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Comparative Effects of Problem-Based Learning, Blended Learning and Demonstrative-Lecture Instructional Strategies on Basic Science Students' Achievement in Delta State

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Abstract

This study compared the effects of problem-based learning, blended learning, and demonstrative-lecture instructional strategies on Delta State students' achievement in basic science. Five research questions and five hypotheses were developed and tested at the 0.05 level of significance. The study used a quasi-experimental approach with a 3x2 factorial design with non-equivalent pre- and post-tests. 77,293 Junior Secondary School II (JSS II) students from Delta State's 485 public secondary schools for the 2023/2024 academic session made up the study's population. A sample of 419 JSS II pupils was selected from Delta State's twenty-four secondary schools. The study's sample was chosen through a multi-stage sampling process. The Basic Science Achievement Test (BSAT) was the two tools utilised to gather data. The reliability index of 0.77 was obtained by applying the Kuder-Richardson formula 21 (KR-21) to calculate the reliability of the BSAT. The BSAT was used to administer a pre-test and post-test to the students in order to gather data for the study. Means, standard deviations, t-tests, and Analysis of Covariance (ANCOVA) were used to analyse the data. The following are some of the study's conclusions: there was a significant difference in the mean achievement scores among basic science students taught with problem-based learning, blended learning, and demonstrative-lecture instructional strategies, there was no significant difference between the mean achievement scores of males and females students taught Basic Science using problem-based learning instructional strategy; blended learning and demonstrative-lecture instructional strategy; there was no significant interaction effect between instructional strategies and sex on students' academic achievement in Basic Science; According to the results, blended learning and problem-based learning are more effective than the demonstrative-lecture method at raising students' academic achievement. Consequently, it was suggested that basic science teachers intentionally try to integrate blended learning as an instructional method into their lessons, among other things.

Keywords: Achievement, Blended Learning, Problem-Based Learning, Demonstrative-Lecture Instructional Strategies, Sex

Introduction

Basic Science is the first form of science that students come across at the junior secondary school level. It is a science subject that prepares learners at the basic educational level for the study of core science subjects like Physics, Chemistry, and Biology. Basic Science is essential across all branches of science, applied science, and social sciences, playing a crucial role in various aspects of the secondary school curriculum. Its content demonstrates how science functions in everyday life and enhances students' understanding of the world around them. It also enables students to see how science affects their life and the world around them. Therefore, students have to be well grounded in Basic Science at the junior secondary school known as upper basic school. While underlining the relevance of Basic Science, Basic Science enables students to grasp science concepts, principles, theories, and laws that are further expanded in the core sciences. Basic science education, according to Jirgba (2008) [5], exposes students to scientific activities.

Thus, Basic Science is a subject that entails the presentation of scientific ideas as a unified whole. Basic Science is taught in junior secondary schools in Nigeria in order to lay the foundation for future scientific and technological progress. Basic Science is taught in junior secondary schools to keep up with this pace and to capture the hearts of the students while they are

still young. Basic Science is given great emphasis in the junior secondary school curriculum. The objectives of Basic Science teaching in Nigeria's secondary schools are to: "provide students at the junior secondary school level a sound basis for continuing science education, enhance the scientific literacy of the citizenry; allow students to understand their environment in its totality rather than in fragments; allow the students to have a general view of the world of science" (Federal Ministry of Education, 2013) [7]. Furthermore, Basic Science is taught at the junior secondary school level of education to allow students to expand on and concretize their science knowledge gained in lower basic level and to create the ground for the study of core science subject.

Over time, Basic Science education has transitioned from traditional lecture knowledge transmission to discovery-based learning and, more recently, to constructivist approaches. The traditional lecture transmission model positions teachers as the primary sources of knowledge, with students assuming passive roles in the learning process. This method often involves expository teaching, where educators directly present scientific concepts to students, who are viewed as passive recipients of information. However, the limitations of this strategy have led educational researchers to seek alternative teaching strategies that could be used to enhance students learning (Omosor *et al*., 2024) [28].

In contemporary science education, constructivism based instructional strategies have been seen by many researchers to be alternative to the traditional lecture instructional strategies. According to constructivist theory, learning occurs as individuals' construct meaning from their experiences rather than passively receiving information. This perspective has led to the development of various instructional strategies aimed at enhancing science education. Nwamaradi *et al*. (2024) [26] stated that employing constructivist instructional strategies could significantly improve critical thinking skills among secondary school students. Similarly, Akinbobola and Afolabi (2010) [12] asserted instructional strategies rooted in constructivist principles have the tendency of impacting students' achievement positively. Examples of instructional strategies that are rooted in the principles of constructivism and that are of interest to the researcher in this study are problem-based learning, blended learning, and demonstrative-lecture instructional strategies.

Problem-Based Learning (PBL) is a pedagogical approach that involves students actively engaging in the learning process by trying to solve real-world problems. According to Thearath (2023) problem-based learning focuses on real and solvable problems that have relevance and practical application. Problem -based learning also encourages active participation from students. So that instead of passively receiving information, students are encouraged to ask questions, explore different options, and collaborate with their peers. Problem-based learning (PBL) empowers students to take charge of their learning process by granting them freedom to explore various options, gather relevant information, and make informed decisions (Mansor, *et al.,* 2015) [23].

Problem-based instructional strategy (PBTS) is one of the student-centred teaching methods and it begins with the assumption that learning involves an active, integrated, and constructed process. This teaching strategy requires active student participation and collaboration within groups, enabling individuals to construct knowledge and develop skills (Eze, & Osuyi, 2018) [6]. That is, students must learn to be conscious of what information they already know about the problem, what information they need to know to solve the problem and the strategies to use to solve the problem. This process of learning will create in the students' the skills that would make them to become problem-solvers and to learn independently.

Blended learning instructional method refers to a pedagogical approach that combines traditional lecture face-to-face instruction with online learning activities and resources (Ijeh, 2022) [18]. In a blended learning model, students engage in a mix of in-person classroom instruction, virtual learning experiences, and independent study, allowing for greater flexibility, personalization, and interactivity in the learning process. Blended learning typically involves a combination of various instructional modalities, such as face-to-face instruction, online learning, Utilization of digital platforms, learning management systems (LMS), and online resources to deliver course content, assignments, quizzes, and multimedia materials (Omosor *et al.,* 2024) [28].

Online components may include recorded lectures, interactive simulations, digital textbooks, and discussion forums. This gives students' opportunity to engage in self-paced learning activities, research projects, and collaborative group work outside of the classroom. Independent study allows students to explore topics of interest, review course materials, and practice skills at their own pace. The integration of face-to-face instruction and online learning in a blended learning model offers several benefits for both students and educators. For students, blended learning provides greater flexibility in terms of when, where, and how they engage with course materials, allowing for personalized learning experiences tailored to individual learning styles and preferences (Abdulrahaman, *et al*., 2020) [2]. Blended learning also promotes active engagement and participation through the use of interactive multimedia resources, collaborative online activities, and real-world applications of knowledge.

Recent research on blended learning has demonstrated its effectiveness in improving student outcomes, engagement, and satisfaction across various educational settings and subject areas (Freeman *et al*., 2019; Means *et al*., 2019 [25]). Studies have shown that blended learning models can lead to higher levels of student achievement, greater retention rates, and increased motivation and confidence in learning (O'Byrne & Pytash, 2019; Watson *et al*., 2020) [27, 34]. Additionally, blended learning has been found to promote the development of essential 21st-century skills, such as digital literacy, critical thinking, and collaboration, preparing students for success in an increasingly digital and interconnected world.

The rationale for including blended learning instructional method in this study stems from the revealed of some authors (Dziuban, *et al*., 2018; Tong, Uyen, & Ngan, 2022) [15, 31] for a shift from teacher-centred instructional strategies such as the lecture method to a student-centred instructional strategy in the teaching of sciences. This is due to drawbacks of the teacher-centred instructional strategies ranging from students' inability to control their learning pace to limited active participation in classroom activities. These drawbacks can hinder effective learning among students when it comes to learning science (Tong, *et al*,

2022) [31]. Hence the need for student-centred instructional strategy like blended learning instructional strategy.

The demonstrative-lecture Instructional strategy is an approach in which the teacher delivers a lecture to students in the classroom and demonstrates the concept using visual aids such as real objects, diagrams, charts, and models. In the demonstrative-lecture instructional strategy classroom, the instructor first of all provides an overview of the topic to be taught to the students. The overview may include key definitions, objectives, and the importance of the topic (Stroud, 2013). The instructor then delivers a lecture portion, explaining the main concepts and procedures verbally while simultaneously demonstrating how to perform a task. According to Kim *et al*. (2019) [22], demonstrative-lectures strategy increases student engagement and motivation by creating interactive learning experiences. The interactive nature of demonstration-lecture strategy also stimulates curiosity, making lessons more engaging and increasing students' intrinsic motivation to learn. The demonstrative-lecture instructional strategy allows teachers to engage students with diverse learning needs and interests by verbally explaining concepts while simultaneously demonstrating tasks. Unlike pure lecture method, demonstrative-lecture strategy enhances learning by incorporating practical demonstrations, making it more engaging and effective for student understanding.

According to Karamanis *et al*. (2020) [20], supporting verbal explanations of concept with demonstrations helps clarify abstract ideas, facilitate knowledge transfer, and reinforce learning outcomes. This implies that demonstrative-lecture instructional strategy promotes active learning and participation among students with the tendency of enhancing learning outcome. Zhang *et al*. (2021) [38] revealed that demonstrative-lecture Instructional strategy when effectively implemented in the classroom could promote interaction and encourage active participation leading to deeper learning and higher academic achievement and interest. Unlike traditional lectures where students passively receive information, demonstrative-lecture Instructional strategy give students opportunity to observe, ask questions, and discuss outcomes, making learning an active process (Karamanis *et al*. 2020) [20].

Academic achievement refers to knowledge and understanding acquired through formal education. It is a measure of a student's proficiency in various subjects and their ability to apply that knowledge effectively. Achievement was described by Illahi and Khandai (2015) as the result of a classroom learning experience. The success of the students is one of the most crucial outcomes of any educational institution. Student achievement is often used as a benchmark to assess the quality of schools and educators. Based on their achievement in a particular subject, students are generally categorized as high achievers, average achievers, or low achievers.

Achievement holds the utmost significance as it serves as a key indicator of progress, competence, and success in various aspects of life, particularly in education. Academic achievement not only reflects a student's understanding and mastery of subject matter but also influences future opportunities, including career prospects and personal development (Duku *et al*., 2024). It has been found that a large range of factors, including learner characteristics, the organisational environment of the school, curriculum development, the teaching-learning setup, factors emerging from home, and teaching methods employed by teachers, all have varying degrees of influence on students' achievement.

These instructional strategies (problem-based learning, blended learning, and demonstrative-lecture instructional strategies) are currently recognised as being very effective for teaching and learning science. Thus, their effectiveness will be determined in this study with the goal of recommending the most effective one for use in basic science instruction. According to the Federal Government of Nigeria's National Policy on Education (2018) [8], innovative instructional strategies are highly needed at all levels of education for students irrespective of sex. However, it appears most teachers are unaware of the benefits of Problem-based learning, blended learning and demonstrative-lecture instructional strategies. As a result, most schools are not effectively teaching students to become aware of their own learning and derive their own patterns of thought and meaning from content presented through interaction (Borich, 2007; Ajaja, 2014) [13, 11]. This study was carried out in an attempt to fill in the existing knowledge gap on the differential effect of Problem-based learning, blended learning and demonstrative-lecture instructional strategies on students' achievement in Basic Science in Delta State, and also to determine whether the effects vary in the bases of sex. Hence this study find out if the Problem-based learning, blended learning and demonstrative-lecture instructional strategies contribute to variation in achievement of male and female students in basic science.

Statement of the Problem

There is a growing concern regarding the instructional strategies employed in secondary schools to address the declining trend in students' achievement in basic science. From the researcher's personal observations, it appears that basic science teachers predominantly rely on traditional lecture methods rather than innovative approaches that foster active student participation. This reliance on traditional lecture methods may be a significant factor contributing to students' low achievement in basic science. Parents, educators, and students alike expressed a shared aspiration for improved academic performance in subsequent examinations.

However, the problem-based learning, blended learning and demonstrative-lecture instructional strategies have been used as an effective strategy in enhancing students' achievement both in other subjects and outside Nigeria, and it has been reported to have produced the desired effective teaching in secondary schools such that students' achievement improve. There is insufficient evidence to determine whether problem-based learning, blended learning, and the demonstrative-lecture instructional strategies can enhance students' academic achievement in basic science among secondary school students in Delta State. Hence, the problem of this study is therefore to compare the effects of problem-based learning, blended learning and demonstrative-lecture instructional strategies on Basic science students' achievement in Delta State and also ascertained if their effect is sex (male and female) dependent.

Research Questions

The following research questions were answered in the study:

1. What is the difference in mean achievement score among Basic Science students taught with problem-based learning, blended learning and demonstrative-lecture instructional strategies?
2. What is the difference between the mean achievement scores of male and female students taught of Basic Science students using problem-based learning instructional strategy?
3. What is the difference between the mean achievement scores of male and female students taught Basic Science using blended learning instructional strategy?
4. What is the difference between the mean achievement scores of male and female students taught Basic Science using demonstrative-lecture instructional strategy?
5. What is the interactive effect of problem-based learning, blended learning and demonstrative-lecture instructional strategies and sex on students' academic achievement in basic science?

Hypotheses

The following hypotheses were formulated and tested at 0.05 level of significance

1. There is no significant difference in the mean achievement scores among basic science students taught with problem-based learning, blended learning, and demonstrative-lecture instructional strategies.
2. There is no significant difference between the mean achievement scores of male and female students taught Basic Science using problem-based learning instructional strategy.
3. There is no significant difference between the mean achievement scores of male and female students taught Basic Science using blended learning instructional strategy.
4. There is no significant difference between the mean achievement scores of male and female students taught Basic Science using demonstrative-lecture instructional strategy.
5. There is no interactive effect of problem-based learning, blended learning, and demonstrative-lecture instructional strategies and sex on students' academic achievement in basic science.

Research Methods

This study adopted a quasi-experimental research design involving non-equivalent pre-test, post-test, planned variation 3x2 factorial design. The design has instruction at three levels problem-based learning, blended learning and demonstrative-lecture instructional strategies across with sex at two levels (male and female) students. The population of this study comprises a total of 77,293 Junior Secondary School II (JSS II) students in all the 485 public secondary schools in Delta State for the 2023/2024 session (Ministry of Basic and Secondary Education, Asaba, 2023). A sample of 419 JSS2 students were drawn from twenty-four secondary schools in Delta State. Multi-stage sampling procedures was used in selecting the sample for the study.

Research Instruments

Basic Science Achievement Test (BSAT) was the instrument that was used for data collection in this study. The BSAT is divided into two parts. Part A collected student's bio-data (sex). Section B consist of 50 multiple choice test-items with option letters A-D. The multiple test items were developed from the six Basic science topics that were treated in the course of the study. The topics were: Thermal energy, Heat transfer by Conduction, Heat transfer by Convection, Heat transfer by Radiation, Light energy and Crude oil and Petrochemicals. The Basic Science Achievement Test (BSAT) will be use to collect the Pretest and post test data for the study.

To validate the Basic Science Achievement Test (BSAT) the researcher requested the assistance of three experts from Delta State University, Abraka. The experts were requested to verify the instruments, ensuring that each item is clearly worded and unambiguous. Content validity was carried out on BSAT by the use of the table of specifications Difficulty Indices and Discrimination Indices of the items that made up the BSAT were calculated using the scores from the test. The item difficulty (P) and discriminating indices (D) were calculated for 60 on the BSAT to select 50 items. The students' sheets were re-arranged from the highest to the lowest. The upper class of 27% and lower class of 27% were selected and used for the item analysis. In the calculation, Items with difficulty indices that is in the range of 0.40 to 0.70 were accepted and included in the final version of the BSAT while others below 0.40 and above 0.70 were removed as a result of being too difficult or too easy respectively. The value of difficulty index of the BSAT ranged between 0.45 and 0.69. with Item number 43 having the largest value (0.69) and item number 30 having the smallest value (0.40). The item discrimination index (D) ranged from 0.25 to 1.00 and this formed the criterion for retaining or rejecting in the final test. Thus, items in the BSAT have discrimination index (D) of which ranges from 0.41 to 0.76. The researcher administered the Basic Science Achievement Test (BSAT) to 50 JSS II students from two secondary school in the Benin city Edo state using the internal consistency reliability method. The instrument's reliability was calculated using data gathered from the administered test. The reliability index was calculated using the Kuder-Richardson formula -21 and reliability coefficient of 0.77was obtained for the BSAT.

Before beginning treatment, the Basic Science teachers who participated as research assistants in the study were trained on the use of problem-based learning, blended learning, and demonstrative-lecture instructional strategies, according to the training method described in Ajaja (2013) [10]. The training lasted for four days, with each session lasting 45 minutes. The researcher, along with two other specialists, conducted the training for the Basic Science teachers on the use of the three instructional strategies. A day before the start of the treatment, pretests utilizing the BSAT were administered to all the groups. The pretest was used to assess the students' existing knowledge on the topics covered in the test. One week prior to the start of the treatment, the lesson plans for the six weeks of instruction were provided to all the research assistants (Basic Science teachers) involved in the study. The lesson plans outlined both the teachers' and the students' activities during each class session. Teachers presented the selected topics to the students using the instructional strategies assigned to them. At the end of the six weeks of instruction, a post-test was administered to the students, using the same BSAT that had been used for the pretest. The research questions were answered using mean and standard deviations that was obtained from the pretest and post test scores. Hypotheses 1 and 5 were tested using Analysis of Variance (ANOVA).

and Analysis of covariance (ANCOVA). Scheffe post-Hoc test was used to determine the direction of significant. Difference in mean scores of the three instructional strategies. hypotheses 2-4 were tested using independent sample t-test statistics. All hypotheses were tested at 0.05 level of significant.

Results

Research Question One

What is the difference in mean achievement score among Basic Science students taught with problem-based learning, blended learning and demonstrative-lecture instructional strategies?

Table 1: The Mean(X) achievement score among Basic Science students taught with problem-based learning, blended learning and demonstrative-lecture instructional strategies

Treatment method	N	Mean	SD
Problem-based learning	139	56.21	9.09
Blended learning	133	60.88	9.27
Demonstrative-lecture instructional strategy	147	46.84	5.68
Total	419		

Table 1 depict the posttest achievement mean scores of Basic Science students taught using problem-based learning, blended learning, and the demonstrative-lecture instructional strategy were analyzed. The table reveals that students in the problem-based learning group had a posttest mean score of 56.21 with a standard deviation of 9.09. Students in the blended learning group had a mean score of 60.88 and a standard deviation of 9.27. In contrast, students in the demonstrative-lecture instructional strategy group had a mean score of 46.84 with a standard deviation of 5.68. A closer examination of the table indicates that students in the blended learning and problem-based learning groups outperformed those in the demonstrative-lecture instructional strategy group.

To find out whether the mean difference is significant, Ho_1 was tested with Analysis of variance (ANOVA) and presented in Table 2a.

Hypothesis 1: There is no significant difference in mean achievement score among Basic Science students taught with problem-based learning, blended learning and demonstrative-lecture instructional strategies.

Table 2a: ANOVA Comparison of Pretest Achievement Mean Scores of Basic Science Students

Sum of Squares	df	Mean Square	F	Sig.
10.628	2	5.314	1.688	.186
1309.449	416	3.148		
1320.076	418			

Table 2a shows that the ANOVA comparison of pretest achievement scores for students taught using problem-based learning, blended learning, and demonstrative-lecture instructional strategies was not significant ($F = 1.688$, $P \geq 0.05$). This indicates that students had similar levels of prior knowledge before the treatment.

Table 2b: ANOVA Comparison of achievement score among Basic Science students taught with problem-based learning, blended learning and demonstrative-lecture instructional strategies

	Sum of Squares	df	Mean Square	F	Sig.	Decision
Between Groups	14447.729	2	7223.864	109.440	.000	Significant
Within Groups	27459.106	416	66.007			
Total	41906.835	418				

Table 2b presents the ANOVA comparison of the mean achievement scores of students taught using problem-based learning, blended learning, and demonstrative-lecture instructional strategies. The ANOVA result indicated a statistically significant difference among the groups ($F = 109.440$, $p < 0.05$). Consequently, the null hypothesis was rejected. This implies that there is a significant difference in the mean achievement scores of Basic Science students exposed to the different instructional strategies. To determine the specific direction of these differences among the three groups, a post-hoc test was conducted, and the results are presented in Table 3.

Table 3: Scheffe Post-Hoc Test for Direction of Difference in achievement score among Basic Science students taught with problem-based learning, blended learning and demonstrative-lecture instructional strategies

(I) Treatment method	(J) Treatment method	Mean Difference (I-J)	Std. Error	Sig.
Problem-based learning	Blended learning	-4.67107*	.98548	.000
	Demonstrative-lecture instructional strategy	9.37190*	.96120	.000
Blended learning	Problem-based learning	4.67107*	.98548	.000
	Demonstrative-lecture instructional strategy	14.04296*	.97228	.000
Demonstrative-lecture instructional strategy	Problem-based learning	-9.37190*	.96120	.000
	Blended learning	-14.04296*	.97228	.000

*. The mean difference is significant at the 0.05 level.

The post hoc analysis using the Scheffe test, as shown in Table 3, to determine the direction of the observed significance indicated that: (i) Students in the blended learning and problem-based learning groups significantly outscored those in the demonstrative-lecture instructional strategy group. (ii) Students in the blended learning group significantly outscored those in both the problem-based learning and demonstrative-lecture instructional strategy groups. (iii) Students in the problem-based learning and demonstrative-lecture instructional strategy groups significantly differed from one another, with problem-based learning yielding higher achievement scores. This implies that blended learning is the most effective instructional strategy for enhancing students' achievement, followed by problem-based learning, while the demonstrative-lecture instructional strategy is the least effective in improving students' academic achievement.

Research Question Two: What is the difference between the mean achievement scores of male and female students taught Basic Science using problem-based learning instructional strategy?

Table 4: Comparison of the Post Test mean achievement scores of male and female students taught Basic Science using problem-based learning instructional strategy

Sex	N	Mean	Mean Difference	SD
Males	73	56.44	0.49	9.15
Females	66	55.95		9.09
Total	**139**			

Table 4 presents the achievement mean scores of male and female Basic Science students taught using the problem-based learning instructional strategy. The table reveals that males students recorded a mean score of 56.44 with a standard deviation of 9.15, whereas females students had a mean score of 55.95 with a standard deviation of 9.09. The mean difference between the posttest scores of males and females students was 0.49. A closer examination of the table indicates that both males and females students demonstrated significant improvement in their achievement scores after the intervention. However, the minimal mean difference suggests that the problem-based learning instructional strategy had a similar effect on both sexes. To find out whether the mean difference is significant, Ho_3 was tested with independent sample t-test and presented in Table 5.

Hypothesis Two

There is no significant difference between the mean achievement scores of male and female students taught Basic Science using problem-based learning instructional strategy.

Table 5: Independent sample t-test comparing the mean achievement scores of male and female students taught Basic Science using problem-based learning instructional strategy on posttest

Sex	N	Mean	SD	df	t-cal.	Sig. (2-tailed)	Decision
Males	73	56.44	9.15	136	.312	.755	Null hypothesis accepted
Females	66	55.95	9.09				

Table 5 is a summary of the t-test comparing the mean achievement scores of male and female students taught Basic Science using the problem-based learning instructional strategy. The table reveals that the p-value of the calculated t-value is greater than 0.05. With this result, Ho_3 was accepted. Thus, there is no significant difference between the mean achievement scores of males and females' students taught Basic Science using the problem-based learning instructional strategy.

Research Question Three: What is the difference between the mean achievement scores of male and female Basic Science students taught using blended learning instructional strategy?

Table 6: Comparison of the Post Test Mean Achievement Scores of Male and Female Basic Science Students Taught Using Blended Learning Instructional Strategy on Posttest

Sex	N	Mean	Mean difference	SD
Males	81	61.98	2.81	8.64
Females	52	59.17		10.02

Table 6 is a summary of the mean achievement scores of male and female Basic Science students taught using the blended learning instructional strategy in Delta State. The table reveals that males students (N = 81) had a mean score of 61.98 with a standard deviation of 8.64, while females students (N = 52) had a mean score of 59.17 with a standard deviation of 10.02. The mean difference between males and females students' posttest scores was 2.81, indicating that males students slightly outperformed their females counterparts. This suggests that the blended learning instructional strategy may have had a marginally more positive effect on male students' achievement in Basic Science.

Hypothesis Three

There is no significant difference between the mean achievement scores of male and female students taught Basic Science using blended learning instructional strategy.

Table 7: Independent sample t-test comparing the Mean Achievement Scores of Male and Female Students Taught Basic Science Using Blended Learning Instructional Strategy on Posttest

Sex	N	Mean	SD.	df	t-cal.	Sig. (2-tailed)	Decision
Males	81	56.34	9.95	131	1.71	.089	Null hypothesis not rejected
Females	52	62.27	8.57				

Table 7 is a summary of the t-test comparing the mean achievement scores of male and female students taught Basic Science using the blended learning instructional strategy. The table reveals that the p-value (.089) of the calculated t-value (1.71) is greater than 0.05. With this result, Ho_4 was not rejected. Thus, there is no significant difference between the mean achievement scores of males and females students taught Basic Science using the blended learning instructional strategy.

Research Question Four: What is the difference between the mean achievement scores of male and female students taught Basic Science using demonstrative-lecture instructional strategy?

Table 8: Means and Standard Deviations (SD) Comparison of the Pretest and Post Test the mean achievement scores of male and female students taught Basic Science using demonstrative-lecture instructional strategy

Sex	N	Mean	Mean difference	Std. Deviation
Males	70	46.20	1.21	4.46
Females	77	47.41		6.56

Table 8 revealed that the posttest mean achievement scores of male and female students taught Basic Science using the demonstrative-lecture instructional strategy were 46.20 and 47.41, with standard deviations of 4.46 and 6.56, respectively. The mean difference between males and females students' posttest scores was 1.21, with females' students achieving a slightly higher mean score than their males counterparts. This suggests that the demonstrative-lecture instructional strategy had a comparable effect on both genders, with a marginal advantage for females students.

Hypothesis Four

There is no significant difference between the mean achievement scores of males and females students taught

Basic Science using demonstrative-lecture instructional strategy.

Table 9: Independent sample t-test comparing the mean achievement scores of males and females students taught Basic Science using demonstrative-lecture instructional strategy on Posttest

Gender	N	Mean	SD	df	t-cal.	Sig. (2-tailed)	Decision
Males	70	46.20	4.46	145	1.30	.196	Null hypothesis accepted
Females	77	47.41	6.56				

Table 9 is a summary of the t-test comparing the mean achievement scores of males and females students taught Basic Science using the demonstrative-lecture instructional strategy. The table reveals that the p-value of the calculated t-value is greater than 0.05. With this result, H_{05} was accepted. Thus, there is no significant difference between the mean achievement scores of males and females students taught Basic Science using the demonstrative-lecture instructional strategy.

Research Question five

What is the interaction effect of problem-based learning, blended learning and demonstrative-lecture instructional strategies and sex on students' academic achievement in basic science?

Table 10: Mean Interaction Effect of Problem-Based Learning, Blended Learning and Demonstrative-Lecture Instructional Strategies and Sex on Students' Academic Achievement in Basic Science

Treatment methods	Sex	N	Mean	Std. Deviation
Problem-based learning	Males	73	56.44	9.15
	Females	66	55.95	9.09
Blended learning	Males	81	61.98	8.64
	Females	52	59.17	10.02
Demonstrative-lecture instructional strategy	Males	70	46.20	4.46
	Females	77	47.42	6.56

Table 10 revealed that the mean achievement scores of male and female students taught Basic Science using problem-based learning were 56.44 and 55.95, with standard deviations of 9.15 and 9.09, respectively. Also, the mean achievement scores of males and females students taught using blended learning were 61.98 and 59.17, with standard deviations of 8.64 and 10.02, respectively. Furthermore, the mean achievement scores of males and females students taught using the demonstrative-lecture instructional strategy were 46.20 and 47.42, with standard deviations of 4.46 and 6.56, respectively. The results indicate that students taught using blended learning had the highest mean achievement scores, followed by those taught using problem-based learning, while students taught using the demonstrative-lecture instructional strategy had the lowest mean achievement scores. Additionally, males students in the blended learning group had a higher mean achievement score than females, while females students in the problem-based learning and demonstrative-lecture instructional strategy groups had slightly higher mean achievement scores than their males counterparts.

Hypothesis Five

There is no interaction effect of problem-based learning, blended learning, and demonstrative-lecture instructional strategies and sex on students' academic achievement in basic science.

Table 11: ANCOVA of Interaction Effect of Problem-Based Learning, Blended Learning and Demonstrative-Lecture Instructional Strategies and Sex on Students' Academic Achievement in Basic Science

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	16146.116[a]	6	2691.019	43.038	.000
Intercept	19848.576	1	19848.576	317.445	.000
Pretest	1387.411	1	1387.411	22.189	.000
Treatment method	13958.482	2	6979.241	111.621	.000
Sex	11.737	1	11.737	.188	.665
Treatment method * Sex	233.592	2	116.796	1.868	.156
Error	25760.719	412	62.526		
Total	1282031.000	419			
Corrected Total	41906.835	418			
a. R Squared = .385 (Adjusted R Squared = .376)					

Table 11 revealed the ANCOVA of the interaction effect of problem-based learning, blended learning, and demonstrative-lecture instructional strategies and sex on students' academic achievement in basic science in Delta State. The computed F-ratio, F (6, 412) = 1.868, with a p-value of 0.156. Testing the null hypothesis at an alpha level of 0.05, the p-value (0.156) was greater than 0.05, hence the null hypothesis was accepted. This implies that there is no interaction effect of problem-based learning, blended learning, and demonstrative-lecture instructional strategies and sex on students' academic achievement in basic science.

Discussion of Results

The first finding of the study showed that there was a significant difference in the mean achievement score among Basic Science students taught with Problem-Based Learning, Blended Learning, and Demonstrative-Lecture instructional strategies. The post hoc analysis that indicates that among the three instructional strategies treated in this study blended learning is the most effective instructional strategy for enhancing students' achievement, followed by problem-based learning, while the demonstrative-lecture instructional strategy is the least effective in improving students' academic achievement. This suggests that the type of instructional strategy used affects students' academic performance. This finding aligns with Ajaja (2013) [10], who revealed that students achieve better when actively involved in learning activities. Similarly, Ugwuanyi (2016) [33] found that students exposed to student-centered instructional strategies performed better than those taught using conventional lecture methods. The finding, however, contradicts that of Adeyemi (2017) [3], who found no significant difference in students' academic achievement when taught using problem-based learning and traditional lecture methods. The study by Yusuf (2014) [37] also supports this finding, as it highlighted that instructional strategies that actively engage students contribute significantly to improved academic performance.

The second finding of the study showed that there was no significant difference between the mean achievement scores of males and females students taught Basic Science using the problem-based learning instructional strategy. This finding suggests that the problem-based learning method

provides an equal learning opportunity for both males and females students, allowing them to actively engage in the learning process. This finding also indicates that problem-based learning instructional strategy fosters collaboration and active participation, reducing sex-related differences in learning outcomes. This result is in agreement with Sani (2015) [30], who found no significant difference in the academic achievement of males and females students exposed to cooperative and problem-based instructional strategies.

The third finding of the study revealed that there was no significant difference in the mean achievement scores of males and females students taught Basic Science using the blended learning instructional strategy. This finding indicates that the blended learning instructional strategy was equally effective for both males and females students, suggesting that sex did not influence students' academic achievement in this context. The possible reason for this finding could be that blended learning provides an inclusive and balanced learning environment that supports the academic needs of students regardless of sex. The combination of face-to-face instruction with digital content likely ensured equal opportunities for engagement, access to learning materials, and comprehension for both sexes. This finding is supported by Omosor, Ajaja, and Kpangba (2024) [28], who reported that blended learning significantly enhanced students' academic achievement irrespective of sex, highlighting its effectiveness for both males and females learners. It also aligns with Iserameiya and Uwameiye (2018) [19], who found no significant differences in achievement based on sex when students were exposed to technology-driven instructional strategies. However, this result contrasts with Rovai and Baker (2015), who found that females students tend to benefit more from blended learning environments, as such settings improve their confidence and comprehension, unlike traditional lecture classrooms where males students may dominate. Despite such contrasting findings, the result of this study supports the conclusion that blended learning is a sex-inclusive instructional strategy capable of promoting equitable achievement outcomes in Basic Science.

The fourth finding of the study revealed that there is no significant difference between the mean achievement scores of males and females students taught Basic Science using the demonstrative-lecture instructional strategy. A plausible explanation for this finding could be that the demonstrative-lecture method allows the teacher to engage all students equally, regardless of gender, by combining explanations with practical demonstrations. This approach may have minimized gender-based disparities by making the learning process more visual and interactive, thereby promoting equal academic achievement among both males and females students. This finding aligns with that of Ihejiamaizu, Neji, and Agiande (2020) [17], who reported that sex does not significantly contribute to the variance in students' academic achievement in science subjects. Similarly, Vikoo (2011) found that instructional strategies do not have a sex-based effect on students' academic achievement. The result is also in agreement with Abdulwahab, Oyelekan, and Olorundare (2019) [1], who found no significant difference in achievement scores of males and females students in experimental and control groups. These consistent findings suggest that when effective instructional strategies are applied, both males and females students can perform at comparable levels. This implies that the demonstrative-lecture method provided an equal learning environment for both males and females students.

The fifth finding of the study revealed that there is no significant interaction effect of instructional strategies and sex on students' academic achievement in Basic Science. This means that sex is not a determining factor when assigning instructional strategies, as both males and females students responded similarly to the instructional methods used. The finding also suggests that males and females students do not differ in their response to instructional design, indicating that the effectiveness of a teaching strategy is not dependent on the sex of the learner. This finding agrees with Ekaette and Enang (2022), who revealed that there is no significant interaction effect of gender and teaching methods on students' academic achievement. However, the result contradicts the findings of Ugwu (2014) [32], who reported a significant interaction effect between teaching methods and sex on students' achievement. The current result, therefore, strengthens the argument that when instructional strategies are well designed and effectively implemented, they can be equally beneficial to all students, regardless of gender.

Conclusion

The study examined the effects of problem-based learning, blended learning, and demonstrative-lecture instructional strategies on students' academic achievement in Basic Science in Delta State. Based on the findings of the study, it was concluded that the use of blended learning and problem-based learning enhances students' academic achievement in Basic Science more effectively than the demonstrative-lecture instructional strategy, which was found to be the least effective. Additionally, the study concluded that sex did not significantly influence students' achievement when taught using problem-based learning and demonstrative-lecture strategies.

Recommendations

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

1. Since blended learning instructional strategy was found to be the most effective in enhancing both students' academic achievement in Basic Science, secondary schools in Delta State should adopt blended learning as the primary instructional strategy for teaching Basic Science.
2. Teachers should be adequately trained and supported in the design and implementation of blended learning to maximize its effectiveness and ensure successful integration into the Basic Science curriculum.
3. Basic Science teachers should deliberately incorporate both problem-based learning and blended learning strategies into their instructional practices, as these approaches promote student-centered learning, critical thinking, and increased achievement in Basic Science.

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