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Interaction Effects of Problem-Based Learning, Blended Learning, and Demonstrative-Lecture Instructional Strategies and Sex on Students' Interest in Basic Science

Etaneki, O., Ajaja, O.P.& Oyovwi, E.O.

Department of Science Education (Curriculum And Instruction Unit) Faculty Of Education, Delta State University, Abraka

ABSTRACT

This study examined interaction effects of problem-based learning, blended learning, and demonstrative-lecture instructional strategies and sex on students' interest in basic science. Two research questions and two hypotheses were answered 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. The population of the study consist 77,293 Junior Secondary School II (JSS II) students from 485 public secondary schools in Delta State in the 2023/2024 academic year. 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. Basic Science Students' Interest Questionnaire (BSSIQ) was the instrument utilised to gather data. The reliability index of 0.81 was obtained by applying Cronbach's Alpha, BSSIQ were used to administer a pre-test and post-test to the students in order to gather data for the study. Means, standard deviations, Analysis of variance (ANOVA) and Analysis of Covariance (ANCOVA) were used to analyse the data. The following are some of the study's findings: there was a significant difference in the mean interest scores among basic science students taught with problem-based learning, blended learning, and demonstrative-lecture instructional strategies, and there was no significant interaction effect between instructional strategies and sex on students' interest in Basic Science. Based on the results, it was concluded that blended learning and problem-based learning are more effective than the demonstrative-lecture method at raising students' interest. 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:** Problem-Based Learning, Blended Learning, Demonstrative-Lecture Instructional Strategies, Sex, Students' Interest, Basic Science

INTRODUCTION

Interest is a critical affective variable in science education, shaping how learners engage with instructional activities, persist in learning tasks, and develop long-term motivation toward scientific inquiry. In Basic Science—an integrated subject designed to build foundational scientific literacy among junior secondary school students—the level of students' interest often determines the extent to which cognitive and attitudinal outcomes can be achieved. Unfortunately, studies and classroom experiences in Nigeria continue to reveal a persistent decline in students' interest in Basic Science, manifested in low participation, reduced enthusiasm, and weak retention of scientific concepts. This challenge has been linked primarily to the continued use of conventional, teacher-centred strategies that do not stimulate active engagement.

The term *interest* refers to a psychological state characterized by curiosity, engagement, and enthusiasm toward a particular activity, topic, or subject matter (Eyamekware & Oyovwi, 2023). It involves a personal investment of attention, effort, and emotion, as well as a desire to explore, learn, or participate in activities that are enjoyable, meaningful, or personally relevant. Interest motivates individuals to pursue goals, acquire knowledge, and meaningfully engage in learning experiences, thereby influencing attitudes, behaviours, and performance. According to Hidi and Renninger (2018), interest may arise spontaneously in response to immediate stimuli or activities, and it may also develop into an enduring preference or passion over time. Ainley and Ainley (2018) further describe interest as a dynamic and context-dependent construct that fluctuates across situations. Empirical research has shown that interest holds significant implications for learning outcomes. For instance, Harackiewicz et al. (2019) found that students who are intrinsically interested in a subject tend to engage in deeper learning, persist despite challenges, and achieve higher academic success. Consequently, students' interest in Basic Science may be greatly influenced by the instructional strategies adopted by their teachers.

Instructional innovation has therefore become central to revitalizing students' affective disposition toward science learning. Three strategies that have gained prominence globally and locally are Problem-Based Learning (PBL), Blended Learning (BL), and the Demonstrative-Lecture Method (DLM). Each presents distinct pedagogical possibilities that may differentially influence students' interest. Problem-Based Learning is a learner-centred, inquiry-oriented strategy that situates students in authentic problem contexts requiring investigation, reasoning, collaboration, and solution development. Such active engagement stimulates curiosity and ownership of learning—factors known to enhance interest in science. Blended Learning, which integrates face-to-face instruction with digital or online learning experiences, offers flexibility, personalization, and access to multimedia content. By leveraging interactive technologies, BL has the potential to make Basic Science more appealing to digital-native learners. In contrast, the Demonstrative-Lecture Method—although commonly used in Nigerian classrooms—remains largely teacher-centred, emphasizing explanation and demonstrations. While demonstrations can capture students' attention, the limited opportunities for active involvement may weaken sustained interest over time.

Problem-Based Learning (PBL) is a pedagogical approach that engages students actively by placing them in real-world problem situations. According to Thearath (2023), PBL focuses on solvable and meaningful problems with practical relevance. Through this method, students ask questions, explore alternative solutions, gather relevant information, and collaborate with peers in a student-driven learning process. Mansor et al. (2015) assert that PBL empowers learners by granting them autonomy to make informed decisions throughout the learning process. As a student-centred strategy, PBL views learning as an active, integrated, and constructive process. Eze and Osuyi (2018) explain that it requires collaborative participation, prompting students to assess their prior knowledge, identify new information needed, and apply appropriate strategies to solve the problem. This fosters independence, critical thinking, and lifelong problem-solving skills—qualities strongly associated with heightened interest in science learning.

Blended Learning (BL) combines face-to-face instruction with online learning experiences, integrating technology-based resources with classroom interactions to create a flexible and enriched learning environment. Alammary (2019) emphasizes that blended learning optimizes instruction by merging the strengths of digital platforms with traditional teaching. It allows learners to revisit materials, engage with multimedia content, participate in online discussions, and learn at their own pace. Owston et al. (2020) observe that such flexibility enhances motivation, encourages self-regulated learning, and promotes engagement among diverse learners. Through interactive videos, simulations, and electronic learning tools, blended learning supports visualization of scientific concepts, fosters collaboration, and can significantly boost students' interest in Basic Science.

The Demonstrative-Lecture Method (DLM), although widely used in Nigerian classrooms, is predominantly teacher-centred. It involves verbal explanation accompanied by practical demonstration of concepts or scientific procedures. Nsa and Udo (2020) highlight that demonstrations help clarify abstract concepts, making learning more concrete and visually stimulating. Olatoye and Afuwape (2018) note that by modeling scientific processes, teachers help learners observe real-life applications of theories. While demonstrations can temporarily capture students' attention, the method generally limits learners' participation, reducing its ability to sustain long-term interest when compared to more interactive approaches. Nonetheless, it remains useful for introducing new concepts or illustrating procedures that require accuracy.

The unique characteristics of these instructional strategies make it necessary to ascertain their differential effects on students' interest in Basic Science. This is particularly relevant in the Nigerian context, where there is growing emphasis on pedagogical innovations that promote active learning and improve students' affective dispositions toward science. Moreover, existing literature tends to focus more on cognitive outcomes, with limited attention given to how these strategies influence students' interest specifically.

Despite the growing evidence supporting these instructional strategies, many Basic Science teachers in Nigeria appear to lack full awareness of their benefits or fail to apply them effectively. The Federal Government of Nigeria's National Policy on Education (2018) emphasizes the need for innovative instructional approaches at all levels of education, yet studies suggest that classroom practices remain dominated by conventional lecture methods (Borich, 2007; Ajaja, 2014; Adeyemo & Adedokun, 2022). Consequently, many schools are not adequately equipping students to become active learners capable of constructing meaning through interaction, inquiry, and reflective thinking. This gap underscores the necessity of empirically comparing the effects of PBL, BL, and DLM on students' achievement and interest in Basic Science, particularly within the Delta State context.

Furthermore, sex remains an important demographic factor in educational research, especially regarding academic achievement and interest in science-related subjects. Sex, as defined by the World Health Organization (WHO), refers to the biological characteristics that distinguish males from females, including reproductive anatomy and physiological functions (UNESCO, 2019). Biological variations—such as hormonal and neurological differences—have been theorized as potential contributors to variations in learning preferences, performance, and the development of interest in specific subjects (Chen & Gallagher, 2020). Some studies have reported sex-related differences in science learning, indicating that males often gravitate toward abstract, analytical tasks, whereas females tend to prefer practical, relational, or affective learning contexts, which may influence their interest levels (Amenah, 2019). However, existing findings remain inconsistent. While several studies found no significant sex differences in interest (Khan et al., 2018; Jia et al., 2020), others report higher male achievement and stronger inclination toward science subjects (Tsaousis & Alghamdi, 2022; Wrigley-Asante, 2023). These contrasting results suggest that sex may interact with instructional strategies to influence learning outcomes and students' interest in Basic Science. Given these gaps, this study seeks to determine whether Problem-Based Learning, Blended Learning, and Demonstrative-Lecture Instructional Strategies differentially influence male and female students' interest in Basic Science in Delta State.

Research Questions

1. What is the difference in mean interest score among Basic Science students taught with problem-based learning, blended learning and demonstrative-lecture instructional strategies?
2. What is the interaction effect of problem-based learning, blended learning and demonstrative-lecture instructional strategies and sex on students' interest 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 interest scores among basic science students taught with problem-based learning, blended learning, and demonstrative-lecture instructional strategies.
2. There is no interactive effect of problem-based learning, blended learning, and demonstrative-lecture instructional strategies and sex on students' interest in Basic Science.

Research Methods

Design of the Study

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.

Population of the Study

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). The choice of JSS II students as the population for the study was because the JSS III students were considered too busy preparing for the Basic Education Certificate Examination (BECE) and JSS 1 students were not involved in the study because they are considered not mature enough since they are still fresh in the system.

Sample and Sampling Techniques

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. At the first stage two local government areas were randomly selected from each the senatorial district that made up the state making a total of six local government area for the study. The three local government areas includes Ethiope East, Ndokwa West and Isoko North.

At the second stage, three secondary schools from each sampled local government area, making nine secondary schools that were used for the study. The secondary schools were sampled using the purposive sampling method. Purposive sampling technique was used because the researcher needs public secondary schools that meet certain criteria. The criteria include:(1) the school must be mixed public secondary schools (2) a single arm of JSS2 class taught by one basic science teacher, and (3) the school must have a qualified and experienced basic science teacher. Finally, instructional strategy was assigned to each selected schools in their intact JSS2 classes. All the schools that were selected from the same local government area were assigned the same instructional strategy

Research Instrument

Basic Science Students Interest Questionnaire (BSSIQ) was the instruments that was used for data collection in this study. The Basic Science Students Interest Questionnaire (BSSIQ) is divided into two parts. Part A collected student's bio-data (sex). Section B of the Basic Science Students Interest Questionnaire (BSSIQ) consists of 20 items, adapted from Nwafor, *et al* (2018) with modifications. The number of items in the original instrument was used to measured interest in biology. However, it was modified to measure Students Interest in basic science. This was done to make the completion of questionnaire easier for the students. The respondents were requested to indicate their opinion on four-point options such as Very Large Extent (VLE)-4, Large Extent (LE)-3, Small Extent (SE)-2, and Very Small Extent (VSE)-1.

Validity of Research Instrument

To validate the Basic Science Students Interest Questionnaire (BSSIQ), the researcher requested the assistance of three experts from Delta State University, Abraka. Two Science Education experts and one Measurement and Evaluation expert. The experts were requested to verify the instruments, ensuring that each item is clearly worded and unambiguous. The content and constructs validity of the Basic Science Students Interest Questionnaire (BSSIQ) were determined using factor analysis. 50 copies of the Basic Science Students Interest Questionnaire (BSSIQ) were produced and administered to JSS II students in two secondary school Benin-City, Edo State, and the data collected was subjected to factor analysis. Using the factor analysis, the instrument's content and construct validity were estimated. The content validity of the items in the instrument was established by the total cumulative variance of all the items. A total cumulative variance of 76.589% was obtained for the entire Basic Science Students Interest Questionnaire (BSSIQ). The total cumulative variance of all the items was 71.36% with a total of unexplained variance of 23.411%. The explained variance is less than 40%. This indicated that all the 20 items in BSSIQ is content valid. On the other hand, the construct validity was estimated with the rotated factor loadings matrix. Item with rotated factor loading matrix of .40 and above was considered construct valid (Okorodudu, 2016). Items on Basic Science Students Interest Questionnaire (BSSIQ) has rotated factor loadings matrix which ranged between .495 and .887. Since the rotated factor loading matrixes range above .40, the instrument was considered construct valid

Reliability of the Instruments

The researcher also administered the Basic Science Students Interest Questionnaire (BSSIQ) 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 of the Basic Science Students Interest Questionnaire (BSSIQ) was calculated using Cronbach Alpha. The reliability coefficient of

0.813 was obtained for the BSSIQ (Appendix E). Cronbach's alpha was deemed adequate for use in calculating the reliability of the instrument since the response format for based on four-point scale. The reliability coefficients indicate that the instruments are internally consistent and suitable for the study

Treatment Procedures

The treatment was conducted in three phases. Phase One involved assigning instructional strategies to the sampled schools. Nine intact classes, one from each school, were randomly assigned to Problem-Based Learning (PBL), Blended Learning (BL), or Demonstrative-Lecture (DL) strategies. Schools from the same local government area were assigned the same strategy. Assignment was done using a simple random selection: three labeled papers representing the instructional strategies were placed in a container, and a teacher representing each local government area drew one paper to determine the strategy for all schools in that area. Each strategy was thus applied to three intact classes.

Phase Two focused on training the research assistants. Basic Science teachers selected as research assistants underwent a four-day training program, with daily 45-minute sessions, conducted by the researcher and two specialists. The first day introduced the meaning and characteristics of the three instructional strategies. On the second day, teachers were trained using strategy-specific manuals that detailed teaching steps and the roles of teachers and students. The third and fourth days involved practical sessions where teachers practiced applying the strategies to selected Basic Science topics. Training concluded once the trainers confirmed that the teachers could effectively implement the strategies.

Phase Three consisted of the actual treatment. Pretests (BSSIQ) were administered to all groups a day before instruction to assess students' prior knowledge. One week before the start of instruction, lesson plans for six weeks were provided to the teachers, detailing both teacher and student activities. Group A was taught using PBL, Group B using BL, and Group C using DL. Instruction lasted six weeks, with teachers following the procedures learned during training. At the end of the period, post-tests were administered using the same instruments to measure students' interest in Basic Science.

Method of Data Analysis

The research questions were answered using mean and standard deviations that was obtained from the pretest and post test scores. Hypotheses 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. All hypotheses were tested at 0.05 level of significant.

Results

Research Question One

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

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

Instructional strategies	N	Mean	SD
Problem-based learning	139	50.40	5.29
Blended learning	133	51.69	.79
Demonstrative-lecture	147	43.07	3.27
Total	**419**		

Table 1 presents the mean interest scores of Basic Science students taught using problem-based learning, blended learning, and demonstrative-lecture instructional strategies. The results show that students taught with blended learning recorded the highest mean interest score (M = 51.69, SD = 8.79), followed closely by those taught with problem-based learning (M = 50.40, SD = 5.29). Students taught using the demonstrative-lecture instructional strategy had the lowest mean interest score (M = 43.07, SD = 3.27). These descriptive statistics suggest that students exposed to blended learning and problem-based learning showed higher levels of interest in Basic Science compared to those taught using the demonstrative-lecture method

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

Table 2: ANOVA Comparison of interest 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.

Between Groups	6167.014	2	3083.507	81.948	.000
Within Groups	15653.119	416	37.628		
Total	**21820.134**	**418**			

Table 2 presents the ANOVA comparison of the mean interest 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 ($F = 81.948$, $p < 0.05$). Consequently, the null hypothesis was rejected. This implies that there is a significant difference in the mean interest scores of Basic Science students exposed to the different instructional strategies.

Table 3: Scheffe Post-Hoc Test for Direction of Difference in interest 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	-1.289	.744	.224
	Demonstrative-lecture instructional strategy	7.335*	.726	.000
Blended learning	Problem-based learning	1.289	.744	.224
	Demonstrative-lecture instructional strategy	8.624*	.734	.000
Demonstrative-lecture instructional strategy	Problem-based learning	-7.335*	.726	.000
	Blended learning	-8.624*	.734	.000

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

The post hoc analysis using the Scheffé test, as shown in Table 3, to determine the direction of the observed significance indicated that: (i) Students in the problem-based learning and blended learning groups significantly outscored those in the demonstrative-lecture instructional strategy group in terms of interest scores. (ii) There was no significant difference between students in the problem-based learning group and those in the blended learning group, indicating comparable levels of interest between the two. (iii) Students in the demonstrative-lecture instructional strategy group scored significantly lower than those in both the problem-based and blended learning groups. This implies that problem-based learning and blended learning are more effective instructional strategies for enhancing students' interest in Basic Science compared to the demonstrative-lecture method. Among the three, blended learning had the highest mean interest score, although the difference from problem-based learning was not statistically significant. The demonstrative-lecture instructional strategy was the least effective in stimulating students' interest.

Research Question Two: What is the interaction effect of problem-based learning, blended learning and demonstrative-lecture instructional strategies and sex on students' interest in basic science?

Table 4: Mean Interaction Effect of Problem-Based Learning, Blended Learning And Demonstrative-Lecture Instructional Strategies and Sex on Students' Interest in Basic Science

Treatment method	Sex	N	Mean	SD
Problem-based learning	Males	73	51.12	5.29
	Females	66	49.61	5.23
	Total	139	50.40	5.29
Blended learning	Males	81	50.67	5.70
	Females	52	49.67	11.54
	Total	133	50.28	8.45
Demonstrative-lecture instructional strategy	Males	70	42.99	3.37
	Females	77	43.14	3.20

Table 4 revealed that the mean interest scores of males and females students taught Basic Science using problem-based learning were 51.12 and 49.61, with standard deviations of 5.29 and 5.23, respectively. Also, the mean interest scores of males and females students taught using blended learning were

50.67 and 49.67, with standard deviations of 5.70 and 11.54, respectively. Furthermore, the mean interest scores of males and females students taught using the demonstrative-lecture instructional strategy were 42.99 and 43.14, with standard deviations of 3.37 and 3.20, respectively. The results indicate that students taught using problem-based learning had the highest mean interest scores, followed closely by those taught using blended learning, while students taught using the demonstrative-lecture instructional strategy had the lowest mean interest scores. Additionally, males students in the problem-based learning and blended learning groups had slightly higher mean interest scores than their females counterparts, while females students in the demonstrative-lecture group had a marginally higher interest score than males.

Hypothesis Two

There is no interaction effect of problem-based learning, blended learning, and demonstrative-lecture instructional strategies and sex on students' interest in Basic Science.

Table 5: ANCOVA of Interaction Effect of Problem-Based Learning, Blended Learning, and Demonstrative-Lecture Instructional Strategies and Sex on Students' Interest in Basic Science

Source	**Type III Sum of Squares**	**Df**	**Mean Square**	**F**	**Sig.**
Corrected Model	6096.990[a]	6	1016.165	30.297	.000
Intercept	6871.467	1	6871.467	204.873	.000
Pretest	934.976	1	934.976	27.876	.000
Treatment method	4727.863	2	2363.932	70.481	.000
Sex	33.229	1	33.229	.991	.320
Treatment method * Sex	**26.693**	**2**	**13.346**	**.398**	**.672**
Error	13818.528	412	33.540		
Total	976862.000	419			
Corrected Total	19915.518	418			

a. R Squared = .277 (Adjusted R Squared = .267)

Table 5 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, $F(2, 412) = .398$, with a p-value of .672. Testing the null hypothesis at an alpha level of 0.05, the p-value (.672) was greater than 0.05, hence the null hypothesis was rejected. This implies that there is no significant interaction effect of problem-based learning, blended learning, and demonstrative-lecture instructional strategies and sex on students' interest in Basic Science.

Discussion of Results

The first finding showed that there was a significant difference in the mean interest scores of Basic Science students taught with problem-based learning, blended learning, and demonstrative-lecture instructional strategies. This result suggests that different instructional strategies influence students' interest levels differently. The higher interest scores recorded among students taught using problem-based learning and blended learning suggest that these strategies create an interactive and engaging learning environment, which sustains students' curiosity and thus boast their interest. This finding is in agreement with Yusuf (2014), who found that instructional strategies that involve students in problem-solving and interactive activities enhance their interest in learning. Similarly, Iserameiya and Uwameiye (2018) found that students taught using blended learning strategies exhibited greater engagement and interest in the subject compared to those taught using conventional methods. However, this finding contradicts the work of Wei, Shi, Yang, and Liu (2017), who found no significant difference in students' interest levels when exposed to blended learning and traditional lecture methods. Despite this, the observed trends in the present study favor problem-based learning and blended learning as more effective strategies for sustaining students' interest in Basic Science.

The second finding revealed that there was no significant interaction effect between instructional strategies (problem-based learning, blended learning, and demonstrative-lecture) and sex on students' interest in Basic Science. This implies that the influence of the instructional strategies on students' interest was not dependent on sex, and vice versa. In other words, both males and females students responded similarly to the different instructional strategies in terms of developing interest in Basic Science. A possible explanation for this finding is that the instructional strategies used—particularly blended and problem-based learning—may have been inherently inclusive, providing opportunities for active engagement, collaboration, and individualized learning that resonate equally across sexes. These approaches may help neutralize traditional lecture classroom dynamics that sometimes favour one sex over the other. This finding is supported by Ibrahim and Oyeleke (2022), who reported no significant interaction between sex and instructional strategy on students' interest in science subjects, noting that the design and delivery of modern, student-centered strategies tend to bridge sex-related engagement gaps. Similarly, Chukwuma and Edet (2023) found that when properly implemented, learner-centered strategies can stimulate student interest without sex-based bias. This finding is in contrast with Abanikannda (2018), who reported that there was no significant difference between the mean interest scores of males and females students. It also contradicts Onu, Anyaegbunam, and Uzoigwe (2020), who found no significant difference in the interest ratings of males and females students. Similarly, Ryan (2015) revealed that the effect of instructional strategies on student interest was similar for both males and females students. Additionally, Ashleyann (2015) found no significant difference in the interest scores of males and females students when taught using the same instructional strategies.

Conclusion

The study examined the effects of problem-based learning, blended learning, and demonstrative-lecture instructional strategies on students' academic achievement and interest 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' interest in Basic Science more effectively than the demonstrative-lecture instructional strategy, which was found to be the least effective. Furthermore, the study demonstrated that instructional strategies and students' sex did not interact to influence students' academic achievement or interest in Basic Science. This implies that the effectiveness of the instructional methods was generally consistent across males and females students, and that the choice of strategy—particularly blended learning—is more critical to enhancing interest than students' sex.

Recommendations

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

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

1. Since blended learning instructional strategy was found to be the most effective in enhancing both students' interest in Basic Science, secondary schools in Delta State should adopt blended learning as the primary instructional strategy for teaching Basic Science.
2. Although the study revealed no consistent significant differences in achievement and interest based on sex across most strategies, teachers should still promote equal participation of males and females students when using blended and problem-based learning. This will help maintain inclusive classroom dynamics and support equitable learning outcomes.
3. Regular workshops, seminars, and symposia should be organized by educational institutions, teacher-training bodies, and the Ministry of Education to build teachers' capacity in the effective use of blended and problem-based learning strategies in Basic Science instruction.
4. Government and school administrators should provide adequate infrastructure, including ICT facilities, laboratory equipment, and digital learning resources, to support the implementation of blended and problem-based learning strategies in secondary schools.

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