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COMPARATIVE EFFECTIVENESS OF PEER-LED, INQUIRY-BASED AND LECTURE INSTRUCTIONAL STRATEGIES ON BASIC SCIENCE STUDENTS' ACHIEVEMENT AND RETENTION IN DELTA CENTRAL SENATORIAL DISTRICT

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Abstract:
This study examined the effects of peer-led, inquiry-based, and lecture instructional strategies on students' achievement and retention in basic science in Delta Central Senatorial District. 5 research questions and 5 hypotheses guide the study. The pretest-posttest delayed-posttest planned variation quasi-experimental design was employed for the study. The population of the study consisted of 82,712 JSII basic science students in the 183 public secondary schools. The sample size is 292 basic science students selected from 6 public mixed junior secondary schools. The instrument for data collection, which was duly face and content validated, was the Basic Science Achievement Test (BSAT). The instrument, with a reliability coefficient of 0.79, was established using the Kuder-Richardson Formula – 21 (K-R-21). All research questions were answered using mean and standard deviation, while the hypotheses were tested at a 0.05 level of significance with t-test, and ANCOVA. The study found that; there is a significant difference in the mean achievement scores among students taught basic science using peer-led, inquiry-based and lecture instructional strategies, there is a significant difference in the mean retention scores among students taught basic science using peer-led, inquiry-based and lecture instructional strategies, there is no significant difference in the mean achievement scores of male and female students taught basic science using peer-led, inquiry-based

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and lecture instructional strategies, there is no significant interaction effect of method and gender on basic science students' achievement, and there is a significant interaction effect of method and gender on basic science students' retention. the study, therefore, concluded that the peer-led instructional strategy and the inquiry-based instructional strategy are more effective in enhancing basic science students' achievement and retention than the lecture method. The study also, amongst others, recommends that basic science teachers should adopt the use of peer-led instructional strategy in teaching basic science in junior and senior secondary schools.

Keywords: peer-led, inquiry-based, lecture, instructional strategy, students, achievement, retention, basic science

1. Introduction

Basic science combines all other science subjects, such as physics, chemistry, biology, health science, information technology, and agricultural science. The National Policy on Education introduced basic science and technology as a core subject at the junior secondary school level to introduce students to the world of science and technology, and to prepare them for higher education in science and technology (Federal Republic of Nigeria, 2013). Basic science equips learners with essential knowledge and skills needed to understand scientific concepts, processes, and phenomena in their environment. It develops the ability to observe, ask questions, and interpret natural events. It serves as a stepping stone to specialized subjects such as physics, chemistry, and biology. Through basic science, students develop interest and readiness for careers in medicine, engineering, technology, agriculture, and other STEM fields. The importance of basic science to the national development of any country cannot be overemphasized. This is because knowledge and skills in basic science are vital in the development of any society. The fast-changing applications of science and technology and the global reliance on its processes and products in all areas of human endeavor have made them so invaluable that any society or country without them risks being alienated from the global village. This means that for an individual to be well-grounded in science and competent enough to face the challenges of life in his society, he or she must have gone through a basic science programme that is well planned, assessed, and implemented.

According to the National Policy on Education (FRN, 2013), the aims of basic science is directed at enabling students who are exposed to it, to acquire the following skills: observe carefully and thoroughly; report completely and accurately what is observed; organize information acquired; generalize based on the acquired information; predict as a result of the generalization; design experiments (including control where necessary) to check predictions; use models to explain phenomena where appropriate; and continue the process of inquiry when new data do not conform to predictions. To achieve these aims, appropriate opportunities should be provided during basic science

and technology instruction for students to learn through direct experience by manipulating materials and engaging in scientific processes. Invariably, the objectives of basic science can be effectively achieved when teachers adopt appropriate innovative instructional strategies, learning activities, and classroom practices that promote scientific understanding, inquiry, and application. Some such innovative instructional strategies include peer-led and inquiry-based strategies.

Peer-led instructional strategy is a strategy that consists of students teaching other students of the same or different ages, on a one-on-one basis or one tutor working with two or three students simultaneously (Digest, 2002). Peer-led instructional strategy has been broadly used across academic subjects, and has been found to result in academic achievement for a diversity of learners within a wide range of content areas, just like academic and cognitive gain. Peer-led instructional strategy is a systematic process where the teacher sets the environment for learning, while the learners play the teacher role to a small group of learners for a short or long-time duration. This can be made possible if the teacher relinquishes a great part of his role and authority to the learners and assumes more responsibility as a facilitator of learning. Al-Hebaishi (2017) defined peer-led instruction as a method where students are able to acquire knowledge through observation, study, teaching of other students, or through their own experiences. Emmanuel (2019) opined that peer-led strategy is a method of teaching in which one student (or a small group of students) receives personalized and individualized instruction. It is a process by which a pupil (learner called the tutor) with minimal training and with the teacher's guidance helps one or more students at the same grade level (called the tutees) (Eskay, Onu, Obiyo, Obidoa, 2012). Through the use of peer-led strategy, being a learner-centered strategy with the capacity to promote inquiry, critical thinking, and problem-solving skills, the objectives of the basic science education mentioned earlier may be achieved, because as students experience certain phenomena that will expose them to certain knowledge, in a real-life situation.

Inquiry-based instructional strategy is another strategy that has been found empirically to enhance students' academic achievement. Inquiry instructional strategy is a student–centered, activity–oriented teaching strategy in which the teacher directs students through a problem-solving approach to discover answers to an instructional topic. Nwanze (2016) opined that inquiry instructional strategy is a method of teaching where the learner, with minimal guidance from the teacher, seeks to discover and create an answer to a recognized problem through the procedure of making a diligent search. Furtak (2006) asserted that scientific teaching stands somewhere between the boundaries of the traditional method, in which certain answers known by the teachers are transferred to the students, and the open inquiry method, in which students construct their own problems and problem solutions. Inquiry-based instructional strategy integrates the scientific and constructivist rationales together with the facts, principles, and rules accepted as scientific and stressed by contemporary science education reforms. Inquiry-based instructional strategy requires a high degree of communication among the

environment, content, materials, and learners and teachers. The most important feature of this method is to enable both teachers and learners to be researchers, idea propagators, and problem solvers. Furthermore, it has some positive consequences, such as making students active, developing their understanding, improving their research skills, and understanding the nature of science

Another method whose characteristics differ from peer-led and inquiry-based instructional strategies is the lecture method. The lecture method is a teacher-centred approach in which the instructor presents facts and principles orally. Ajaja (2009) referred to the lecture method as an address, a talk, a lesson, or other types of verbal presentation to students by a teacher. Some of the advantages of the lecture method, as highlighted by Ajaja, include: being economical as it saves time, coverage of large content and syllabus, teaching of a large number of students, as well as presenting students with new information. In this method, the teacher dominates the lesson procedure and takes the lead in coordinating the classroom activities as regards what to do. According to Akpoghol, Samba, and Asemave (2013), the lecture method is one of the conventional methods of teaching in Nigeria's secondary schools. The teacher does most of the activities in the form of talking, while the students are passive listeners or slightly involved. This kind of method leads to rote learning. This method, which involves mostly a talk-chalk approach, may not have been effective for teaching basic science since it does not promote meaningful learning, hence lacks a retentive quality. In view of this, the lecture method has been criticized as a poor method of teaching hands-on skills in science, although it provides for effective use of time and manpower, especially in presenting ideas to a large group of people. The continuous usage of the lecture method in the teaching and learning of basic science in secondary schools may be connected to students' poor academic achievement and retention in basic science.

Academic achievement basically is the product of the extent to which educational or instructional goals and objectives have been attained (Ovuworie, 2024). Academic achievement refers to the extent to which a student has internalized, leading to a degree of success in a given educational task, which can serve as a predictive measure of students' future academic excellence. Academic achievement is the level of success attained by students in school subjects. Olorode and Jimoh (2016) asserted that academic achievement can be used to indicate students' level of success in a particular task previously exposed to. In other words, academic achievement is the extent to which students recall facts previously exposed to. Therefore, academic achievement and retention are closely related.

Retention is the ability of students to remember or recognize the content that has been taught and learned, which is very critical in teaching and learning. There are different ways in which one can easily retain knowledge. Nikos (2017) opined that active learning increases engagement and leads to much better retention. It is thought that students' retention of lesson content is a function of students' ability to conceptualize what is learnt or being taught (Nwanze, 2016). This can happen if the instructional

strategy provides enough learning experience for the students to make many connections between the concept being learnt and their previous knowledge of similar concepts. Also, retention may take place when there are provisions for active interaction and self-discovery of knowledge. Retention, therefore, may be enhanced by students' active involvement in the teaching-learning process and by providing many learning experiences during the process of learning, irrespective of their gender.

Gender in this study refers to the state of being male or female. It is the characteristics by means of which people define male or female. Gender is one of the factors that has been empirically reported to influence students' achievement in science subjects. While some studies have proven that male students performed significantly better than their female counterparts (Effiom & Abdullahi, 2021), others have shown that female students performed better than their male counterparts (Ademola & Nadaraj, 2018). However, studies have equally revealed no significant difference in the mean achievement and retention scores of male and female students (Ovuworie, & Ajaja, 2024; Umar, Ossom, & Egbita, 2021). This study, therefore, seeks to investigate the effects of peer-led, inquiry-based, and lecture instructional strategies on students' achievement and retention in basic science in the Delta Central Senatorial District.

2. Statement of the Problem

The basic science academic achievement among junior secondary school students has been below standard (Delta State Ministry of Basic and Secondary Education Reports, 2020-2024). Students' poor academic achievement in basic science has been attributed to a variety of factors by various scholars. Some factors that they attributed the students' poor achievement in basic science to include: lack of qualified teachers and inappropriate teaching methods, among others. Most teachers prefer the lecture method in teaching, perhaps because it is easier to implement compared to other teaching strategies that may encourage active learning by students. The lecture method of teaching promotes rote learning and a lack of opportunity for students to manipulate materials and reflect on what they do during the teaching and learning processes. For students to achieve better academic outcomes, the teacher must use teaching methods that will enable the students to participate actively during learning, reason logically, and also link the lesson to true-life phenomena. It is assumed that peer-led and inquiry-based instructional strategies will enhance active participation of students irrespective of gender and consequently lead to better academic achievement and retention during teaching and learning of basic science than the lecture method. Therefore, the statement of the problem of this study, put in a question form, is: Will the use of peer-led and inquiry-based instructional strategies improve students' academic achievement and retention in basic science in the Delta Central Senatorial Districts more than the lecture method?

2.1 Research Questions

The following research questions guided the study:

1) What is the difference in the mean achievement scores among students taught basic science using peer-led, inquiry-based, and lecture instructional strategies?
2) What is the difference in the mean retention scores among students taught basic science using peer-led, inquiry-based, and lecture instructional strategies?
3) What is the difference in the mean achievement scores of male and female students taught basic science using peer-led, inquiry-based, and lecture instructional strategies?
4) What is the interaction effect of teaching strategies and gender on students' achievement in basic science?
5) What is the interaction effect of teaching strategies and gender on students' retention in basic science?

2.2 Hypotheses

The following hypotheses were tested at the 0.05 level of significance:

1) There is no significant difference in the mean achievement scores among students taught basic science using peer-led, inquiry-based, and lecture instructional strategies
2) There is no significant difference in the mean retention scores among students taught basic science using peer-led, inquiry-based, and lecture instructional strategies
3) There is no significant difference in the mean achievement scores of male and female students taught basic science using peer-led, inquiry-based, and lecture instructional strategies
4) There is no significant interaction effect of teaching strategies and sex on students' achievement in basic science.
5) There is no significant interaction effect of teaching strategies and sex on students' retention in basic science.

3. Methodology

The pretest-posttest delayed-posttest planned variation quasi-experimental design was employed for this study. The population of the study consisted of 82,712 JSII basic science students in the 183 public secondary schools. The sample size is 292 basic science students from 6 intact classes from 6 randomly selected public mixed junior secondary schools. The instrument for data collection, which was duly face and content validated, was the Basic Science Achievement Test (BSAT), which consisted of 50 multiple-choice test items. The instrument, with a reliability coefficient of 0.79, was established using the Kuder-Richardson Formula – 21 (K-R-21). Before the commencement of the treatment, the six (6) schools randomly selected for the study were randomly assigned into groups: the peer-

led, inquiry-based, and lecture instructional strategy groups. The groups were pre-tested to establish equivalence and to ensure that any observed changes at post-test could be attributed to the treatment administered. Following the pre-test, the groups underwent the treatment, where one group was taught using the peer-led instructional strategy, the inquiry-based instructional strategy, and the other with the lecture method. Post-tests were then conducted immediately after the treatment. Thereafter, a delayed posttest was conducted four weeks after the posttest. Data collected were analyzed with mean, standard deviation for the research questions, while the hypotheses were tested at a 0.05 level of significance using t-test, and Analysis of Covariance (ANCOVA).

4. Results

Research Question 1: What is the difference in the mean achievement scores among students taught basic science using peer-led, inquiry-based, and lecture instructional strategies?

Table 1: Descriptive statistics of mean and standard deviation showing the difference at post-test on the achievement scores of students taught basic science using peer-led, inquiry-based, and lecture instructional strategies

Groups	N	$\bar{X}$	SD
PLIS	97	34.65	4.82
IBIS	96	33.35	4.68
LM	99	25.86	3.66

Table 1 shows that at posttest, scores of students taught basic science using peer-led instructional strategy had a mean score of 34.65 with a standard deviation of 4.82, and those taught with inquiry-based instructional strategy had a mean score of 33.35 with a standard deviation of 4.68 while, students taught using the lecture method had a mean score of 31.24, with a standard deviation of 3.66. The result indicates that the group exposed to the peer-led instructional strategy achieved higher posttest scores, followed by the group exposed to the inquiry-based instructional strategy, while the group exposed to the lecture method had the lowest score. The mean scores of the three groups also indicate a difference among the groups. To determine if the difference is significant, Hypothesis 1 was tested.

Hypothesis 1: There is no significant difference in the mean achievement scores among students taught basic science using peer-led, inquiry-based, and lecture instructional strategies.

Table 2: Analysis of Covariance (ANCOVA) conducted to determine the effect of peer-led, inquiry-based, and lecture instructional strategies on students' posttest basic science achievement scores

Dependent Variable: Post Test					
Source	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Corrected Model	5055.234[a]	3	1685.078	97.245	.000
Intercept	7414.158	1	7414.158	427.868	.000
Pre-Test	631.559	1	631.559	36.447	.000
Group	4488.179	2	2244.090	129.506	.000
Error	4990.502	288	17.328		
Total	295077.000	292			
Corrected Total	10045.736	291			
a. R Squared = .503 (Adjusted R Squared = .498)					

Table 2 shows that the calculated F-value for teaching methods is 129.506, and its p-value is 0.000. Since the p-value of 0.000 is less than the 0.05 level of significance, **F(2, 288) = 129.506, p = .000.** The null hypothesis, which states that there is no significant difference in the mean achievement scores among students taught basic science using peer-led, inquiry-based, and lecture instructional strategies, is rejected. Therefore, there is a statistically significant difference in the post-test scores of students taught with the three instructional strategies, after adjusting for pre-test scores. Scheffe's post-hoc test was therefore employed to show the direction of the difference and significance among the three groups.

Table 3: Scheffe's post-hoc analysis comparison of peer-led, inquiry, and lecture instructional strategies on basic science students' achievement

(I) Group	**(J) Group**	**Mean Difference (I-J)**	**Std. Error**	**Sig.**	**95% Confidence Interval**	
					Lower Bound	**Upper Bound**
PLIS	Inquiry	1.29532	.63497	.127	-.2670	2.8577
	Lecture	8.79090*	.63012	.000	7.2405	10.3413
IBIS	Peer	-1.29532	.63497	.127	-2.8577	.2670
	Lecture	7.49558*	.63178	.000	5.9411	9.0501
LM	Peer	-8.79090*	.63012	.000	-10.3413	-7.2405
	Inquiry	-7.49558*	.63178	.000	-9.0501	-5.9411
*. The mean difference is significant at the 0.05 level.						

The Scheffe post-hoc test was conducted to determine which pairs of instructional strategies differed significantly in students' basic science achievement after the treatment. The analysis compared: peer-led, inquiry-based, and lecture instructional strategies. For peer-led vs inquiry-based instructional strategy, the mean difference = 1.29532, the Sig. = .127 (not significant) and the confidence interval = [-0.2670, 2.8577]. For peer-led instructional strategy vs the lecture method, the mean difference = 8.79090, the Sig. = .000 (significant), and the confidence interval = [7.2405, 10.3413]. Finally, for the inquiry-based

instructional strategy vs the lecture method, the mean difference = 7.49558, the Sig. = .000 (significant), and confidence interval = [5.9411, 9.0501].

Research Question 2: What is the difference in the mean retention scores among students taught basic science using peer-led, inquiry-based, and lecture instructional strategies?

Table 4: Descriptive statistics of mean and standard deviation comparing the mean retention scores of students taught basic science using peer-led, inquiry-based, and lecture instructional strategies

Groups	N	$\bar{X}$	SD
PLIS	97	27.53	7.46
IIS	96	24.73	6.61
LM	99	18.47	6.69

Table 4 presents the mean and standard deviation of basic science delayed posttest achievement scores of students taught using peer-led, inquiry-based, and lecture instructional strategies. The table indicated that basic science students taught with peer-led instructional strategy had a mean delayed posttest score of 27.53 with a standard deviation of 7.46, basic science students taught with inquiry-based instructional strategy had a mean delayed posttest score of 24.73 with a standard deviation of 6.61, while students taught with lecture method had a mean delayed posttest score of 18.47 with a standard deviation of 6.69. This shows that basic science students taught with a peer-led instructional strategy had the highest mean delayed posttest score, followed by basic science students taught with an inquiry-based instructional strategy, and lastly, students taught with the lecture method. To determine if the difference is significant, hypothesis 2 was tested.

Hypothesis 2: There is no significant difference in the mean retention scores among students taught basic science using peer-led, inquiry-based, and lecture instructional strategies

Table 5: Analysis of Covariance (ANCOVA) conducted to determine to determine the effect of peer-led, inquiry-based, and lecture instructional strategies for students' delayed posttest basic science achievement scores

Dependent Variable: Delayed Post-test					
Source	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Corrected Model	4300.101[a]	3	1433.367	29.900	.000
Intercept	4167.843	1	4167.843	86.941	.000
Post-test	75.363	1	75.363	1.572	.211
Group	3002.406	2	1501.203	31.315	.000
Error	13806.406	288	47.939		
Total	179928.000	292			
Corrected Total	18106.507	291			
a. R Squared = .237 (Adjusted R Squared = .230)					

Table 5 shows that the calculated F-value for teaching methods is 31.315, and its p-value is 0.000. Since the p-value of 0.000 is less than the 0.05 level of significance, **F(2, 288) = 31.315, p = 0.000,** the null hypothesis, which states that there is no significant difference in the mean retention scores among students taught basic science using peer-led, inquiry-based, and lecture instructional strategies, is rejected. Therefore, there are statistically significant differences among the three instructional strategies in terms of how well students retained basic science knowledge over time. Scheffe's post-hoc test was therefore employed to show the direction of the difference among the three groups.

Table 6: Scheffe's post-hoc analysis showing the direction of significance among peer-led, inquiry-based, and lecture instructional strategies on basic science students' retention

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
PLIS	Inquiry	2.80692*	.99777	.020	.3519	5.2619
	Lecture	9.06133*	.99014	.000	6.6251	11.4976
IBIS	Peer	-2.80692*	.99777	.020	-5.2619	-.3519
	Lecture	6.25442*	.99274	.000	3.8118	8.6971
LM	Peer	-9.06133*	.99014	.000	-11.4976	-6.6251
	Inquiry	-6.25442*	.99274	.000	-8.6971	-3.8118
*. The mean difference is significant at the 0.05 level.						

The Scheffe post-hoc test was conducted to identify which pairs of instructional strategies differed significantly in students' retention of basic science concepts after some time had passed (delayed posttest). For peer-led vs inquiry-based instructional strategy, the mean difference = 2.80692, the Sig. = .020 (significant) with a 95% confidence interval = [.3519, 5.2619]. This indicates that students taught with the peer-led instructional strategy retained significantly more basic science concepts than those taught with the inquiry-based instructional strategy. For peer-led instructional strategy vs lecture method, the mean difference = 9.06133, the Sig. = .000 (highly significant) with 95% confidence interval = [6.6251, 11.4976]. This indicates that students taught using a peer-led instructional strategy retained far more basic science content than those taught using the lecture method. For inquiry-based instructional strategy vs lecture method, the mean difference = 6.25442, the Sig. = .000 (highly significant) with 95% confidence interval = [3.8118, 8.6971]. This indicates that students taught with the inquiry-based instructional strategy also retained significantly more than those taught using the lecture.

Research Question 3: What is the difference in the mean achievement scores of male and female students taught basic science using peer-led, inquiry-based, and lecture instructional strategies?

Table 7: Descriptive statistics of mean and standard deviation comparing the male and female mean achievement scores of students taught basic science using peer-led, inquiry-based, and lecture instructional strategies

Group	Gender	N	$\bar{X}$	SD
PLIS	Male	44	35.80	4.63
	Female	53	33.70	4.80
IBIS	Male	41	35.20	4.69
	Female	55	31.98	4.21
LM	Male	40	27.10	4.65
	Female	59	25.02	2.53

Table 7 compares the mean achievement scores of male and female students taught basic science using peer-led, inquiry-based, and lecture instructional strategies. The table indicates that the male students taught using peer-led instructional strategy had a mean score of 35.80 with a standard deviation of 4.63, while their female counterparts had a mean score of 33.70 with a standard deviation of 4.80. For the inquiry-based instructional strategy group, the male students had a mean score of 35.20 with a standard deviation of 4.69, while their female counterparts had a mean score of 31.98 with a standard deviation of 4.21. On the other hand, male students taught with the lecture method had a mean score of 27.10 with a standard deviation of 4.65, while their female counterparts had a mean score of 25.02 with a standard deviation of 2.53. These indicate that there are differences in the mean achievement scores of male and female students taught basic science using peer-led, inquiry-based, and lecture instructional strategies. Hypothesis three was therefore tested to determine if the differences were significant.

Hypothesis 3: There is no significant difference in the mean achievement scores of male and female students taught basic science using peer-led, inquiry-based, and lecture instructional strategies.

Table 8: Analysis of Covariance (ANCOVA) conducted to determine the mean achievement scores of male and female students taught basic science using peer-led, inquiry-based, and lecture instructional strategies

Dependent Variable: Post-test						
Source		**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Intercept	Hypothesis	7336.741	1	7336.741	205.883	.001
	Error	106.722	2.995	35.636[a]		
Pre-test	Hypothesis	680.856	1	680.856	43.222	.000
	Error	4489.477	285	15.753[b]		
Group	Hypothesis	4311.725	2	2155.863	127.426	.008
	Error	33.779	1.997	16.919[c]		
Gender	Hypothesis	469.895	1	469.895	27.775	.034
	Error	33.810	1.998	16.918[d]		
Group * Gender	Hypothesis	33.835	2	16.917	1.074	.343
	Error	4489.477	285	15.753[b]		

Table 8 shows an ANCOVA statistic conducted to determine the effects of peer-led, inquiry-based, and lecture instructional strategies on male and female students' mean achievement scores in basic science. The table showed that the calculated F-value is 1.074 and its p-value is 0.343. Since the p-value of 0.343 is greater than the 0.05 level of significance, **F(2, 285) = 1.074, p = 0.343,** the null hypothesis, which states that there is no significant difference in the mean achievement scores of male and female students taught basic science using peer-led, inquiry-based, and lecture instructional strategies, is not rejected. Therefore, there is no significant difference in the mean achievement scores of male and female students taught basic science using peer-led, inquiry-based, and lecture instructional strategies.

Research Question 4: What is the interaction effect of teaching strategies and gender on students' achievement in basic science?

Table 9: Descriptive statistics of mean and standard deviation showing the effect of the interaction of method and sex on basic science students' achievement

Methods	**Gender**	**N**	$\bar{X}$	**SD**
PLIS	Male	44	35.79	4.63
	Female	53	36.09	5.31
IBIS	Male	41	35.19	4.69
	Female	55	34.91	6.28
LM	Male	40	27.10	4.46
	Female	59	27.12	4.61

Table 9 presents the mean achievement scores and standard deviations of basic science students based on the interaction of teaching method (peer-led, inquiry-based, and lecture instructional strategies) and gender (male and female). The result showed that male students taught with a peer-led instructional strategy had a mean achievement score of 35.79 with a standard deviation of 4.63, while the female students taught with a peer-led instructional strategy had a mean score of 36.09 with a standard deviation of 5.31. The male students taught with an inquiry-based instructional strategy had a mean achievement score of 35.19 with a standard deviation of 4.69, while the female students taught with an inquiry-based instructional strategy had a mean score of 34.91 with a standard deviation of 6.28. The male students taught with the lecture method had a mean achievement score of 27.10 with a standard deviation of 4.46, while the female students taught with the lecture method had a mean achievement score of 27.12 with a standard deviation of 4.61. From the mean scores, it can be seen that female students taught with a peer-led instructional strategy had a slightly higher mean score than their male counterparts. The male students taught with inquiry-based instructional strategy had a higher mean score than their female counterparts, while the female students taught with the lecture method had a higher mean score. This shows that there is an interaction effect.

To determine if the interaction effect is significant, ANCOVA statistics were used to test Hypothesis four.

Hypothesis 4: There is no significant interaction effect of teaching strategies and gender on students' achievement in basic science.

Table 10: Analysis of Covariance (ANCOVA) statistics showing the interaction effect of method and gender on basic science students' achievement

Dependent Variable: Post-Test					
Source	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Corrected Model	5556.259[a]	6	926.043	58.787	.000
Intercept	7336.741	1	7336.741	465.749	.000
Pretest	680.856	1	680.856	43.222	.000
Group	4311.725	2	2155.863	136.858	.000
Gender	469.895	1	469.895	29.830	.000
Methods * Gender	33.835	2	16.917	1.074	.343
Error	4489.477	285	15.753		
Total	295077.000	292			
Corrected Total	10045.736	291			
a. R Squared = .553 (Adjusted R Squared = .544)					

Table 10 shows the result of the Analysis of Covariance (ANCOVA) conducted to show the interaction effect of method and gender on basic science students' achievement. The table indicates that the calculated F-value is 1.074 and its p-value is 0.343. Since the p-value of 0.343 is greater than the 0.05 level of significance, **F = 1.074, p = 0.343**, the null hypothesis, which states that there is no significant interaction effect of teaching strategies and gender on students' achievement in basic science, is not rejected.

Research Question 5: What is the interaction effect of teaching strategies and Gender on students' retention in basic science?

Table 11: Descriptive statistics of mean and standard deviation showing the effect of the interaction of method and sex on basic science students' retention

Dependent Variable: Delayed Posttest				
Method	**Gender**	**N**	$\bar{X}$	**SD**
PLIS	Male	44	28.97	7.78
	Female	53	26.33	7.03
IBIS	Male	41	28.58	5.55
	Female	55	28.16	5.59
LM	Male	40	18.45	6.81
	Female	59	18.49	6.67

Table 11 presents mean retention scores based on the interaction between teaching strategy (peer-led, inquiry-based, and lecture instructional strategies) and sex (male,

female). The result from the Table shows that the male basic science students taught with a peer-led instructional strategy had a higher mean retention score of 28.97 with a standard deviation of 7.78. The male basic science students taught with an inquiry-based instructional strategy had a higher mean retention score of 28.58 with a standard deviation of 5.55, while the female basic science students taught with the lecture method had a higher mean retention score of 18.49 with a standard deviation of 6.81. This shows that there is an interaction effect. To determine if the interaction effect is significant, Hypothesis 5 was tested.

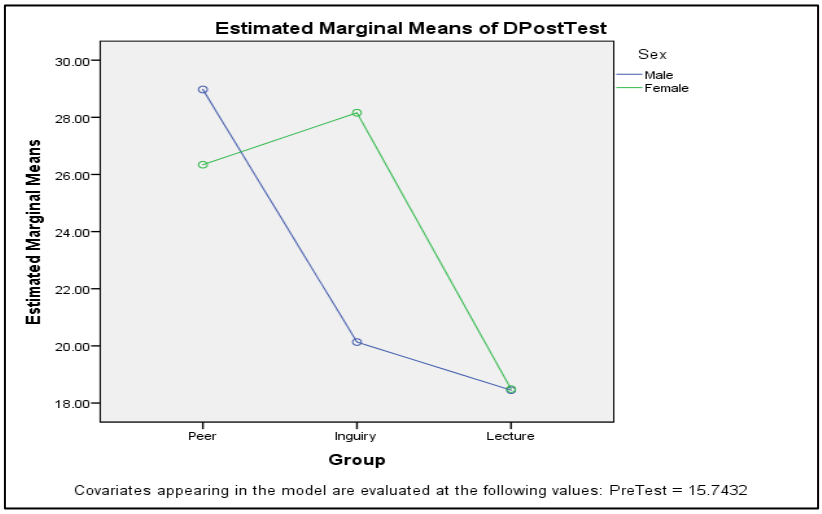
Hypothesis 5: There is no significant interaction effect of teaching strategies and gender on students' retention in basic science.

Table 12: Analysis of Covariance (ANCOVA) statistics showing the interaction effect of method and gender on basic science students' retention

Dependent Variable: Delayed Post-Test					
Source	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Corrected Model	5912.407[a]	6	985.401	23.031	.000
Intercept	6664.296	1	6664.296	155.758	.000
Pretest	1.328	1	1.328	.031	.860
Group	4113.382	2	2056.691	48.069	.000
Gender	233.698	1	233.698	5.462	.020
Method * Gender	1452.888	2	726.444	16.978	.000
Error	12194.099	285	42.786		
Total	179928.000	292			
Corrected Total	18106.507	291			
a. R Squared = .327 (Adjusted R Squared = .312)					

Table 12 shows the result of the Analysis of Covariance (ANCOVA) conducted to show whether teaching method, sex, and their interaction significantly influenced students' retention of basic science concepts. The table indicates that the calculated F-value is 16.978, and its p-value is 0.001. Since the p-value of 0.001 is less than the critical Sig. value of 0.05, **F = 16.978, p < .001,** the null hypothesis, which states that there is no significant interaction effect of method and sex on basic science students' retention, is rejected. Therefore, there is a significant interaction effect between teaching method and gender on retention. This also means that the retention pattern of males and females differs across methods. Furthermore, the Table indicates that the interaction between teaching methods and sex on students' retention is disordinal.

Figure 1: Plot of interaction between teaching methods and sex on Students' Basic Science Retention



5. Discussion of Findings

The first finding of the study showed a significant difference among peer-led, inquiry-based, and lecture instruction strategies on basic science students' achievement. However, Scheffe's post-hoc test showed that the peer-led instructional strategy yielded significantly higher achievement scores in basic science, followed by the inquiry-based instructional strategy and then the lecture method. This may be predicated on the fact that active learning strategies (peer-led and inquiry-based) were more effective than the conventional lecture method in improving students' achievement. The peer-led instructional strategy is more effective because it offers students the opportunity to carry out a variety of hands-on activities in the course of learning, with constant interaction amongst students with the teacher as a facilitator. This finding is consistent with constructivist learning theory, which emphasizes student engagement, collaboration, and discovery as key drivers of meaningful learning. The finding of superiority of peer-led instructional strategy and inquiry-based instructional strategy over the lecture method aligns with findings of other studies in literature such as Joseph, Joel and Elbert (2015), Jonas, Bernedeth, Nkiruka, Ome, Adole and Panden (2020) and Irfan, Rabia and Muhammad (2018) who reported that peer-led instructional strategy was significantly better than the lecture method in achievement of science subjects and the development of scientific thinking; Kessy and Irénée (2021) and Azowenunebi, Adeyemo and Babajide (2019) who reported statistically significant difference between the mean scores of those taught using inquiry-based instructional strategy and those taught using the lecture in favour of inquiry-based instructional strategy.

The Second finding of the study showed a significant difference among peer-led, inquiry-based, and lecture instruction strategies on basic science students' retention. The findings of the study show that students taught using peer-led instructional strategy had the highest retention scores, followed by students taught using inquiry-based

instructional strategy, while the students taught using the lecture method had significantly the lowest retention scores. The results suggest that active learning strategies (peer-led and inquiry-based) are more effective than the lecture method in promoting long-term retention of basic science concepts. The non-significant effect of the immediate posttest covariate implies that high achievement immediately after instruction does not guarantee strong retention; how students interact with content during learning is more important for sustaining knowledge over time. These findings align with constructivist learning theories, which emphasize that engagement, collaboration, and inquiry foster deeper understanding and retention. This finding agrees with those of Essien (2016), who reported a significant difference in the retention scores of students using the peer-led instructional strategy and the lecture method, in favour of the peer-led instructional strategy. Furthermore, the finding aligns with that of Emmanuel, Olodu, Omebe, Egbe, and Elom (2024), Dauda (2020), and Oluwaseyi (2022), who reported a significant difference in students' retention ability in favour of the group taught using an inquiry-based instructional strategy.

The third finding of the study showed that there is no significant difference in the mean achievement scores of male and female students taught basic science using peer-led, inquiry-based, and lecture instructional strategies. This indicates that the male and female students taught using peer-led instructional strategy, inquiry-based instructional strategy, and lecture method benefited equally from the teaching-learning process. The explanation for this finding is predicated on the level of involvement of both sexes. Both male and female students in the three groups were actively involved during the teaching and learning processes. This finding for the peer-led instructional strategy group agrees with those of Juweto (2018), Yusuf, Hamdallat, and Adesegun (2017), and Okeya (2022), who reported that sex does not have any influence on students' academic achievement in basic science. The findings for the inquiry-based instructional strategy group also corroborate those of Kessy and Irénée (2021) and Azowenunebi, Adeyemo, and Babajide (2019), who reported no significant difference in the academic achievement scores of male and female students in science subjects.

The fourth finding of the study showed that there was no significant interaction effect of method and sex on basic science students' achievement. In other words, students' achievement in basic science when taught using peer-led instructional strategy, inquiry-based instructional strategy, and lecture method is not dependent on students' sex. This indicates that the combined effects of method and sex did not influence basic science students' achievement scores. Rather, the variables (methods and sex) acted independently in affecting basic science students' achievement scores. This finding is in line with the findings of Adeyemi (2012), Ezedinma and Nwosu (2018), Okotcha (2018), and Ovuworie and Ajaja (2024), who in their different studies found no significant interaction effect between teaching method and sex on students' achievement.

Finally, the fifth finding of the study showed that there was a significant interaction effect of method and sex on basic science students' retention. This means that

the retention outcomes for male and female students varied depending on the teaching method used. Under a peer-led instructional strategy, males retained more than females, under an inquiry-based instructional strategy, males and females had nearly equal retention, while under a lecture method, both sexes performed similarly poorly. This significant interaction implies that certain teaching strategies favour one sex more than the other in terms of long-term memory. The presence of a significant interaction disagrees with the earlier study of Ajaja (2013), which found no combined effect of method and sex on retention.

6. Conclusion

In conclusion, this study established that the peer-led and inquiry-based instructional strategies are more effective in enhancing basic science students' achievement and retention than the lecture method. Learner-centred approaches such as peer-led and inquiry-based instructional strategies provide superior learning outcomes compared to the conventional lecture method. Furthermore, the peer-led and inquiry-based instructional strategies are not sex-biased regarding enhancing basic science students' achievement. Finally, while the methods do not interact with sex to influence basic science students' achievement, sex interacted with methods to influence retention.

6.1 Recommendations

Arising from the findings, the following recommendations were made:

1) Basic science teachers should adopt the use of the peer-led instructional strategy in teaching basic science in Junior Senior Secondary Schools.
2) Basic science teachers should adopt the use of an inquiry-based instructional strategy as an alternative strategy when the use of a peer-led instructional strategy is not possible in teaching basic science in Junior Secondary Schools. This is because using the peer-led and inquiry-based instructional strategies, students were actively participating in the teaching and learning process. This also led to their scoring higher marks compared to their counterparts in the lecture method group.
3) The government and educational administrators should organize seminars and workshops through the Ministry of Education to train teachers on how to use the peer-led and inquiry-based instructional strategy to teach, as well as furnish schools with relevant educational resources to facilitate the implementation of the Peer-led instructional strategy

Conflict of Interest Statement

The authors declare that there are no conflicts of interest regarding the publication of the study titled "Comparative Effectiveness of Peer-Led, Inquiry-Based, and Lecture Instructional Strategies on Basic Science Students' Achievement and Retention in Delta Central Senatorial District."

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References

Ademola, O. O., & Nadaraj, G. (2018). Effectiveness of polya problem-solving and target-task collaborative learning approaches in electricity amongst high school physics students. *Journal of Baltic Science Education, 17(5)*, 765-777. https://doi.org/10.33225/jbse/18.17.765

Adeyemi, A. B. (2012). Effects of computer-aided instruction (CAI) on students' achievement in social studies in Osun State, Nigeria. *Journal of Social Sciences*, 3(2), 269-277. https://doi.org/10.5901/mjss.2012.v3n2.269

Agboola, O. S., & Abe, O. J. (2017). Effects of inquiry-based and field-trip instructional strategies on pupils' learning outcomes in basic science in Ado-Ekiti, Ekiti State, Nigeria. *Journal of Education and Practice 8(29*), 143-151. Retrieved from https://www.iiste.org/Journals/index.php/JEP/article/view/39266/40374

Ajaja, O. P. (2009). *Teaching methods across disciplines*. Ibadan, Bomn Prints.

Ajaja, P. (2013). Which strategy best suits biology teaching? Lecturing, Concept mapping, Cooperative learning, or Learning cycle? *Electronic Journal of Science Education. 17(1*): 1-37. Retrieved from https://files.eric.ed.gov/fulltext/EJ1188391.pdf

Al-Hebaishi, S. M. (2017). The effect of the peer instruction method on pre-service teachers' conceptual comprehension of the methodology course. *Journal of Education and Learning*, 6(3), 70-82. https://doi.org/10.5539/jel.v6n3p70

Azowenunebi, L. O., Adeyemo, S. O. & Babajide, V. F. T. (2019). Effect of inquiry instructional strategy on students' academic achievement in physics in senior secondary schools in Education District II in Lagos State. *Education & Science Journal of Policy Review and Curriculum Development, 9(2), 50-62.* Retrieved from https://internationalpolicybrief.org/wp-content/uploads/2023/10/ARTICLE5-91.pdf

Dauda, M., (2020). Effects of reflective inquiry teaching method on students' retention ability in domestic installation module in technical colleges of Yobe State, Nigeria. *International Journal of Social Sciences & Educational Studies,* 7(3), 52-62. https://doi.org/10.23918/ijsses.v7i3p52

Digest, E. (2002). Peer Helping Relationships in Urban Schools. Retrieved from http://www.ericdigest.org/ericdigests.htm

Effiom, W. A. & Abdullahi, A. (2021). Effect of polya's problem-solving strategy on senior secondary school students' performance in algebraic word problems in Katsina Metropolis, Katsina State, Nigeria. *Sapientia Foundation Journal of Education, Sciences and Gender Studies 3(2),* 344-351. Retrieved from https://sfjesgs.com/index.php/SFJESGS/article/view/196

Emmanuel, E. O. & John, N. N. (2020). Effects of two peer instructional strategies on secondary school students' achievement in science. *American Journal of Educational Research, 8(2), 80-89.* Retrieved from https://pubs.sciepub.com/education/8/2/3/index.html

Emmanuel, O., Olodu, G., Omebe, C. A., Egbe, I., & Elom, I. (2024). Effects of guided inquiry instructional strategy on students' achievement and retention in basic science in secondary schools. *Journal of Nigeria Association of Mathematical Physics (JNAMP*), 66(3), 85-98. https://doi.org/10.60787/jnamp-v66-312

Eskay, M., Onu, V.C., Obiyo, N., Obidoa, M., (2012). Use of peer tutoring, co-operative learning, and collaborative learning: Implications for reducing anti-social behavior

of schooling adolescents, *US-China Education Review*, A (11), 932-944, 2012. Retrieved from https://files.eric.ed.gov/fulltext/ED538819.pdf

Essien, E. U. F. (2016). Effect of Peer Tutoring on Students' Academic Performance and Retention in Junior Secondary School Basic Science. *International Journal of Educational Benchmark* (IJEB), 3(1), 91-100.

Ezedinma, F. O. & Nwosu, A. (2018). Effects of the steps achievement in Basic Science. *Journal of the Department of Science Education, University of Nigeria, Nsukka*, 4(1), 54-68. Retrieved from https://www.ajstme.com.ng/admin/img/paper/178-186%20Ezedinma%20&%20Nwosu.pdf

Federal Republic of Nigeria (FRN). (2013). *National policy on education*. Lagos: NERDC Press.

Furtak, E. M. (2006). The problem with answers: An exploration of guided scientific inquiry teaching. *Journal of Science Education*, 90(3), 454-467. https://doi.org/10.1002/sce.20130

Irfan, U., Rabia, T. & Muhammad, K. (2018). Effects of Peer Tutoring on the Academic Achievement of Students in the Subject of Biology at the Secondary Level. *Journal of Education Science*, 8(112), 1-11. https://doi.org/10.3390/educsci8030112

Jonas, N. O., Bernedeth, N. E., Nkiruka, C. A., Ome, S. O., Adole, A. E., & Panden, P. E. (2020). Teachers' Perception of Girl-Child Involvement in Universal Basic Education (UBE) In Ado Local Government Area, Benue State. *International Journal of Studies in Education* (IJSE), 16 (1), 98-112. https://doi.org/10.3390/educsci8030112

Joseph, B. C., Joel, C., Elbert, G. (2015). The effect of peer tutoring on the achievement of students in discrete structures. *Asia Pacific Journal of Multidisciplinary Research*, 3(5), 8-12. Retrieved from https://www.researchgate.net/publication/337000254_The_Effect_of_Peer_Tutoring_on_Achievement_of_Students_in_Discrete_Structures

Juweto, G. A. (2018). Effects of jigsaw co-operative teaching/learning strategy and school location on students' achievement and attitude towards biology in secondary school in Delta State. *International Journal of Education and Research*, 3(8), 31-40. Retrieved from https://www.ijern.com/journal/2015/August-2015/04.pdf

Kessy, S. M., & Irénée, N., (2021). Effects of inquiry-based teaching on students' academic achievement in biology in lower secondary schools in Ilala –Dar es Salaam – Tanzania. *A Journal of Contemporary Research, 18 (4)*: 2-14. Retrieved from https://www.ajol.info/index.php/lwati/article/view/219671

Nikos A. (2017). Make your eLearning stick: 8 Tips & Techniques for Learning Retention. Retrieved 12/11/2025 from https://www.talentlms.com/blog/8-tips-techniques-learning-retention/.

Nwanze, A. C. (2016). Effect of multimedia synchronized instructional strategy on students' achievement and retention in secondary school chemistry in Onitsha education zone. Unpublished M.Ed. Dissertation Submitted to the Department of Science Education, Nnamdi Azikiwe University, Awka. Retrieved from

https://scholar.google.com/citations?view_op=view_citation&hl=en&user=m9jxfXkAAAAJ&citation_for_view=m9jxfXkAAAAJ:Y0pCki6q_DkC

Okeya, A. E. (2022). Effect of peer-led team learning approach on students' academic performance in basic science in Ekiti State Secondary Schools. *Commonwealth Journal of Academic Research, (CJAR.EU),* 6(3). Retrieved from https://www.cjar.eu/wp-content/uploads/2022/06/3.6-2022-1-Effect-of-Peer-Led-Team-Learning-Approach-On-Students%E2%80%99-Academic-Performance-in-Basic-Science-in-Ekiti-State-Secondary-Schools.pdf

Okotcha, E. N. (2018). Effects of a constructivist-based instructional model on students' conceptual change in Chemistry. *Journal of the Department of Science Education, University of Nigeria, Nsukka. 4(1).* Retrieved from https://www.ajstme.com.ng/admin/img/paper/170-177%20Okotcha.pdf

Olorode, J. J., & Jimoh, A. G. (2016). Effectiveness of guided discovery learning strategy and gender sensitivity on students' achievement in financial accounting in the College of Education. *Int. J. Acad. Rev., 4*(6), 182-189. Retrieved from https://academicresearchjournals.org/IJARER/Abstract/2016/December/OLORODE%20AND%20JIMOH.htm

Oluwaseyi, O. E. (2022). Relative effectiveness of guided inquiry and collaborative learning instructional strategies on students' performance and retention ability of physics students in Akoko Southwest Local Government Area, Ondo State, Nigeria. *Aquademia,* 6(2), 24-39. Retrieved from https://www.aquademia-journal.com/article/relative-effectiveness-of-guided-inquiry-and-collaborative-learning-instructional-strategies-on-12378

Ovuworie, O. O., & Ajaja, O. P. (2024). Effects of polya's problem-solving instructional strategy on physics students' academic achievement and retention in Delta State, Nigeria. *Rivers State University Journal of Education* (RSUJOE), 27(1). 35-44. Retrieved from https://www.rsujoe.com.ng/index.php/joe/article/view/196

Ovuworie, O. O., (2024). Comparative Effects of Observation Instructional Strategy and Lecture Method on Physics Students' Achievement in Senior Secondary Schools in Delta State. *DELSU Journal of Educational Research and Development (DJERD*), 22(1), 456-466. https://doi.org/10.61448/djerd22141

Umar, B. K., Ossom, M. O., & Egbita, A. U. (2020). Impact of multimedia instructional strategies on students' achievement and retention in basic science and technology in Minna, Niger State. *International Journal of Research and Scientific Innovation* 7(6), 150-155. Retrieved from https://ideas.repec.org/a/bjc/journl/v7y2020i6p150-155.html

Yusuf, A. Hamdallat, T. Y. & Adesegun, O. O. (2017). Effect of Peer Tutoring on Students' Academic Performance in Economics in Ilorin South, Nigeria. *Journal of Peer Learning*, 10 (1), 95-102. Retrieved from https://files.eric.ed.gov/fulltext/EJ1147960.pdf