



Effects of Jigsaw IV Strategy on Academic Achievement and Retention in Digestive System and Feeding Mechanism among Secondary School Biology Students in Kano-Nigeria

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Abstract

Considerable errors were observed in the performance of Biology students by WAEC Chief Examiners in their various reports, including poor spelling of technical terms, inability to name the illustrated diagrams of organisms, and inability to describe the process of conversion of food to chime. These errors cause low performance in the students' overall result of Biology. As a consequence, this study investigated the effects of J4CLS on academic achievement and retention in digestive system and feeding mechanism among Biology students in science secondary schools in Kano State, Nigeria. The study adopted pre-test, post-test and post-post-test quasi-experimental design. The population of the study consisted of 3402 SS II Biology students (1468 males and 1934 females), while the sample of the study consisted of 216 subjects from four intact classes drawn through stratified random sampling technique. Digestive System Achievement Test (DSAT) with reliability index of 0.94 was used as instrument of data collection. The result of the study revealed that Biology students taught using J4CLS performed and retained better than their counterpart taught using lecture method of teaching (Mean gain for J4CLS is 25.82 as against 12.57 for Lecture Method group; $p=0.000<0.05$). It was also discovered that female students performed better than their male counterpart (Mean gain for Female is 24.48 as against 27.14 for Male; $p=0.032>0.05$), but gender was not a significant factor in the retention of Biology students taught using J4CLS. It was recommended among others that school authorities should encourage Biology teachers to adopt J4CLS in their classrooms.

Keywords: Jigsaw IV, Academic Achievement, Retention, Digestive System, Feeding Mechanism

Introduction

Science is of utmost importance to the human life worldwide due to its major contributions to the sustainable development of the world through researches and innovations. Science is a systematic process of seeking knowledge about nature through systematic observation and experimentation (Anaekwe, 2016). In our present world, it is the core of the affluence of nations and it is central in their economic, scientific and technological development as well as improves the quality of the life of people and the community at large. Science is taught in all levels of education as asserted by Ihejiamaizu and Ochui (2016) because modern science is the firm which upon modern advances in technology depends on, as man has improved his life through the knowledge of science. The importance of science education to the nation cannot be over emphasized as it is an integrated field of study which considers both the subject matter of science discipline such as Chemistry, Physics, Biology among others, as well as processes involved in learning and teaching science (Okeke, 2017). It includes all education processes aimed at providing unlimited opportunities for learners to understand and utilize necessary knowledge, skills and attitude required to operate effectively in scientific and technological society. Biology as a subject of science education involves formal training and preparation of students for professional skills like Physiotherapy, Biochemistry, Pharmacy, Bio-Engineering, and Medicine among others. Walter (2015) defined Biology as the study of living things and their vital processes. Ogundiwin et al. (2015) reports that the general goal for teaching Biology

is to equip the learner with the basic knowledge, skills and attitude that will enable him lead an independent and useful life both for himself and the larger community. Biology as a wide subject in science education is made up of a lot of concepts and topics such as genetics, ecology, reproduction, anatomy, digestive system and feeding mechanism among others.

Digestive system is described as a complex mechanism of mechanical and chemical transitions that provides the body with water, electrolytes and nutrients (Galanakis, 2017). Feeding mechanism on the other hand, is an essential behavior that is required not to only sustain the organism but also to acquire the energy needed for reproduction (Marshall, 2015). The choice of food is immense; plants grow in a multitude of forms, from seaweeds to cactuses and from grasses to forest trees. Animals elaborate strategies for feeding and the modification of organisms varies. Vertebrate feeders feed on minute plants and animals, typically engulf many food particles during each feeding, and they are unselective about what they eat. Although, Biology has been described as one of the most important science subject in Nigerian secondary school system, the performance of students in the subject at WAEC and NECO is worrisome, as attested by WAEC chief examiner's report of 2017-2021. Researchers and scholars alike have attributed many factors to this low performance in science subjects generally, and Biology in particular. Issues that have to do with students' attitude and interest (Mukhtar & Musa, 2024); adequacy and utilization of Biology laboratory resources (Abdullahi, 2023); and teaching approaches (Bichi et al., 2019) have been investigated. This undoubtedly implies that science teaching and learning must shift from product-focused to process-focused teaching as emphasized by the National Policy on Education [NPE] (2009) that teaching and learning of science subjects in senior secondary schools should be process-oriented and student-centered in order to promote students' academic achievement. Science teachers are therefore, strongly encouraged to support the constructivist approach, minimize competition-based learning and instead favors collaboration and cooperation among students (Kim & Alghamdi, 2019). As a consequence, this study is designed to probe the effects of Jigsaw IV Cooperative Learning Strategy on the academic achievement and retention of Biology students in Digestive System and Feeding Mechanism in Kano State Science and Technical schools Board (KSSTSB).

Jigsaw IV is described as cooperative learning that assigns students to a heterogeneous home groups based on the number of items in the content to be learnt. Members in the heterogeneous groups with the same code are regrouped into different expert groups where they learn only a part of the material content. They return to their home groups to teach member and take quizzes as prepared by the teacher based on the process. Jigsaw IV has the features of jigsaw I, II and III but includes introduction of materials, quizzes and re-teaching of materials after evaluation (Samuel, 2018). Here, the topics are the same at home groups but different at expert group. Each student is assigned to a specific topic but unlike jigsaw II, students are not exposed to all the topics at home groups. Gonzalez (2015) proposed the implementation phase of jigsaw IV to include: formation of groups of 4-7 heterogeneous students, splitting the learning material into smaller parts in line with the number of students and assigning each part to one student, and lastly generating expert groups by bringing students of like topics together. It presents opportunity for participants to return from expert groups to their home groups to further discuss new discoveries or correct any errors committed while in home groups. Jigsaw IV has proved to be effective strategy in improving the performance of students at different levels of education as evident in the studies carried out by Bose (2025), Isma'il (2025) to mention but a few.

Academic Achievement of students is the center around which the whole education system revolves. Academic achievement is a measure of what a person has accomplished after exposure to educational program. Walberg, et al. (2006) stressed that academic achievement is the measure of students' success in educational institutions or how well students meet standards set by examination bodies or the schools. The academic achievement of Biology students in secondary schools has been found to be low in the external examinations (WAEC chief Examiners report, 2021). This could be attributed to the low retention as observed by Egara and Mosigeme (2023) and Stanley et al. (2024). Retention is the ability to remember and practice what has been learned for a long period of time (Okolocha & Chukwudi, 2020). The ability of students to recall past learnt Biology concepts is an objective of the basic science teaching and learning process which may likely enhance achievement in the subject. Over a long period of time, researchers have been keen in understanding what could be done by teachers to enhance maximum retention in teaching and learning whether in the classroom or outside the classroom. This could equally be of importance to the system of education if researchers understand the achievement and retention rate between males and females.

Gender refers to self-categorization as a man, woman, non-binary person (Ashley, 2019). Musa et al. (2024) found that gender has no significant influence on students' academic achievement in Biology. While Olasehinde and Olatoye (2014) reported that female students achieve higher scores than their male counterparts in Biology, Egara and Mosimege (2023) reported the opposite. This could be due to differences in the cultural and social backgrounds of the targeted population. Therefore, the influence of gender on achievement in Biology is still inconclusive among science researchers. It is upon this background that this study is set to investigate the effect of Jigsaw IV strategy on academic achievement and retention in digestive system and feeding mechanism among Biology students in science senior secondary school in Kano State, Nigeria.

Problem Statement

This study was necessitated by the weaknesses observed by the WAEC chief examiners' reports in the performance of Biology students. These reports show that there was poor spelling of some technical terms and inability of some students to name the illustrated diagrams of organisms, lack of understanding of some questions, inability to describe the process of conversion of food to chyme, inability to label the diagram of open stomata, inability to use diagrams to explain the process of osmosis, making the diagrams without labels, poor spelling of labels and diagrams not drawn to size (WAEC Chief Examiners' Report, 2017-2019). Furthermore, Sambo and Eriba (2019); Mukhtar and Musa (2024) and Musa et al. (2024) showed high rate of low achievement of students in Biology in the senior secondary school certificate examinations. It was further observed that students under the Kano State Science and Technical Schools Board performed low in secondary school certificate examination as shown table 1.1.

Table 1: SSCE Biology Results of Students under Kano State Science and Technical Schools Board (2017 – 2021)

Year	No. of Students Registered	No. of Students with A1-C6	% of Students with A1-C6	No. of Student with D7 – F9	% of student with D7 – F9
2017	2,364	1,364	57.69	1000	42.31
2018	2,187	688	31.45	1499	68.65
2019	1,490	954	64.00	536	36.00
2020	1,569	561	35.75	1,008	64.25
2021	994	177	17.80	817	82.20

Source: Kano State Science and Technical Schools Board (2022)

The table 1 shows that the students' performance in Biology over the years is worrisome. Many factors were cited as causes for such dwindling performance by researchers. Notably, the work of Bichi et al. (2019) shows that teaching strategies employed by teachers affect Biology students' academic achievement which also directly connected with their inability to remember learnt materials quickly and readily. As a consequence, this study is poised to investigate the effects of Jigsaw IV strategy on academic achievement and retention in digestive system and feeding mechanism among Biology students in science senior secondary school in Kano State, Nigeria.

Research Questions

The following research questions were answered:

1. What is the difference in the mean academic achievement scores of Biology students taught Digestive System and Feeding Mechanism using Jigsaw IV Learning Strategy and those taught using lecture methods in science secondary schools of Kano State, Nigeria?
2. Is there any difference in the mean academic achievement scores of Male and Female Biology students when taught Digestive System and Feeding Mechanism using Jigsaw IV Learning Strategy in science secondary

schools of Kano State, Nigeria?

3. What is the difference in the mean Retention scores of Biology students taught Digestive System and Feeding Mechanism using Jigsaw IV Learning Strategy and those taught using lecture methods in science secondary schools of Kano State, Nigeria?
4. Is there any difference in the mean Retention scores of Male and Female Biology students when taught Digestive System using Jigsaw Learning Strategy in science secondary schools of Kano State, Nigeria?

Hypotheses

The following null hypotheses were formulated and tested at 0.05 levels of significance:

H0₁: There is no significant difference in the mean academic achievement scores of Biology Students taught Digestive System and Feeding Mechanism using Jigsaw IV Learning and those taught using lecture methods in science secondary schools of Kano state, Nigeria.

H0₂: There is no significant difference in the mean academic achievement scores of Male and Female Biology Students taught Digestive System and Feeding Mechanism using Jigsaw IV Cooperative Learning in science secondary schools of Kano State, Nigeria.

H0₃: There is no significant difference in the mean retention scores of Biology Students taught Digestive System and Feeding Mechanism using Jigsaw IV Learning and those taught using lecture methods in science secondary schools of Kano State, Nigeria.

H0₄: There is no significant difference in the mean Retention scores of Male and Female Biology students taught Digestive System and Feeding Mechanism using Jigsaw IV Learning in science secondary schools of Kano State.

Materials and Methods

This study adopted pre-test, post-test and post-post-test, nonequivalent, non-randomized quasi-experimental design. The population of this study comprised of three thousand, four hundred and two (3,402) subjects in which one thousand, four hundred and sixty-eight (1,468) are males, while one thousand, nine hundred and thirty-four (1,934) are females Biology students respectively. The sample of the study consisted of two hundred and sixteen (216) Biology students which comprised of one hundred and seven (107) males and one hundred and nine (109) females selected through stratified and simple random sampling techniques. The male and female experimental groups consist of 57 and 59 subjects respectively; while the male and female control groups consist of 47 and 53 subjects respectively. Since Kano state public secondary schools run single sex schools, two intact classes were selected randomly from each strata for experimental and control groups. The sample size is adequate for this type of study as recommended by Shadish et al. (2002). The data were collected using Digestive System Achievement Test (DSAT) and was face and content validated by experts in the field. The instrument consists of two sections A and B. Section A seeks for the demographic data of the students while section B consist of 40 multiple choice questions on the concept of Digestive System and Feeding Mechanism. The 40 objective items have four options (A-D) with only one option as the correct answer. The items were adopted from the WAEC past question papers of Biology of 2017-2021. The specific topics covered include Digestion and Digestive System in Man, Digestive Enzymes in the Human Alimentary Canal, Feeding and Nutrition in Flowering Plants, Modification and Feeding in insects and Modification and Feeding in Invertebrate Animals. The instrument was face and content validated by five experts who were senior lecturers and above from Departments of Science Education, Test and Measurement, Biological Sciences, and English, all of Bayero University, Kano. Moreover, a graduate Biology secondary school teacher with 10 years teaching experience was included among the validators. All corrections and suggestions made were considered in producing the final draft of the instrument. The reliability of the instrument was established through pilot testing through test-retest, and the coefficient of reliability was computed using Pearson Product Moment Correlation. The reliability coefficient was found to be 0.94. Mean and standard deviation were used in answering the research questions, while analysis of covariance (ANCOVA) was used for testing the hypotheses at 0.05 levels of significance using statistical product and services solution (SPSS).

Results

Research Question 1: What is the difference in the mean academic achievement scores of Biology students taught Digestive System and Feeding Mechanism using Jigsaw IV Learning Strategy and those taught using lecture methods in science secondary schools of Kano State, Nigeria?

Table 1: Mean and Standard Deviation of Pre-test and Post-test Scores of Experimental and Control Groups

Groups	Pre-test scores		Post – test scores			
	N	SD		SD	Mean gain	
		$\bar{X}$		$\bar{X}$		
Jig Saw IV	116	11.21	2.92	37.03	3.06	25.82
Lecture	100	10.34	3.11	22.91	10.08	12.57
Mean difference		0.87		14.12		

Table 1 shows the means and standard deviations of pre-test and post-test achievement scores administered to the experimental and control groups. For the pre-test, the experimental group is found to have a mean of 11.21 and standard deviation of 2.92, while the control group has a mean of 10.34 and standard deviation of 3.11. The standard deviations of the scores in both the groups imply that the individual scores are a bit away from the mean. Also, the pre-test mean difference between the two groups is 0.87 in favor of the experimental group, which implies that the two groups are almost equivalent in terms of their academic achievement. In the post-test, the experimental group has a mean of 37.03 and standard deviation of 3.06, while the control group has a mean of 22.91 and standard deviation of 10.08. The standard deviation of the scores in the experimental group implies that the individual scores are a bit away from the mean; whereas that of the control group implies that the individual scores are far away from the mean. While the post-test mean difference between the two groups is 14.12 in favor of the experimental group, the mean gain score for the experimental group is 25.82 and that of control group is 12.57. This suggests that students taught digestive system and feeding mechanism using Jigsaw IV strategy perform better than those taught using lecture teaching method.

H0₁: There is no significant difference in the mean academic achievement scores of Biology students taught digestive system and feeding mechanism using Jigsaw IV cooperative learning and those taught using lecture methods in science secondary schools of Kano state, Nigeria

Table 2: Summary of Analysis of Covariance (ANCOVA) of Students' Pre-Test and Post-Test Achievements Scores of Experimental and Control Groups

Tests of Between – Subjects Effects					
Dependent variables: POSTTEST					
Source	Type III Sum Of Squares	df	Mean Square	F	Sig.
Corrected model	1954.105 ^a	2	977.052	3.635	.000
Intercept	17629.864	1	17629.864	697.121	.000
Pretest	138.694	1	138.694	5.484	.020
Groups	1639.623	1	1639.623	64.834	.000
Error	5386.668	213	25.290		
Total	299577.000	216			
Corrected total	7340.773	215			

Levels of Significance = 0.05

Table 2 shows the result of the ANCOVA test of difference for the post-test mean achievement scores of the experimental and control groups. The observed significant value of the treatment is 0.000, which is less than the significance level of 0.05 with df = 1. The null hypotheses one is therefore rejected because sig-value (0.000) is less than the significant level (0.05). Consequently, there is significant difference between the mean

achievement scores of science secondary schools Biology students taught digestive system and feeding mechanism using Jigsaw IV cooperative learning strategy and those taught using lecture method of teaching in favor of Jigsaw IV group (F -value = 64.83, df = 1, Sig-value = 0.000 < 0.05).

Research Question 2: What is the difference in the mean academic achievement scores of male and female Biology students when taught digestive system and feeding mechanism using Jigsaw IV cooperative learning strategy in science secondary schools of Kano state, Nigeria?

Table 3: Mean and Standard Deviation of Pre-test and Post-test Scores of Male and Female Students in the Experimental Group.

Gender	Pre-test score			Post – test score		Mean gain
	N	$\bar{X}$	SD	$\bar{X}$	SD	
Male	57	10.98	2.79	35.46	3.51	24.48
Female	59	11.42	3.06	38.56	1.36	27.14
Mean difference		0.44		3.10		

Table 3 shows the means and standard deviations of pre-test and post-test achievement scores administered to male and female students in the experimental group. For the pre-test, the males are found to have a mean of 10.98 and standard deviation of 2.79, while the females have a mean of 11.42 and standard deviation of 3.06. The standard deviations of the scores in both the groups imply that the individual scores are a bit away from the mean. Also, the pre-test mean difference between the two groups is 0.44 in favor of the females, which implies that the two groups are almost equivalent in terms of their academic achievement. In the post-test male students have a mean of 35.46 and standard deviation of 3.51, while the female students have a mean of 38.56 and standard deviation of 1.36. The standard deviation of the scores of male students implies that the individual scores are a bit away from the mean; whereas that of the females implies that the individual scores are clustered around the mean. While the post-test mean difference between the two groups is 3.10 in favor of the females, the mean gain score for the male students is 24.48 and that of females is 27.14. This clearly shows that female students taught digestive system and feeding mechanism using Jigsaw IV strategy perform better than male students.

H₀₂: There is no significant difference in the mean academic achievement scores of male and female Biology students taught digestive system and feeding mechanism using Jigsaw IV cooperative learning in science secondary schools of Kano state, Nigeria.

Table 4: Summary of Analysis of Covariance (ANCOVA) of Male and Female Students' Pre-Test and Post-Test Achievements Scores in the Experimental Group

Tests of Between – Subjects Effects						
Dependent Variables: POSTTEST						
Source	Type III Sum Of Squares	df	Mean Square	F	Sig.	
Corrected model	20.549 ^a	2	10.275	2.368	.098	
Intercept	11532.204	1	11532.204	2657.444	.000	
Pretest	.639	1	.639	.147	.702	
Gender	20.339	1	20.339	4.687	.032	
Error	490.373	113	4.340			
Total	181263.000	116				
Corrected total	510.922	115				

Levels of Significance = 0.05

Table 4 shows the result of the ANCOVA test of difference for the post-test mean achievement scores of the male and female students in the experimental group. The observed sig-value is 0.032 which is less than the significant level (0.05) with $df = 1$. The null hypothesis two is hereby rejected because the observed sig-value (0.032) is less than the significant level (0.05). Therefore, there is significant difference between the mean achievement scores of male and female science secondary schools Biology students taught digestive system and feeding mechanism using jigsaw IV teaching strategy in favor of the female students (F -value 4.69, $df = 1$, sig-value = $0.032 < 0.05$).

Research Question 3: What is the difference in the mean retention scores between Biology students taught digestive system and feeding mechanism using Jigsaw IV cooperative learning strategy and those taught using lecture methods in science secondary schools of Kano state, Nigeria?

Table 5: Mean and Standard Deviation of Post-test and Post-Post-test Scores of Experimental and Control Groups

Group	Post-test score		Post Post-test score		
	N	SD		SD	
Experimental	116	37.03	3.06	35.90	2.74
Control	100	22.91	10.08	20.04	5.84
Mean difference		14.12		15.86	

Table 5 shows the means and standard deviations of post-test and post- The instrument consists of two sections A and B. Section A seeks for the demographic data of the students while section B consist of 40 multiple choice questions on the concept of Digestive System and Feeding Mechanism. The 40 objective items have four options (A-D) with only one option as the correct answer. The items were adopted from the WAEC past question papers of Biology of 2017-2021. The specific topics covered include Digestion and Digestive System in Man, Digestive Enzymes in the Human Alimentary Canal, Feeding and Nutrition in Flowering Plants, Modification and Feeding in insects and Modification and Feeding in Invertebrate Animals. The instrument was face and content validated by five experts who were senior lecturers and above from Departments of Science Education, Test and Measurement, Biological Sciences, and English, all of Bayero University, Kano. Moreover, a graduate Biology secondary school teacher with 10 years teaching experience was included among the validators. All corrections and suggestions made were considered in producing the final draft of the instrument.

post-test administered to the experimental and control groups. In the post test, the experimental group has mean scores of 37.03 and standard deviation of 3.06, while the control group has mean scores of 22.91 and standard deviation of 10.08. The standard deviation of the scores in the experimental group implies that the individual scores are a bit away from the mean; whereas that of the control group implies that the individual scores are far away from the mean. The post-test mean difference between the two groups is 14.12 in favor of the experimental group. In the post- post-test, the experimental group has mean scores of 35.90 and standard deviation of 2.74, while the control group has mean scores of 20.04 and standard deviation of 5.84. The standard deviation of the scores in the experimental group implies that the individual scores are a bit away from the mean; whereas that of the control group implies that the individual scores are far away from the mean. The post-post-test mean difference between the two groups is 15.86 which show that students taught digestive system and feeding mechanism using Jigsaw IV learning strategy have high retention scores than students taught using lecture method of teaching.

H0₃: There is no significant difference in the mean retention scores of Biology students taught digestive system and feeding mechanism using Jigsaw IV cooperative learning and those taught using lecture methods in science secondary schools of Kano state, Nigeria?

Table 6: Summary of Analysis of Covariance (ANCOVA) of Students Post-Test and Post-Post-Test Scores of Experimental and Control Groups.

Tests of Between – Subjects Effects					
Dependent Variable: RETENTION POSTTEST					
Source	Type III Sum Of Squares	df	Mean Square	F	Sig.
Corrected Model	1922.799 ^a	2	961.399	81.917	.000
Intercept	14094.559	1	14094.559	1200.940	.000
RETENTION TEST GROUPS	1735.971	1	1735.971	147.915	.000
Error	405.768	1	405.768	34.574	.000
Total	2499.826	213	11.736		
Corrected total	1319971.000	216			
	4422.625	215			

Levels of Significant = 0.05

Table 6 shows the result of the ANCOVA test of difference for the post posttest mean scores of the experimental and control groups. The observed sig-value of the treatment is 0.000 which is less than the significant level of 0.05 with df. = 1. The null hypothesis 3 is hereby rejected because the observed sig-value (0.000) is less than the significant level (0.05). Therefore, there is significant difference between the mean retention scores of science secondary schools Biology students taught digestive system and feeding mechanism using Jigsaw IV cooperative learning strategy and lecture method of teaching in favor of the experimental group (F-value = 34.574, df = 1, Sig-value = 0.000).

Research Question 4: What is the difference in the mean retention scores of male and female Biology students taught digestive system and feeding mechanism using Jigsaw IV cooperative learning strategy in science secondary schools of Kano State, Nigeria?

Table 7: Mean and Standard Deviation of Post-test and Post-Post-test Scores of Male and Female Students in the Experimental Group

Gender	Post-test score		Post – post-test score	
	N	SD	SD	
		$\bar{X}$	$\bar{X}$	
Male	57	35.46	3.51	33.12
				1.27
Female	59	38.56	1.36	31.69
				2.36
Mean difference		3.10		1.43

Table 7 shows the means and standard deviations of post-test and post posttest administered to the male and female in the experimental groups. In the post-test, male students have a mean of 35.46 and standard deviation of 3.51, while the female students have a mean of 38.56 and standard deviation of 1.36. The standard deviation of the scores of male students implies that the individual scores are a bit away from the mean; whereas that of the

females implies that the individual scores are clustered around the mean. The post-test mean difference between the two groups is 3.10 in favor of the females. In the post posttest, male students have a mean of 33.12 and standard deviation of 1.27, while the female students have a mean of 31.69 and standard deviation of 2.36. The standard deviation of the scores of male students is more clustered around the mean than found in the female students. The post posttest mean difference is 1.43 in favor of the male students which shows that male students retained the learnt concept better than the female.

H04: There is no significant difference in the mean retention scores of male and female Biology students taught digestive system and feeding mechanism using Jigsaw IV cooperative learning strategy in science secondary schools of Kano state, Nigeria

Table 8: Summary of Analysis of Covariance (ANCOVA) of Male and Female Students' Post-Test and Post Post -Test Scores of the Experimental Group

Tests of Between – Subjects Effects					
Dependent Variable: RETENTION POSTTEST					
Source	Type III Sum Of Squares	df	Mean Square	F	Sig.
Corrected Model	415.464 ^a	2	207.732	52.339	.000
Intercept	7609.278	1	7609.278	1917.194	.000
RETENTION TEST	394.599	1	394.599	99.421	.000
GENDER	4.802	1	4.802	1.210	.274
Error	448.493	113	3.969		
Total	723083.000	116			
Corrected total	863.957	115			

Levels of Significant = 0.05

Table 8 shows the result of the ANCOVA test of difference for post-post-test mean scores of male and female in the experimental group. The observed sig-value of the treatment is 0.274 which is higher than the significant level 0.05 with df = 1. The null hypothesis 4 is hereby failed to be rejected because the observed sig-value (0.274) is higher than the significant level (0.05). Therefore, there is no significant difference between the mean retention scores of male and female science secondary schools Biology students taught digestive system and feeding mechanism using Jigsaw IV cooperative learning strategy (F-value = 1.210, df = 1, Sig-value = 0.274 > 0.05).

Discussion

The findings of Research question 1 shows that students taught digestive system and feeding mechanism using J4CLS performed better than those taught using lecture method. This finding is in line with the study of Timayi (2016) who found that students taught Geometry using Jigsaw J4CLS outperformed those taught using lecture method. The finding is also in agreement with the work of Josiah (2022) who revealed that students taught using J4CLS performed better than those taught under conventional teaching method. However, the finding disagrees with Muhammad (2014) who found that students taught Educational Research and Statistics using J4CLS did not perform better than those taught using lecture method. Also, the findings is not in consonant with the work of Sani (2014) who showed that both students taught using J4CLS and those taught using lecture method performed equally well. Hypothesis 1 reveals that there is significant difference in the academic achievement of students taught digestive system and feeding mechanism using J4CLS and those taught using lecture method in favor of J4CLS group. This finding is in line with the work of Gambari and Yusuf (2016) who discovered that students taught Physics using J4CLS performed significantly higher than those taught using lecture method. Moreover the finding is in consonant with Yakubu (2016) who showed that there is significant difference in the performance of students taught using J4CLS and those taught using lecture method in favor of J4CLS group. Nevertheless, the finding of the study is not in line with the finding of Nnorom (2015) who found that significant difference does not exist between the performance of students taught using J4CLS and those taught using conventional teaching method.

The finding of Research Question 2 demonstrates that female students taught digestive system and feeding mechanism using J4CLS perform better than male students. This finding is in line with the work of Josiah and Mankilik (2021) who discovered that female students exposed to J4CLS achieved higher than the male students. The finding is also in agreement with the work of Pepple, Danladi and Okoro (2024) that female students taught nutrition performed better than those taught using conventional teaching. However, the finding doesn't agree with work of Ibeh and Okigbo (2024) who found that male students achieved higher with the J4CLS than their female counterparts. Furthermore, Azi, et al (2024) observed no variations in achievement based on gender. Hypotheses 2 reveals that there is significant difference between the mean achievement scores of male and female science secondary schools Biology students taught digestive system and feeding mechanism using J4CLS in favor of the female students. This finding corroborates the study of Pepple, Danladi and Okoro (2024) who found that female students significantly performed better than their male counterparts. Nonetheless, the finding is not in harmony with the finding of Ezeaghasi, Eucharia and Uchechukwu (2021) that discovered no gender difference in the achievement of students when taught using Jigsaw IV teaching strategy.

The finding of Research Question 3 shows that students taught digestive system and feeding mechanism using J4CLS have high retention scores than students taught using lecture method. This is in agreement with Tran (2014) who showed that students in the J4CLS had higher scores in knowledge retention than those in the conventional teaching group. The finding is also in agreement with the finding of Abdurrasheed (2015) who revealed that J4CLS is effective in enhancing students' academic retention than those exposed to lecture method. Hypothesis 3 discloses that there is significant difference between the mean retention scores of science secondary schools Biology students taught digestive system and feeding mechanism using J4CLS and lecture method of teaching in favor of the J4CLS group. This is supported by the findings of John, et al. (2023) that Biology students taught using J4CLS retained the materials learnt better than their counterparts in the lecture method group. The finding align well also with a study carried out by Jamilu et al. (2022) which reveals that students exposed to J4CLS had retained 2-D Geometry concepts higher than those taught using conventional method of teaching.

Research Question 4 divulges that male students retained the learnt concept better than the female. This finding is in agreement with the work of Egara and Mosimege (2023) which showed a significant gender difference in the mean retention scores of students taught algebra concepts in favor of male students. Moreover, the finding is in consonant with the study finding of Stanley, Dania and Osakwe (2024) that reveals that the male students scored higher than their female counterparts in Social Studies when they were exposed to the J4CLS. Hypothesis 4 reveals that there is no significant difference between the mean retention scores of male and female science secondary schools Biology students taught digestive system and feeding mechanism using J4CLS. This finding is in line with work of Azi et al. (2022) who found no significant difference between the post-post-test scores of the male and female students in the treatment group after exposure to J4CLS. This is also true with the finding of a study conducted by Chinweuba-Eze (2021) which disclosed that gender was not a significant factor in determining students' retention in biology. On the contrary, the finding doesn't agree with the work of Enikanolaye (2021) who found that there was a significant difference in mathematics retention of secondary school students based on gender, with females showing higher retention. Furthermore, Owodunni and Ogundola (2013) found that while boys had higher achievement scores, girls showed higher retention in electronic works trade.

Conclusion

The following conclusions were drawn, based on the finding of the study:

1. The use of J4CLS in teaching Biology concepts improves student academic achievement.
2. J4CLS improves academic achievement of female better than the male Biology students
3. J4CLS enhances the retention of learnt materials of students better than those instructed using lecture method
4. J4CLS enhances the retention of learnt materials of male better than the female Biology students.

Recommendations

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

1. School authorities should be encouraging Biology teachers to adopt the Jigsaw IV learning strategy in their classrooms. This can be made possible through provision of all what is required in adequately executing Jigsaw IV learning strategy, including workshops and seminars for teachers on how to effectively conduct a Jigsaw IV class.
2. Biology teachers should encourage male students to engage in participatory learning and should be allowed

to interact with themselves in their studies.

3. The Ministry of Education through School Authorities should ensure that Jigsaw IV Learning Strategy used in teaching Biology in secondary school as it seen to have improved their retention in Biology.

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