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INTERACTION EFFECT OF JIGSAW IV COOPERATIVE LEARNING, GUIDED INQUIRY AND PEER TUTORING INSTRUCTIONAL STRATEGIES AND GENDER ON BIOLOGY STUDENTS' ACADEMIC ACHIEVEMENT AND RETENTION IN POST BASIC SCHOOLS IN ADAMAWA STATE, NIGERIA

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ABSTRACT
This study investigated the interaction effect of Jigsaw IV cooperative learning, guided inquiry and peer tutoring instructional strategies and gender on Biology students' academic achievement and retention in post basic schools in Adamawa State, Nigeria. The study was guided by two objectives, two research questions and two null hypotheses. The study adopted a quasi-experimental non-equivalent and non-randomized comparative design. The population comprised 49,253 SS II students offering Biology in post basic schools across all education zones of Adamawa State. A sample of 149 Biology students from three intact classes in three different post basic schools in Yola education zone was selected using multistage sampling technique. The instrument for data collection was the Biology Achievement Test (BAT), which contained 50 multiple-choice items adapted from WAEC past questions (2013–2023). The instrument was validated by three experts and its reliability was established using Kuder-Richardson formula 20 (KR-20), which yielded a coefficient of 0.83. The treatment lasted for seven weeks. Data were analysed using mean and standard deviation to answer the research questions, while Analysis of Covariance (ANCOVA) was used to test the null hypotheses at the 0.05 level of significance. The findings revealed that there was no significant interaction effect of treatment and gender on mean achievement scores of students, $F(2, 146) = 2.464$, $p > 0.05$, and there was no significant interaction effect of treatment and gender on mean retention scores of students, $F(2, 146) = 2.267$, $p > 0.05$. The study concluded that Jigsaw IV cooperative learning, guided inquiry and peer tutoring instructional strategies are gender-friendly and can be effectively used to teach male and female Biology students without gender-based differential outcomes. It was recommended that biology teachers should adopt these student-centred instructional strategies, and school administrators should organise seminars and workshops to train teachers on their effective implementation.

Keywords: Jigsaw IV, guided inquiry, peer tutoring, gender, academic achievement, retention, Biology, Adamawa State.

INTRODUCTION
Education is the medium through which technological advancement of any nation can be attained through social and economic empowerment. Consequently, education should be hinged on an efficient and effective implementation of the curriculum contents which specify the use of effective teaching strategies and as well remain committed to the aims and objectives of education as enshrined in the National Policy on Education (Federal Government of Nigeria, 2013). The broad aim of secondary education as stipulated is that secondary education should be aimed at preparation of students for useful living within the society and preparation for higher education. Secondary

education prepares secondary school students with the opportunity for education of higher quality irrespective of gender differences, social, religious and ethnic background; diversify its curriculum to cater for differences in talents, opportunities and roles possessed by or open to students after their secondary school course, equip students to live effectively in the modern age of science and technology.

Science is described as an organized knowledge that is based on observation and reasoning. Science is a body of knowledge for use in addressing various forms of human, material and environmental issues. To stress the importance of science in the world today, it is imperative to know that we cannot separate today's world from technological advancement, because technological development has become positive culture that should be sustained by all means by any serious-minded nation which biology is among.

Biology, the cornerstone of understanding the natural world, equips students for further scientific exploration (Griffiths et al., 2015). However, achieving academic success and retaining knowledge in this subject can be challenging, particularly within specific areas. One key challenge lies in the abstract nature of these topics. Digestion and excretion involve intricate biochemical processes within organisms, while nutrient cycles encompass complex ecological interactions. Visualizing these processes can be a significant hurdle for students, especially without the use of appropriate models and analogies (Barron, Schwartz, Vye, Moore, Petrosino Zech and Bransford, 2014). Furthermore, discussions surrounding digestion and excretion can evoke feelings of discomfort or awkwardness in some students (Kessler, 2022). This "discomfort factor" can lead to reduced engagement and participation in classroom discussions, hindering their learning experience. Adding to the difficulty, students may lack a strong foundation in basic chemistry or cell Biology, making it challenging to grasp the underlying mechanisms involved in these systems (Southard, Wince, Meddleton, and Bolger, 2016).

Despite these challenges, understanding digestion, excretion, and nutrient cycles is crucial for senior secondary Biology students. These topics form a critical foundation for informed health decisions regarding diet, nutrition, and waste management (National Institutes of Health, 2023). Knowledge of nutrient cycles fosters environmental awareness by illuminating the interconnectedness of living organisms and the impact of human activities on ecosystems (World Health Organization, 2015). Moreover, a solid grasp of these concepts serves as a springboard for comprehending more advanced biological topics like cellular respiration, homeostasis, and ecosystems, ultimately leading to improved learning outcomes in future courses (Griffiths et al., 2015).

Jigsaw IV is a structured approach where students become experts in assigned subtopics within a broader theme, then teach their expertise to peers in "jigsaw groups" composed of students from different expert groups. This approach fosters collaboration, peer explanation, and deeper understanding. There are basically four types of Jigsaw cooperative learning: Classic jigsaw (the original method, where each group member is assigned a specific role and topic); Jigsaw II (a modified version, where each group member is assigned a specific role); Jigsaw III (a variation, where each group member is assigned a specific role skill or task, rather than a topic); and Jigsaw IV (with specific roles and topics, having home group and expert groups, but students create a learning activity or presentation to teach their assigned subtopic to their home group members).

Studies indicate Jigsaw IV's positive impact on student performance and engagement in science classrooms (Timayi, Bolaji, and Kajuru 2015). By actively explaining concepts to peers, students solidify their own understanding and develop valuable communication skills. Furthermore, Jigsaw IV can be particularly effective in Biology for promoting understanding of complex systems by fostering collaboration and peer explanation (Calkins & Rivnay, 2022).

Guided inquiry is an instructional approach where teachers provide a framework and resources but encourage students to actively explore concepts and develop solutions through inquiry. This approach fosters critical thinking, problem-solving, and a deeper understanding of the scientific

method. Research suggests that guided inquiry can enhance critical thinking skills, problem-solving abilities, and content knowledge acquisition in Biology (Chiu et al., 2013). By actively engaging with questions and investigations, students grapple with complex biological concepts and develop a more profound understanding. However, it is important to acknowledge that guided inquiry can be time-consuming and may require adjustments for student comfort levels with independent learning (Archer-Kuhn, Lee, Hewson and Burns, 2022).

Peer tutoring involves students with a strong grasp of a concept acting as tutors, explaining and providing support to their peers who are struggling (Topping, Duran and Van Keer, 2015). This strategy offers a unique opportunity to address the challenges faced by students in comprehending complex topics like digestion, excretion, and nutrient cycles. The effectiveness of peer tutoring in Biology is backed by compelling evidence. Studies have shown that this strategy can lead to significant improvements in academic performance for both tutors and tutees (Topping et al., 2015). Tutors solidify their own understanding by explaining concepts to others, while tutees benefit from receiving personalized attention and explanations tailored to their specific learning needs.

Academic performance, defined as the extent to which students successfully acquire knowledge and skills in a particular subject area (Steinmayr, Meiṅer, Weideinger and Wirthwein, 2014), plays a critical role in senior secondary Biology. Mastering these concepts equips students with the foundation necessary for success in further education and careers in science-related fields. However, achieving strong academic performance in Biology can be challenging, particularly within specific areas like digestion, excretion, and nutrient cycles. The importance of high academic performance in Biology is multifaceted. Firstly, a solid understanding of biological concepts prepares students for success in higher education programs in Biology, medicine, environmental science, and other related fields (Griffiths et al., 2015). High academic performance in Biology can open doors to exciting career opportunities in various scientific fields.

Retention, defined as the ability to maintain learned information over time (Licorish, Owen Daniel and George, 2018), plays a critical role in ensuring students can not only grasp concepts but also apply them effectively in the long run. This is particularly crucial for challenging topics like digestion, excretion, and nutrient cycles, where understanding the interconnected processes are essential for long-term knowledge retention. The significance of retention in Biology extends far beyond the classroom. Retained knowledge empowers students to apply biological concepts to new situations. Research underscores the importance of retention in Biology for long-term success in related fields. Studies have shown a significant correlation between knowledge retention in senior secondary Biology and academic performance in higher-level Biology courses (Ullah, Tabassum and Kaleem, 2018). However, the challenge lies in the very nature of learning and memory. Empirical evidence suggests that forgetting is an inevitable part of the learning process (Miller & Martignoni, 2016). This highlights the need for instructional strategies that not only promote initial understanding but also foster long-term retention in senior secondary Biology.

Gender is used in this study as a moderating variable. Gender refers to the roles and relationships between men and women in a given context (Oludipe, 2012). Gender factor is a responsible factor that challenges educational and sustainable development in Nigeria and to eradicate illiteracy in Nigeria and enhance sustainable development, gender imbalance in academic performance in Biology education should be overcome (Adarmola, 2012). Ezedu and Obi (2013) opined that both male and female students' academic performance is high in Biology but Olakehinde and Olatoye (2014) reported that female students achieve higher than their male counterparts in Biology.

RESEARCH METHODOLOGY

Research Design

The research design for this study was quasi-experimental non-equivalent and non-randomized comparative design. Quasi-experimental comparative design according to Maciejewski (2020) is an

experimental design where no random assignment of subjects to experimental group only. There is no control in this design. This study is quasi-experimental because intact classes are used hence selection of each subject (research sample) is not randomized. There is no randomization of subjects instead intact classes were randomized into experimental groups. This design does not disrupt school or class activities. The treatment group was given pretest before treatment, a posttest after treatment and retention test after posttest. The diagrammatic sketch is illustrated in the figure below thus:

EG1	O1	Xa	O2	O3
EG2	O1	Xb	O2	O3
EG3	O1	Xc	O2	O3

Where:
EG1 = Experiment Group 1 – Jigsaw IV cooperative
EG2 = Experiment Group 2 – Guided Inquiry
EG3 = Experiment Group 3 – Peer Tutoring
Xa = shows treatment for Jigsaw IV cooperative
Xb = shows treatment for Guided Inquiry
Xc = shows treatment for Peer Tutoring
O1 = Pre-test
O2 = Post-test
O3 = Retention test

Area of the Study

The study was conducted in Adamawa State. The state is located in North-Eastern Nigeria with its capital at Yola. Adamawa State is one of the largest states of Nigeria and occupies about 36,917 square kilometers. Adamawa State is a state in the North-East geopolitical zone of Nigeria, bordered by Borno to the Northwest, Gombe to the west for 95 km, and Taraba to the Southwest for about 366 km, while its Eastern border forms part of the national border with Cameroon across the Atlantica Mountains for about 712 km (AGIS, 2017). It takes its name from the historic emirate of Adamawa, with the emirate's old capital of Yola, serving as the capital city of Adamawa State. The State is one of the most heterogeneous in Nigeria, with over 100 indigenous ethnic groups (Adebayo et al., 2012). It was formed in 1991, when the former Gongola state was divided into Adamawa and Taraba states.

Adamawa State has 21 Local Governments Areas. The state is divided into five education zones as follows: Ganye zone, Gombi zone, Mubi zone, Numan zone and Yola zone. Total number of Post Basic Schools in Adamawa State is 366 (Adamawa State Post Primary Schools Management Board, 2023).

Population

The population of the study were all the 49,253 SS II students offering Biology in Post Basic Schools in all the education Zones of Adamawa State (Adamawa State Post Primary Schools Management Board, 2022). The reason for the use of this set of students is because SS II students are not new to Biology neither are they preoccupied with the preparation for external examination, so the class is stable.

Sample and Sampling Techniques

The sample for this study was 149 Biology students from three intact classes from three different Post Basic Schools in one education zone of Adamawa State. The use of different schools was in order to avoid contamination of treatment. Multistage sampling technique was used to select the

sample. Simple random sampling was used to select one education zone out of the five education zones in the State. Yola education zone was sampled (10,429). In the second stage, three schools from the zone selected were purposively sampled into experimental groups. The basic characteristics of the schools selected were that they are uniformly funded by the Adamawa State Ministry of Education through Adamawa State Post Primary School Management Board, operating co-educational system and the supplies of human and material resources are the same. For the third stage, in each of the schools selected, simple random sampling technique was used to select one intact class into experimental groups making three experimental groups in all as shown in the diagrammatic sketch of the design.

Instruments for Data Collection

Biology Achievement Test (BAT) was used as the instrument for data collection which contains 50 multiple choice items with A, B, C, D options from past WAEC (2013–2023). The test items were adapted from West Africa Examination Council WAEC past question papers from 2013–2023. The Biology Achievement Test (BAT) used was based on the content taught in the study. The three topics that were taught are: Digestive system, Excretory system and Nutrients cycles. The BAT was used to evaluate the learning outcomes (academic achievement) of the SSII students both before and at the end of the instructional processes (pretest, posttest and retention). The items covered six educational objectives in the cognitive domains developed by Benjamin Bloom, known as Bloom taxonomy of educational objectives: Knowledge 25%, Comprehension 25%, Application 15%, Analysis 15%, Synthesis 10%, and Evaluation 10%.

Validation of the Instrument

The Biology Achievement Test (BAT) was subjected to content and face validity. The content and face validity were done by three validators. A Senior Lecturer from the Department of Environmental and Life Science Education, Modibbo Adama University Yola, a lecturer from Federal University Kashere in the Department of Science Education and one Principal from Government Senior Secondary Schools Yola. The experts were requested to assess the instrument and vet the lesson plans. These experts validated the items in terms of clarity of language, appropriateness and adequacy of the items in measuring what they are supposed to measure. The advice of the experts helped to delete the column for name, modify male and female column and select the set of test items for the study as the final draft.

Reliability of the Instrument

The BAT items were subjected to trial testing to ascertain the reliability of the instrument. The researcher administered the instruments to SSII students of Government Secondary School II Girei Local Government Area of Adamawa State. One intact stream consisting of 50 students were used for the BAT trial testing. This school is not part of the sample of the study. The scores obtained from the trial testing were used to determine the internal consistency reliability coefficient of the instrument using Kuder-Richardson formula (KR-20), the coefficient obtained was 0.83.

Procedure for Data Collection

First, a letter of introduction was collected from the office of the Head of Department of Environmental and Life Sciences Education to introduce the researcher to the Principals of the schools for the study; while the data for the study were collected from the three intact classes using the BAT. The three intact classes in different schools were made to cover the same Biology contents. Three lesson plans were produced for the jigsaw IV cooperative learning, guided inquiry and peer tutoring (experimental groups). The treatment lasted for seven weeks. The researcher made use of the permanent Biology teachers in the sampled schools as research assistants. The reason for the

choice of using the permanent Biology teachers as research assistants was that if a new teacher other than the regular teachers comes in to teach the students, the students may think that something (experiment) is going on and that may affect their academic achievement and retention in Biology. The biology teachers were trained on how to use the jigsaw IV co-operative learning, guided inquiry and peer tutoring instructional strategies lesson plans during the training session. The essence of training the teachers was to ensure uniform instruction towards the validity of the experiment for easy generalization. However, before treatment, all groups (experimentals) were given pre-test which lasts for one week. After treatment was administered on the experimental groups for four weeks. The scores of both pre-test and post-test were recorded. Post test was done the following week after treatment and Retention test was carried out after one week of post-test. The scores obtained were compared, to determine whether there is a significant difference in the mean achievement scores of students that were taught with Jigsaw IV cooperative learning, Guided Inquiry and Peer tutoring instructional strategies; whether gender will influence students' academic achievement and retention when students were exposed to jigsaw IV cooperative learning, guided inquiry and peer tutoring instructional strategies.

Control of Extraneous Variables

In order to minimize the influence of extraneous variables that may likely affect the result of the study, measures were taken as follows:

1. Experimental bias/Hawthorn effect: Simple random sampling was used to select one intact class in each school, with regular time table for the lesson.
2. Testing effect: In order to control the effect of testing, the pretest instrument was reshuffled and printed before use as posttest to avoid remembering of the pretest items.
3. Maturation: To control this effect, students of the same class level that are of similar age range were used (SSII). In addition, pretest was administered to determine their entry behavior on the topics that were taught.
4. Initial group difference: Statistical control was employed to control initial differences in the intact class. Pretest was administered. Analysis of Covariance (ANCOVA) was used in data analysis using the pretest score as covariate.
5. Teacher variables: In order to control this variable in the study, the researcher made use of Biology teachers as research assistants who have the same academic qualification and experience and were trained equally.

Method of Data Analysis

Mean and standard deviation were used to answer the research questions while the hypotheses were tested at 0.05 level of significance using Analysis of Covariance (ANCOVA). ANCOVA was used because of the Pretest and Posttest. The choice of ANCOVA is to reduce variances and therefore reduce the chances of committing errors. Taking decision on testing the null hypotheses was based on comparing the computed p-value and F-value at 0.05 level of significance. If the computed p-value is > 0.05 the null hypothesis is not rejected and it is concluded that there is no significant effect of treatment on the dependent variable. If the computed p-value is ≤ 0.05 reject the null hypothesis and conclude that there is significant effect of treatment on the dependent variable. Post hoc analysis was used when the computed F ratio value is found to be significant in order to determine the treatment that brings about the significant effect.

RESULTS

This chapter presents data analysis, results and discussion of the findings.

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Presentation of Results

Research Question 1: What is the interaction effects of treatments and gender on students' academic achievement?

Table 1: Mean and Standard Deviation of Pre-Test and Post-Test Scores Difference of Male and Female Students Taught Biology using Jigsaw IV Co-operative Learning, Guided Inquiry and Peer Tutoring Instructional Strategies

Group	Gender	N	Pre-Test M	Pre-Test S.D	Post-Test M	Post-Test S.D	Mean Difference
Jigsaw	Male	19	15.32	3.97	38.58	3.29	23.26
	Female	30	16.13	3.50	35.73	2.35	19.60
Guided Inquiry	Male	24	13.67	4.19	44.46	12.37	30.79
	Female	28	15.39	3.37	48.82	11.72	33.43
Peer Tutoring	Male	21	20.43	5.18	42.57	7.64	22.14
	Female	27	19.37	3.98	40.52	11.79	21.15

Table 1 examines the mean and standard deviation of pretest and posttest scores for male and female students taught Biology using the instructional strategies. In the Jigsaw group, male students had a pretest mean score of 15.32 (SD = 3.97) and a posttest mean score of 38.58 (SD = 3.29), resulting in a mean difference of 23.26. Female students had a pretest mean score of 16.13 (SD = 3.50) and a posttest mean score of 35.73 (SD = 2.35), yielding a mean difference of 19.60. For the Guided Inquiry group, male students had a pretest mean score of 13.67 (SD = 4.19) and a posttest mean score of 44.46 (SD = 12.37), resulting in a mean difference of 30.79. Female students had a pretest mean score of 15.39 (SD = 3.37) and a posttest mean score of 48.82 (SD = 11.72), yielding a mean difference of 33.43. In the Peer Tutoring group, male students had a pretest mean score of 20.43 (SD = 5.18) and a posttest mean score of 42.57 (SD = 7.64), resulting in a mean difference of 22.14. Female students had a pretest mean score of 19.37 (SD = 3.98) and a posttest mean score of 40.52 (SD = 11.79), yielding a mean difference of 21.15. These results indicate that both male and female students showed improvements in their scores across all instructional strategies, with male students generally showing slightly higher mean differences in the Jigsaw and Peer Tutoring groups, and female students performing better than male in the Guided Inquiry group.

Research Question 2: What are the posttest and retention mean scores difference of male and female students when taught Biology using Jigsaw IV Co-operative Learning, Guided Inquiry and Peer Tutoring Instructional Strategies?

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Table 2: Mean and Standard Deviation of Post-Test and Retention Scores of Male and Female Students Taught Biology using Jigsaw IV Co-operative Learning, Guided Inquiry and Peer Tutoring Instructional Strategies

Group	Gender	N	Post-Test M	Post-Test S.D	Retention M	Retention S.D	Mean Difference
Jigsaw	Male	19	38.58	3.29	39.42	3.20	0.84
	Female	30	35.73	2.35	37.27	2.46	1.54
Guided Inquiry	Male	24	44.46	12.37	45.67	12.08	1.21
	Female	28	48.82	11.72	50.18	11.89	1.36
Peer Tutoring	Male	21	42.57	7.64	43.76	7.91	1.19
	Female	27	40.52	11.79	41.93	12.22	1.41

Table 2 presents the mean and standard deviation of posttest and retention scores for male and female students taught Biology using the three instructional strategies. In the Jigsaw group, male students had a posttest mean score of 38.58 (SD = 3.29) and a retention mean score of 39.42 (SD = 3.20), resulting in a mean difference of 0.84. Female students in the same group had a posttest mean score of 35.73 (SD = 2.35) and a retention mean score of 37.27 (SD = 2.46), yielding a mean difference of 1.54. This suggests that female students in the Jigsaw group showed a slightly higher improvement in retention over the posttest period compared to male students.

In the Guided Inquiry group, male students had a posttest mean score of 44.46 (SD = 12.37) and a retention mean score of 45.67 (SD = 12.08), resulting in a mean difference of 1.21. Female students had a posttest mean score of 48.82 (SD = 11.72) and a retention mean score of 50.18 (SD = 11.89), yielding a mean difference of 1.36. This indicates that female students in the Guided Inquiry group exhibited a greater improvement in retention compared to their male counterparts.

For the Peer Tutoring group, male students had a posttest mean score of 42.57 (SD = 7.64) and a retention mean score of 43.76 (SD = 7.91), resulting in a mean difference of 1.19. Female students had a posttest mean score of 40.52 (SD = 11.79) and a retention mean score of 41.93 (SD = 12.22), yielding a mean difference of 1.41. This shows that female students in the Peer Tutoring group also had a slightly higher improvement in retention over the posttest period compared to male students.

The results indicate that female students generally showed slightly higher mean differences in retention scores across all instructional strategies compared to male students, suggesting better retention of the material learned. The Guided Inquiry group exhibited the highest mean difference in retention scores for both male and female students, highlighting its effectiveness in enhancing long-term retention of Biology concepts.

Hypotheses Testing

H_{O1}: There is no significant interaction effect of treatment and gender on mean achievement scores of students in Post Basic School in Adamawa State.

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Table 3: Summary of ANCOVA of Interaction Effect of Treatment and Gender on Mean Achievement Scores of Students in Post Basic School in Adamawa State

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	3000.986[a]	6	500.164	5.787	.000	.196
Intercept	15862.640	1	15862.640	183.524	.000	.564
Pretest	92.883	1	92.883	1.075	.302	.008
Teaching methods	2081.530	2	1040.765	12.041	.000	.145
Gender	.225	1	.225	.003	.959	.000
Teaching methods * Gender	425.909	2	212.954	2.464	.089	.034
Error	12273.564	146	86.434			
Total	275513.000	149				
Corrected Total	15274.550	148				

a. R Squared = .196 (Adjusted R Squared = .163)

In analyzing the interaction effect of treatment and gender on mean achievement scores of students in Post Basic Schools in Adamawa State, the ANCOVA results in Table 3 indicate that the interaction effect is not statistically significant. Specifically, the interaction between teaching methods and gender has an $F(2, 146) = 2.464$, $p > 0.05$, suggesting that the interaction does not significantly affect mean achievement scores. Therefore, the null hypothesis (H_{01}) is **not rejected**. This implies that the effect of the instructional strategies on students' academic achievement in Biology does not depend on gender. In other words, Jigsaw IV cooperative learning, guided inquiry and peer tutoring instructional strategies are equally effective for both male and female students in enhancing academic achievement in Biology.

H_{02}: There is no significant interaction effect of treatment and gender of academic achievement and retention when taught using Jigsaw IV Cooperative Learning, Guided Inquiry Instructional and Peer Tutoring Instructional Strategies in Post Basic School in Adamawa State.

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Table 4: Summary of ANCOVA of Interaction Effect of Treatment and Gender on Mean Retention Scores of Students in Post Basic School in Adamawa State

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	3029.916[a]	6	504.986	5.727	.000	.195
Intercept	17363.431	1	17363.431	196.916	.000	.581
Pretest	144.482	1	144.482	1.639	.203	.011
Teaching methods	2113.149	2	1056.575	11.982	.000	.144
Gender	3.210	1	3.210	.036	.849	.000
Teaching methods * Gender	399.840	2	199.920	2.267	.107	.031
Error	12521.118	146	88.177			
Total	292085.000	149				
Corrected Total	15551.034	148				

a. R Squared = .195 (Adjusted R Squared = .161)

Similarly, when examining the interaction effect of treatment and gender on mean retention scores using different instructional strategies, the ANCOVA results in Table 4 show that this interaction is also not significant. The F-value for the interaction between teaching methods and gender is $F(2, 146) = 2.267$, $p > 0.05$, indicating that the interaction does not significantly influence mean retention scores. Therefore, the null hypothesis (H_{02}) is **not rejected**. This implies that the effect of the instructional strategies on students' retention in Biology does not depend on gender. In other words, Jigsaw IV cooperative learning, guided inquiry and peer tutoring instructional strategies are equally effective for both male and female students in enhancing retention of Biology concepts.

Summary of Major Findings

Based on the data analysis and interpretation of results, the following major findings emerged from this study:

1. There is no significant interaction effect of treatment and gender on mean achievement scores of students in Post Basic School in Adamawa State, $F(2, 146) = 2.464$, $p > 0.05$. This means that the effect of the instructional strategies on students' academic achievement in Biology does not depend on gender.

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2. There is no significant interaction effect of treatment and gender on mean retention scores of students in Post Basic School in Adamawa State, $F(2, 146) = 2.267$, $p > 0.05$. This means that the effect of the instructional strategies on students' retention in Biology does not depend on gender.

DISCUSSION OF FINDINGS

Interaction Effect of Treatment and Gender on Academic Achievement

The finding revealed that there is no significant interaction effect of treatment and gender on mean achievement scores of students in Post Basic School in Adamawa State. This means that the effectiveness of Jigsaw IV cooperative learning, guided inquiry and peer tutoring instructional strategies on students' academic achievement in Biology does not depend on gender. In other words, these instructional strategies are gender-friendly and can be used to teach both male and female students without gender-based differential outcomes.

This finding is consistent with Audu, Ajayi and Angura (2023), who found no significant interaction effect between guided and structured inquiry instructional strategies and gender on the mean retention scores of students in Basic Science and Technology. Similarly, Sallah, Owusu, Narh-Kert and Mensah (2023) indicated that the assessment of interaction effects indicated that gender did not significantly interact with the teaching strategy in relation to students' average performance.

The finding also aligns with Aziaka and Azonwu (2023), who revealed that Peer Tutorial does not have significant effect on gender when performances of male and female students are compared in each option. Audu, Ajayi and Angura (2023) revealed no significant difference was found in the mean performance scores between male and female students taught Basic Science and Technology using guided inquiry instructional strategy. Osei-Himah, Parker and Naah (2022) found that the male students' performance in Physics does not significantly differ from that of the female students as a result of the peer tutoring method adopted for the study. Azeez, Akeem, Emmanuel, Kwasi, Ndanusa, and Abuh (2022) revealed that gender has no influence on the academic performance of students exposed to Jigsaw and peer tutoring instructional strategies.

The finding is also consistent with Chinwe and Ndioho (2022), who revealed that there was no significant interaction effect between Peer Tutoring, Think-Pair-Share, 3-2-1, and chalk-talk instructional strategies and gender on students' retention in Computer Science. Similarly, Akudo and Olaoye (2021) reported that there was no significant interaction effect of jigsaw and gender in attitude towards coordinate geometry lessons.

However, the finding contradicts Odo and Nwachukwu (2020), who revealed that male students in the jigsaw group achieved higher than male students in peer tutoring group, and female students taught science using the Jigsaw IV instructional strategy had significantly higher performance mean score than female students taught using the Peer Tutoring instructional strategy. In the same way, Adeosun (2002) found that girls have better retention than boys in his research carried out on effect of multi-media packages on students' achievement and retention in Social Studies.

The absence of a significant interaction effect in the present study suggests that the instructional strategies employed were equitable in their effects on male and female students. This finding is particularly important for educational practice in Adamawa State, where gender disparities in science education have been a concern. The result implies that teachers can confidently use Jigsaw IV cooperative learning, guided inquiry and peer tutoring instructional strategies without worrying about gender-related differential outcomes. These strategies create inclusive learning environments where both male and female students can benefit equally from collaborative and inquiry-based learning experiences.

Interaction Effect of Treatment and Gender on Retention

The finding revealed that there is no significant interaction effect of treatment and gender on mean retention scores of students in Post Basic School in Adamawa State. This means that the

effectiveness of Jigsaw IV cooperative learning, guided inquiry and peer tutoring instructional strategies on students' retention in Biology does not depend on gender. In other words, these instructional strategies are gender-friendly and can be used to teach both male and female students without gender-based differential outcomes in retention.

This finding is consistent with Chinwe and Ndioho (2022), who revealed that there was no significant interaction effect between Peer Tutoring, Think-Pair-Share, 3-2-1, and chalk-talk instructional strategies and gender on students' retention in Computer Science. Similarly, Audu, Ajayi and Angura (2023) found no significant interaction effect between guided and structured inquiry instructional strategies and gender on the mean retention scores of students in Basic Science and Technology. Akudo and Olaoye (2021) revealed that there was no significant interaction effect of treatment and gender in attitude towards coordinate geometry lessons.

However, the finding contradicts Akudo and Olaoye (2021), who reported that there was significant interaction effect of jigsaw and gender in attitude towards coordinate geometry lessons. Similarly, Adeosun (2002) found that there is significant difference in the mean performance scores between girls and boys on effect of multi-media packages on students' achievement and retention in Social Studies.

The absence of a significant interaction effect in the present study suggests that the retention benefits of the instructional strategies were consistent across gender. This finding is important because it indicates that male and female students were able to retain Biology concepts equally well when taught using these student-centred instructional strategies. The collaborative and interactive nature of Jigsaw IV, guided inquiry and peer tutoring may have provided equal opportunities for both male and female students to engage with the content, discuss concepts with peers, and construct meaningful understanding that persisted over time.

CONCLUSION

Based on the findings of this study, it is concluded that Jigsaw IV cooperative learning, guided inquiry and peer tutoring instructional strategies are gender-friendly instructional approaches that can be effectively used to teach Biology to both male and female students in Post Basic Schools in Adamawa State. The study found no significant interaction effect of treatment and gender on students' academic achievement and retention in Biology. This implies that the effectiveness of these instructional strategies does not depend on gender, and they can be used to promote equitable learning outcomes for male and female students. The study therefore concludes that these student-centred instructional strategies are suitable for creating inclusive Biology classrooms where both male and female students can achieve and retain biological concepts effectively.

RECOMMENDATIONS

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

1. School administrators should encourage Biology teachers to use Jigsaw IV Cooperative Learning, Guided Inquiry and Peer Tutoring Instructional Strategies in teaching and learning of Biology content. These strategies have been shown to be gender-friendly and effective for both male and female students.
2. Educational institutions should emphasise the integration of Jigsaw IV Cooperative Learning, Guided Inquiry and Peer Tutoring Instructional Strategies into the Biology curriculum to enhance student achievement and retention.
3. School administrators should encourage Biology teachers to engage both male and female students actively during lessons. The finding that these strategies are gender-friendly means that teachers should not discriminate based on gender when implementing these instructional approaches.

SUGGESTIONS FOR FURTHER STUDIES

Based on the results of this study, the following suggestions for further studies are made:

1. There is need for further research comparing Jigsaw IV Cooperative Learning, Guided Inquiry, Peer Tutoring Instructional Strategies and Lecture method on students' academic achievement and interest in senior secondary schools.
2. Further research should explore Jigsaw IV Cooperative Learning and Peer Tutoring Instructional Strategies in relation to virtual learning instructional strategies on students' academic achievement and interest toward Biology in senior secondary schools in Adamawa State, Nigeria.
3. Future studies should investigate the interaction effect of treatment and other moderating variables such as school location, socio-economic status, and prior knowledge on students' academic achievement and retention in Biology.

REFERENCES

Abbey-Kalio, I. A. K. (2019). Effect of Guided-inquiry Approach on Senior Secondary School Students' Academic Performance in Practical Chemistry in Okrika Local Government Area, Rivers State, Nigeria. Unpublished MSc Thesis, Department of Chemistry, Ignatius Ajuru University of Education, Rumuolumeni, River State, Nigeria.

Abubakar, A., Idris, S. & Abdullahi, A. R. I. (2023). Effects of Jigsaw Cooperative Learning Strategy on Secondary School Students' Attitudes and Performance in Physics in Sokoto State, Nigeria. *Journal of Educational Studies Trends and Practice, 2*(2), 128-137.

Achor, E. E. & Musa, W. (2014). Looking for a More Facilitative Cooperative Learning Strategy for Biology: Students' Team Performance Division or Jigsaw? *British Journal of Education, Society & Behavioural Science, 4*(12), 1664-1675.

Adamawa State Post Primary School Management Board (2022). *Guideline for the management and administration of post-primary schools in Yola, Adamawa State*. Nigeria.

Adebayo, A. A., Tukur, A. L. & Abubakar, M. B. (2012). *Adamawa State in Maps* (2nd ed.). Paraclete Publishers.

Adekoya, Y. M. & Olatoye, R. A. (2011). Effect of demonstration, peer-tutoring, and lecture teaching strategies on senior secondary school students' achievement in an aspect of agricultural science. *The Pacific Journal of Science and Technology, 12*(1), 320-332.

Akudo, O. K. & Olaoye, A. A. (2021). Effects of Jigsaw-iv Instructional Strategy on Students' Attitude Towards Co-ordinate Geometry. *Nigerian Online Journal of Educational Sciences and Technology (NOJEST), 3*(2), 109-119.

Akpokiniovo, O. R. S. & Akudolu, L. R. (2020). Effects of Guided Inquiry and Peer Tutoring Teaching Strategies on Achievement of Physics Students' in Delta State. *International Journal of Library Science and Educational Research, 3*(10), 2160-2164.

Audu, T. C., Ajayi, O. V. & Angura, M. T. (2023). Guided and Structured Inquiry Instructional Strategies: Comparative Effects on Students' Performance in Basic Science and Technology. *Journal of Education and Practice, 8*(33), 81-88.

Azeez, A., Akeem, A., Emmanuel, O., Kwasi, O., Ndanusa, A. & Abuh, A. (2022). Effects of Jigsaw and Peer Tutoring Instructional Strategies on Students' Academic Performance and Interest in Periodic Table of Elements Concept of Chemistry. *Journal of Educational Research, 5*(2), 45-58.

Chinwe, N. & Ndioho, U. (2022). Effects of Peer Tutoring, Think-Pair-Share, 3-2-1, and Chalk-Talk Instructional Strategies on Students' Retention in Computer Science. *Journal of Educational Technology, 9*(3), 112-125.

Cochon Drouet, O., Lentillon-Kaestner, V., & Margas, N. (2023). Effects of the Jigsaw method on student educational outcomes: systematic review and meta-analyses. *Frontiers in Psychology, 14*, 1216437.

Federal Ministry of Education. (2013). *National Policy on Education*. Nigerian Educational Research and Development Council (NERDC).

Fakiye Olabode Kayode (2021). Effects of Peer Tutoring on Students' Achievement in Biology in Senior Secondary Schools in Ekiti State, Nigeria. *Journal of Educational Research, 7*(3), 45-58.

Josiah M. M. & Mankilik M. (2021). Jigsaw IV Cooperative Learning Strategy: Closing the Gender and School Type Gaps in Physics Performance of Senior Secondary Two Students. *British Journal of Education, Learning and Development Psychology, 4*(2), 18-30.

Karacop, A. (2017). Effects of Using Jigsaw Method Based on Cooperative Learning Model in the Undergraduate Science Laboratory Practices. *Universal Journal of Educational Research, 5*(3), 420-434.

Kulik, J. A., & Fletcher, J. D. (2016). Effectiveness of intelligent tutoring systems: a meta-analytic review. *Review of Educational Research, 86*(1), 42-78.

Maciejewski, M. L. (2020). Quasi-experimental design. *Biostatistics & Epidemiology, 4*(1), 38-47.

Odo, J. & Nwachukwu, P. (2020). Effect of Jigsaw Instructional Strategy on Science Students' Achievement. *Journal of Science Education, 5*(2), 78-92.

Ojekwu, I. N. & Ogunleye, B. O. (2020). Effects of Jigsaw Learning Strategy on Science Students' Performance and Interest in Biology in Selected Schools in Rivers State, Nigeria. *Journal of Education, 2*(3), 48-55.

Okeke N. V. (2023). Effect of Problem-Solving and Jigsaw Teaching Techniques on Academic Performance of Business Education Students in Financial Accounting in Universities in Anambra State, Nigeria. *Department of Vocational Education, Chukwuemeka Odumegwu Ojukwu University Igbariam Campus, 3*(2), 61-74.

Osei-Himah, V., Parker, J. & Naah, A. (2022). Peer Tutoring Method and Pre-Service Teachers' Performance in Physics. *Journal of Science Education, 8*(1), 23-38.

Sallah, O. N. M. (2023). Peer Tutoring Strategy: A Quantitative Analysis of Pre-Service Teachers' Academic Achievement in Mathematics. *Evangelical Presbyterian College of Education, Amedzofe, Ghana, 5*(9), 34-48.

Stanczak, A., Darnon, C., Robert, A., Demolliens, M., Sanrey, C., Bressoux, P., ... & Butera, F. (2022). Do jigsaw classrooms improve learning outcomes? Five experiments and an internal meta-analysis. *Journal of Educational Psychology, 114*(6), 14-61.

Timayi, J. M., Bolaji, C., & Kajuru, Y. K. (2015). Effects of Jigsaw IV cooperative learning strategy (J4CLS) on academic performance of secondary school students in geometry. *International Journal of Mathematics Trends and Technology-IJMTT, 28*(1), 12-18.

Topping, K., Duran, D., & Van Keer, H. (2015). *Using peer tutoring to improve reading skills: a practical guide for teachers*. Routledge.

Ullah, I., Tabassum, R., & Kaleem, M. (2018). Effects of peer tutoring on the academic performance of students in the subject of Biology at secondary level. *Education Sciences, 8*(3), 112.

Vygotsky, L. S. (1978). *Mind in Society: The Development of Higher Psychological Processes*. Harvard University Press.

Yusuf AbdulRaheem, Hamdallat T. Yusuf, Adesegun O. Odutayo (2017). Effect of peer tutoring on students' academic performance in economics in Ilorin South, Nigeria. *Journal of Peer Learning, 10*(1), 95-102