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Blended Instructional Strategy and the Enhancement of Secondary School Students' Learning Outcomes in Geometry

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Abstract
The research aimed to assess the impact of a blended instructional strategy on the improvement of secondary school students' achievements and interest in geometry. Employing a quasi-experimental, non-equivalent control group design, the study encompassed all mathematics students in the state as the population, with a sample of 179 students from two schools. The assignment of intact classes to either the experimental or control group was done through a coin flip, and these groups were subsequently instructed separately by their regular mathematics teachers, who had undergone prior training for this purpose. The reliability of the instrument was established using Kudder-Richardson-20 and reliability indices of 0.79 and 0.80 were obtained respectively. Pre and post-tests were administered to all groups, utilizing the Geometry Achievement Test (GAT) and Geometry Interest Inventory (GII) as data collection instruments. The study was guided by two research questions and two hypotheses. Mean and standard deviation were employed to address the research questions, while Analysis of Covariance (ANCOVA) was utilized to test the hypotheses at a significance level of 0.05. The findings revealed that students instructed in geometry using the blended instructional strategy exhibited a higher mean gain in both achievement and interest compared to those taught using the lecture method. The study recommends the implementation of the Blended Instructional Strategy in the teaching of geometry and mathematics across Nigerian secondary schools to foster enhanced student achievement and interest.

Keywords: Blended Instructional Strategy, Achievement, Interest, Geometry

Introduction

In the ever-evolving landscape of education, the quest to optimize learning experiences for secondary school students remains paramount. The realm of mathematics, particularly geometry, stands as a cornerstone in the academic journey, fostering critical thinking and problem-solving skills essential for both academic and real-world applications. Amidst this pursuit for effective pedagogy, the concept of blended instructional strategy emerges as a transformative approach poised to revolutionize the learning paradigm in secondary school geometry (Charles-Owaba, 2018). The blended instructional strategy represents a harmonious fusion of traditional face-to-face teaching methodologies with innovative digital tools and online resources. It intertwines the strengths of both conventional classroom interaction and cutting-edge technological platforms to create an enriched, multifaceted learning environment. Within the realm of geometry education, this approach has emerged as a beacon of promise, catering to diverse learning styles, individual pacing, and varied cognitive abilities among students.

Geometry, often perceived as an abstract domain, necessitates a pedagogical shift that engages students beyond passive reception, cultivating an active and immersive learning experience. The amalgamation of in-person instruction with digital resources empowers educators to craft a dynamic curriculum, leveraging interactive software, multimedia presentations, virtual simulations, and online collaborative platforms (Charles-Owaba & Ahiakwo, 2021). This synergy aims not only to elucidate complex geometric concepts but also to instigate curiosity, foster creativity, and augment problem-solving proficiency among students. The pivotal focus of employing a blended instructional strategy in secondary school geometry education revolves around elevating both academic achievement and nurturing a sustained interest in the subject. Charles-Owaba and Omeodu (2022) disclosed that by harnessing technology's prowess, educators can personalize learning pathways, provide immediate feedback, and

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offer tailored support, thereby addressing individual student needs comprehensively. Moreover, the integration of real-world applications and visualizations through digital mediums serves to bridge the gap between abstract theories and practical relevance, fostering a deeper appreciation and engagement with geometric principles. Omeodu and Charles-Owaba (2021) submitted that while the blended instructional strategy heralds immense potential, its effective implementation requires thoughtful orchestration. Educators must adeptly balance the utilization of digital tools with traditional pedagogy, ensuring a seamless fusion that maximizes learning outcomes while preserving the essence of interpersonal connections within the classroom. Furthermore, considerations for equitable access to technology, professional development for educators, and continuous assessment to gauge efficacy become imperative facets in the successful deployment of this innovative approach.

As the educational landscape continues to evolve, the exploration of blended instructional strategies in secondary school geometry education stands as a beacon of innovation. The fusion of traditional teaching methodologies with cutting-edge digital resources promises to not only enhance academic achievement but also kindle a profound and enduring interest in geometry among students, equipping them with the essential skills and mindset necessary for success in both academic pursuits and the dynamic landscape of the future. The performance of students in mathematics, particularly in Bayelsa State, Nigeria, has consistently been subpar over the years. External examination bodies such as the West African Examination Council (WAEC) and the National Examination Council (NECO) have consistently highlighted the inadequate performance of students in mathematics. Analysis of research reports, Chief Examiners' reports, and WAEC and NECO SSCE results spanning from 2010 to 2023 reveals a persistent challenge among students, particularly in solving mathematical problems involving geometry. The ongoing concern over students' low success rates in mathematics is not unique to Nigeria but is a shared issue in many countries. Several factors are believed to contribute to students' struggles in geometry, as indicated by scholars such as Adolphus (2011), Gamage and Charles-Ogan (2019), and Imoko and Agwagah (2016). One prominent factor identified is the traditional teaching approach in mathematics, which has been recognized as ineffective. Furthermore, scholars like Ado (2018), Ajaegba and Ekwueme (2019), and Mman and Tukunkaya (2019) attribute poor learning interest and assimilation of mathematical ideas, concepts, principles, processes, and teachers' failure to employ suitable and engaging teaching methods as additional reasons for the low achievement of students in geometry in Nigeria. Though much attention has been directed towards studying mathematics at the primary and secondary levels of education to improve students' achievement and interest, regrettably, this has not given the required result of improved achievement in our schools. There is a shortage of empirical evidence on geometry teaching using blended instructional strategies to enhance students' achievement and interest in geometry in Nigeria. Therefore, the problem of the study put in question is: Would using a blended instructional strategy be an effective way of improving students' achievement and interest in geometry in Bayelsa State?

Aim and Objectives of the Study

This study examined the effect of a blended instructional strategy on the enhancement of secondary school students' achievement and interest in geometry**.** Specifically, the study achieved the following;

i. Determine the difference in mean achievement scores of students taught geometry using blended instructional strategy and those taught using modified lecture method.
ii. Determine the difference in mean interest scores of students taught geometry using blended instructional strategy and those taught using modified lecture method.

Research Questions

The following research questions were formulated to guide the study;

i. What is the difference in mean achievement scores between students taught geometry using a blended instructional strategy and those taught using a modified lecture method?
ii. What is the difference in mean interest scores between students taught geometry using a blended instructional strategy and those taught using a modified lecture method?

Research Hypotheses

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

H_{01}: There is no significant difference in the mean achievement scores of students taught geometry using blended instructional strategy and those taught using the modified lecture method.

H_{02}: There is no significant difference in the mean attitude scores of students taught geometry using blended instructional strategy and those taught using the modified lecture method.

Methodology

The study employed a pre-test, post-test, non-equivalent control group quasi-experimental design. This design was chosen to allow for the investigation of intact groups in a real-life classroom setting, as assembling students for random intervention during school hours was impractical to avoid artificial conditions. The population under consideration was all mathematics students in Bayelsa State, and a sample of 179 second-year senior secondary school (SS2) students was utilized. Two co-educational Federal Government Colleges (FGC, Odi, and FSTC, Tungbo) were purposively selected due to their possession of Knowledge-Based Centers with functional computer laboratories. The SS2 class was chosen deliberately, considering the absence of impending external examinations that could distract students from active participation in the study. The content used aligned with the senior secondary mathematics curriculum. In each school, a total of eight classes were available, with four classes selected for the study. Simple random sampling, determined by coin flipping, was employed to select one class from each school, resulting in a total of four classes participating in the study. The allocation of these classes into experimental and control groups was achieved through random sampling via balloting, resulting in two classes assigned to the experimental group and the remaining two to the control group. All 179 SS2 students in the four selected school streams constituted the study's sample. The data collection instruments included a Geometry Achievement Test (GAT) and a Geometry Interest Inventory (GII) developed by the researcher. The GAT comprised two parts: Part I gathered personal data, while Part II consisted of 40 items covering chord property, arc theorem, semi-circle theorem, segment theorem, cyclic quadrilateral theorem, and alternate segment theorem. These items were aligned with the SS2 scheme of work in the mathematics curriculum for senior secondary school by NERDC (2015). The GAT questions were formulated using WAEC past questions from 2010-2019, employing a multiple-choice objective format with four options (A, B, C, and D). Each correctly answered question earned one mark, resulting in a total of 40 marks for the test. The reliability of GAT was established using Kudder-Richardson-20 and a coefficient of 0.79 was obtained and considered appropriate for the study. The GII was used to help students express their feelings towards geometry. It consists of two sections. Section A sought general information about respondents, while Section B bothered about their interest in geometry. The GII is a 30-item inventory with a five-point response type of *"Highly Interested"* if you like it very much to engage in the activity; *"Interested"* if you like to engage in it; *"Undecided"* if you like to neither like nor dislike it; *"Not interested,"* if you dislike engaging in the activity and "*Highly Not Interested"* if you very much dislike engaging in it. Like very much, like, neither like nor dislike, dislike, and dislike very much all had values of 5, 4, 3, 2, and 1, respectively. The instruments were validated by two (2) mathematics educators in the Science Education Department and one (1) measurement and evaluation expert, all of Rivers State University, Port Harcourt. The reliability index of the GII was established using the Cronbach Alpha reliability estimate. Cronbach alpha was used because the GII items were polytomously scored. The reliability index was found to be 0.80. Statistical Package for Social Science (SPSS) software version 26 will be used to analyze the data. The research questions will be answered using mean ($\bar{x}$) and standard deviation (SD) and the research hypotheses will be tested at 0.05 levels of significance using Analysis of Covariance (ANCOVA). The ANCOVA is an extension of the Analysis of Variance that allows you to explore the difference between groups, while statistically controlling for an additional variable called the Covariate (Pallant, 2018). The pre-GAT and pre-GII scores will serve as the covariates.

Results

Research Question 1: What is the difference in mean achievement scores of students taught geometry using blended instructional strategy and those taught using modified lecture method?

Table 1: Mean Achievement Scores, Standard Deviations and Mean Gain of Students Taught Using BIS and Lecture Method

Groups	N	Pre-Gat		Post-Gat		Mean Gain
		$\bar{x}$	SD	$\bar{x}$	SD	
Experimental	86	5.91	2.90	26.63	6.57	20.72
Control	93	7.52	3.63	17.90	3.96	10.33

Source: Fieldwork (2023)

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The table above shows that the experimental group obtained a mean achievement score of 5.91 and a standard deviation of 2.90 in the Pre-GAT a mean achievement score of 26.63 and a standard deviation of 6.57 in the Post-GAT. It was also revealed that the control group which represents those taught with the lecture method obtained a mean achievement score of 7.52 and a standard deviation of 3.63 in the Pre-GAT and a mean achievement score of 17.90 and a standard deviation of 3.96 in the Post-GAT. The standard deviations of students taught geometry using BIS and lecture methods increased from pre-GAT to post-GAT indicating that the scattering of the scores increases as the mean increased. The scattering of the scores was higher for those taught geometry using BIS when compared to those taught geometry using the lecture method. The mean gain between Pre-GAT and Post-GAT for experimental and control groups are 20.72 and 10.33 respectively. This implies that students taught geometry using the Blended instructional Strategy had a higher mean gain when compared with those taught using the lecture method.

Research Question 2: What is the difference in mean interest scores of students taught geometry using blended instructional strategy and those taught using modified lecture method?

Table 2: Mean Interest Scores, Standard Deviations and Mean Gain of Students Taught Using BIS and Lecture Method

Groups	N	Pre-GII		Post-GII		Mean Gain
		$\bar{x}$	SD	$\bar{x}$	SD	
Experimental	86	1.77	0.66	3.26	1.04	1.49
Control	93	1.72	1.55	2.31	0.76	0.59

The result in Table 2 shows that the students in the experimental group had a mean interest score of 1.77 and a standard deviation of 0.66 in the Pre-GII. In contrast, students in the control group had a mean interest score and standard deviation of 1.72 and 1.55, respectively. Similarly, in Post-GII, the mean interest score was 3.26 and the standard deviation was 1.04 for students in the experimental group, respectively, while the mean achievement score and standard deviation of students in the control group were 2.31 and 0.76, respectively. The standard deviations of students taught geometry using BIS increased from pre-GII to post-GII, indicating that the scattering of the scores increased as the mean increased, while the students taught with lecture method decreased from pre-GII to post-GII indicating that the scattering of the scores decreased as the mean increased. The scattering of the scores was higher for those taught geometry using BIS when compared to those taught geometry using the lecture method. The mean interest gain between Pre-GII and Post-GII for students taught in the experimental and control groups are 1.49 and 0.59, respectively. This implies that the mean interest gain of students taught geometry using BIS was higher than those taught using the Lecture method.

H_{01}: There is no significant difference in the mean achievement scores of students taught geometry using blended instructional strategy and those taught using the modified lecture method.

Table 3: Summary of Analysis of Covariance on Experimental and Control Group over achievement

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	3500.785[a]	2	1750.392	61.229	.000	.410
Intercept	14945.017	1	14945.017	522.781	.000	.748
PREGAT	90.550	1	90.550	3.167	.077	.018
GROUP	3479.330	1	3479.330	121.708	.000	.409
Error	5031.405	176	28.588			
Total	95962.000	179				
Corrected Total	8532.190	178				

Source: Fieldwork, 2023

The summary of data analysis presented in Table 3 shows that the main effect, the teaching method has an F-calculated value of 121.708 and a p-value of 0.00 which is less than the critical p-value of 0.05. This is based on 1 degree of freedom for the numerator and 176 degrees of freedom for the denominator. Thus, the null hypothesis is not accepted. This implies that there is a significant difference in the mean achievement scores of students taught geometry using the Blended Instructional Strategy and that taught using the lecture method.

H_{02}: There is no significant difference in the mean interest scores of students taught geometry using blended instructional strategy and those taught using modified lecture method.

Table 4: Analysis of Covariance for Students' Mean Interest Scores by Blended Instructional Strategy and lecture method

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	149.020[a]	2	74.510	91.168	.000	.509
Intercept	310.434	1	310.434	379.839	.000	.683
PREGII	.087	1	.087	.106	.745	.001
GROUP	148.501	1	148.501	181.702	.000	.508
Error	143.841	176	.817			
Total	1245.760	179				
Corrected Total	292.861	178				

Source: Fieldwork (2023)

The summary of data analysis presented in Table 4 shows that the main effect, the teaching approach has an F-calculated value of 181.702 and a p-value of 0.00 which is less than the critical p-value of 0.05. This is based on 1 degree of freedom for the numerator and 176 degrees of freedom for the denominator. This implies that the null hypothesis is rejected. That is the difference in mean interest scores of students taught geometry, using blended instructional strategy and those taught using the lecture method is statistically significant.

Discussion

Findings revealed that students taught geometry using the Blended Instructional Strategy had a higher mean gain when compared with those taught using the lecture method. Also, the finding affirmed a significant difference in the mean achievement scores of students taught geometry using the Blended Instructional Strategy and those taught using the lecture method. This, in general, revealed that the Blended Instructional Strategy, which provides the enabling environment to motivate students to discuss and allow them to develop spatial thinking and easy visualization of geometric concepts, can produce differential effects on students concerning their achievement. This finding aligns with Gamage and Charles-Ogan (2019), who reported a significant difference in favour of the use of a blended instructional strategy on students' achievement. On the contrary, the unhealthy achievement by the control group may be attributed to a lack of inadequate materials students not having the technical skills to construct the geometric shapes, and not knowing the rigorous ways of getting proofs done. This supports Ectuba (2018), Charles-Owaba and Ahiakwo (2021) and Charles-Owaba and Omeodu (2022) who reported that the blended instructional strategy appeals to more learning modalities when compared to the lecture method which appeals to only auditory learning modalities. The finding revealed that the mean interest gains of students taught geometry using BIS were higher than those taught using the Lecture method. Also, the finding affirmed that there is a difference in mean interest scores of students taught geometry using blended instructional strategy and those taught using lecture method is statistically significant. This finding aligns with Ectuban (2018), who reported that the Blended Instructional Strategy used for teaching mathematics attracted students' interest. It also supports the findings of Khristin et al. (2018), who reported that the use of mobile apps improved students' interest scores significantly.

Conclusion

The blended instructional strategy represents a harmonious fusion of traditional face-to-face teaching methodologies with innovative digital tools and online resources. It intertwines the strengths of both conventional classroom interaction and cutting-edge technological platforms to create an enriched, multifaceted learning environment. The study has affirmed that students taught geometry using the Blended Instructional Strategy had a higher mean gain in

achievement and interest when compared with those taught using the lecture method. Therefore, blended learning collaborative settings serve as an alternative methodology to enhance the teaching and learning of geometry in secondary schools.

Recommendations

Based on the findings of the study, it was recommended that:

1. A Blended Instructional Strategy should be implemented in the teaching and learning of geometry and mathematics in Nigerian secondary schools to enhance students' achievement and interest.
2. Students must have regular access to technologies that support learning to advance their mathematical thinking, reasoning, problem-solving, and communication skills.

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