restricted.
2. Teachers training institutions should run broad-based curricula that will encompass the different instructional strategies that could promote problem–solving and enhance better academic achievement.
3. Henceforth the Jigsaw should be used as instructional strategy for teaching carbohydrate and chemistry in Jalingo. This is so because; the result shows that the student taught carbohydrate using Jigsaw performed significantly better than their counterparts taught using think-pair-share and coop-coop cooperative strategies.

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