Effect of Blended Learning Approach on Students' Academic Achievement in Mathematics in Delta North Senatorial District of Delta State

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Abstract— This study investigated the effect of blended learning approach on students' academic achievement in Mathematics in Delta north senatorial district of Delta state. Three research questions and hypotheses were each raised to guide the study. The scope of the study covered the effect of blended learning approach on students' academic achievement in SSS2 Mathematics in Algebra and Probability. The study is delimited to public secondary schools in the senatorial district. The design of the study was a quasi experimental design of pretest-posttest control group. The population of the study comprised all Senior Secondary School 2 (SSS 2) students in public secondary schools in the nine local government areas of Delta north senatorial district in the 2024/2025 academic session. The population of the study was 3,473 candidates. A multi stage sampling technique was used to draw a sample size of 225 SSS2 Mathematics students (105 males, and 120 females). Mathematics Achievement Test (MAT) was used for data collection. The reliability of the instrument was 0.79 obtained using Kudar-Richardson formulae 20 (KR-20). Analysis of Covariance (ANCOVA) and independent sample t-test were employed to test the hypotheses at a 0.05 level of significance. The findings of the result revealed that students exposed to the blended learning approach performed better than those exposed to the conventional lecture method. The findings also showed a significant difference between male and female students exposed to blended learning approach in favor of male students, and no interaction effect between instructional methods and sex. Based on the findings of this study, blended learning approach should be practiced thoroughly by Mathematics teachers as the method has been proven effective in enhancing students' Mathematics academic achievement.

Keywords: Blended Learning Approach; Mathematics; Academic Achievement; Delta State.

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INTRODUCTION

Mathematics remains a foundational discipline for scientific advancement, technological innovation, and socio-economic development. Its integration into formal education systems reflects its role in fostering critical thinking, logical reasoning, and problem-solving competencies essential for functioning in contemporary societies (Sidi, 2019; Egara & Mosimege, 2024; Ofem, et al., 2026). As a core subject, Mathematics underpins knowledge construction across disciplines and serves as a prerequisite for academic and professional progression (Blessing & Peter, 2019; Eraikhuemen, 2025).

Despite its recognized importance, students' academic achievement in Mathematics continues to decline in many contexts, including Delta North Senatorial District of Delta State. Academic achievement, defined as measurable learning outcomes demonstrated through mastery of knowledge and skills, is influenced by a complex interaction of cognitive, instructional, and environmental factors (Enwemasor & Charles-Odili, 2022; Cai & Cao, 2019). Evidence suggests that instructional approaches, teacher–student interactions, and learner engagement significantly determine students' performance outcomes (Anyagh, Agbo-Egwu, & Sabastine, 2018; Ebiala, 2024).

Among the variables associated with academic performance, sex has received considerable research attention. However, findings on sex differences in Mathematics achievement remain inconclusive. While some studies report higher achievement among male students (Anikweze & Shaluko, 2020; Ojaleye & Awofala, 2018), others find no significant differences (Adepeko, 2018), suggesting that observed disparities may be shaped more by socio-cultural and instructional factors than by inherent ability.

Instructional strategy is a critical determinant of learning outcomes. Traditional lecture-based approaches, which dominate Mathematics classrooms, emphasize teacher-centered delivery with limited student interaction and minimal instructional support (Yusuf, 2018; Nwagbo & Chikelu, 2019; Ebiala, 2021). Such approaches have been associated with persistent underachievement, as they often fail to address diverse learning needs or support conceptual understanding. Reports from public examination bodies (WAEC and NECO) consistently indicate unsatisfactory performance in Mathematics, highlighting systemic challenges related to pedagogy, resource availability, and student engagement.

In response, blended learning has emerged as a promising instructional alternative. By integrating face-to-face teaching with digital technologies, blended learning promotes flexibility, learner autonomy, and interactive engagement (Hendriawan & Septian, 2019; Adeyemi & Ojo, 2020; Ebiala, 2023a). It leverages tools such as learning management systems, virtual simulations, and interactive assessments to enhance content delivery and facilitate personalized learning experiences. Empirical evidence consistently demonstrates that blended learning improves academic achievement by

increasing access to resources, enabling repeated practice, and providing immediate feedback (Lateef & Adewale, 2021; Tseng, Kano, & Hsu, 2014; Li & Wang, 2022).

Nevertheless, the effectiveness of blended learning across sex remains insufficiently understood. Differences in learning preferences, self-regulation, and engagement patterns may produce varying outcomes in technology-enhanced environments (Villarroel & Bruna, 2023; Prawat, 2022; Ebiala, 2023b). While several studies report no significant sex-based differences in blended learning outcomes (Al-Fahad, 2020; Adegbija & Fakomogbon, 2021; Deng, Peng, & Li, 2022), the evidence is not yet definitive.

Against this backdrop, this study examines the effect of blended learning on students' academic achievement in Mathematics in Delta North Senatorial District, with particular focus on sex differences. By situating the analysis within a context of persistent underperformance, the study contributes to ongoing efforts to identify effective, evidence-based instructional strategies for improving Mathematics outcomes.

STATEMENT OF THE PROBLEM

Mathematics plays a critical role in the development of logical reasoning, problem-solving abilities, and analytical thinking, all of which are essential for academic progression and participation in science- and technology-driven fields. Despite its importance, persistent underachievement in Mathematics has been widely reported among secondary school students, particularly in Delta North Senatorial District of Delta State.

Conventional instructional practices in Mathematics are predominantly characterized by teacher-centered, face-to-face methods, where content delivery relies heavily on verbal explanation and routine exercises. While this approach facilitates content coverage, it often fails to address individual learning differences or support the conceptual understanding required for mastering abstract mathematical ideas. Consequently, students continue to experience difficulties in comprehension, leading to consistently poor performance in internal and external examinations.

The persistent decline in students' achievement raises concerns regarding the effectiveness of existing instructional approaches. It suggests a potential misalignment between teaching methods and the evolving learning needs of students. This situation necessitates the exploration of alternative instructional strategies that can enhance engagement, improve conceptual understanding, and support diverse learning preferences.

Blended learning, which integrates digital technologies with traditional classroom instruction, has been identified as a potential approach for improving learning outcomes. However, empirical evidence on its effectiveness within the context of Delta North Senatorial District remains limited.

Therefore, this study seeks to empirically examine the effect of the blended learning approach on students' academic achievement in Mathematics in Delta North Senatorial District of Delta State.

RESEARCH QUESTIONS

This study will seek answers to the following questions:

1. Will there be difference in students' mean pretest-posttest achievement scores exposed to blended learning approach and lecture method?
2. Will male and female students show differences in their mean achievement scores when exposed to blended learning approach?
3. What is the interaction effect of instructional method and sex on students' mean achievement scores?

HYPOTHESES

The following null hypotheses were formulated and tested at 0.05 levels of significance:

1. There will be no significant difference in students' mean pretest-posttest achievement scores exposed to blended learning approach and lecture method.
2. There will be no significant difference between Male and female students' mean achievement scores when exposed to blended learning approach.
3. There will be no significant interaction effect of instructional method and sex on students' mean achievement scores.

METHODS AND MATERIALS

This study adopted a quasi-experimental pretest–posttest control group design with a 2 × 2 factorial structure. The factors included instructional approach (blended learning vs. lecture method) and sex (male vs. female). Intact classes were utilized to preserve the natural classroom setting, with one group assigned to the experimental condition (blended learning) and the other to the control condition (lecture method).

The population comprised 3,473 Senior Secondary School II (SSS2) students in public secondary schools across the nine Local Government Areas of Delta North Senatorial District during the 2024/2025 academic session. A multistage sampling technique was employed to enhance representativeness. This involved stratified sampling to ensure coverage across the senatorial district, followed by simple random sampling to select participants. A total sample of 225 students (105 males and 120 females) was obtained.

Data were collected using a researcher-developed Mathematics Achievement Test (MAT). The instrument consisted of two sections: Section A captured demographic information, while Section B contained 30 multiple-choice items (options A–D) covering

Algebra and Probability based on the SSS2 curriculum. The use of objective test items ensured standardization and ease of scoring.

The reliability of the instrument was established using the Kuder–Richardson Formula 20 (KR-20), yielding a coefficient of 0.79, indicating acceptable internal consistency.

Data analysis was conducted using Analysis of Covariance (ANCOVA) and independent samples t-test at a 0.05 level of significance. Pretest scores were treated as covariates to control for baseline differences between groups, thereby improving the precision and validity of the estimated treatment effects.

PRESENTATION OF RESULTS

Data were analyzed to examine the effect of instructional approach (blended learning vs. lecture method) and sex on students' academic achievement in Mathematics. Descriptive and inferential statistics were employed in line with the stated research hypotheses.

Hypothesis 1: There will be no significant difference in students' mean pretest-posttest achievement scores exposed to blended learning approach and lecture method.

Table1: Analysis of Covariance (ANCOVA) on students' mean pretest-posttest achievement scores exposed to blended learning approach and lecture method.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	6546.190[a]	1	6546.190	89.756	.000	.287
Intercept	42138.755	1	42138.755	577.771	.000	.722
Pre	6546.190	1	6546.190	89.756	.000	.287
Error	16264.139	223	72.933			
Total	800264.000	225				
Corrected Total	22810.329	224				

a. R Squared = .287 (Adjusted R Squared = .284)

The results presented in Table 1 show that the effect of instructional approach on students' academic achievement was statistically significant, $F(1, 223) = 89.76$, $p < .001$, with a partial eta squared ($\eta^2 = .287$). Since the calculated p-value is less than the 0.05 level of significance, the null hypothesis is rejected. This indicates that a significant difference exists in the mean achievement scores of students exposed to blended learning and those taught using the lecture method.

The magnitude of the effect size (η^2 = .287) suggests a large practical effect, indicating that approximately 28.7% of the variance in students' posttest achievement scores is attributable to the instructional approach. This demonstrates that the type of instructional method employed plays a substantial role in determining students' academic outcomes in Mathematics. Furthermore, the significant contribution of the covariate (pretest), $F(1, 223) = 89.76$, $p < .001$, confirms that initial differences in students' prior knowledge were effectively controlled. This strengthens the internal validity of the findings and indicates that the observed differences in posttest scores are primarily due to the treatment effect rather than pre-existing ability differences.

The R^2 value of .287 (adjusted R^2 = .284) indicates that the model explains approximately 28.7% of the total variance in students' achievement scores, reflecting a moderate-to-strong explanatory power within an educational research context.

Overall, the findings provide empirical evidence that the blended learning approach significantly enhances students' academic achievement in Mathematics compared to the conventional lecture method.

Hypothesis 2: There will be no significant difference between Male and female students' mean achievement scores exposed to blended learning approach.

Table 2: t-test difference between male and female students' mean achievement scores exposed to blended learning approach

Variable	Gender	N	Mean	Std. Deviation	Df	T	Sig. (2-tailed)	Decision
blended learning approach	Male	105	60.44	10.118	223	2.321	.021	Rejected
	Female	120	57.33	9.883				

$\alpha = 0.05$

The independent samples t-test results presented in Table 2 indicate a statistically significant difference between male and female students' mean achievement scores, $t(223) = 2.321$, $p = .021$. Since the p-value is less than the alpha level of 0.05, the null hypothesis is rejected.

Male students (M = 60.44, SD = 10.12) achieved higher posttest scores than female students (M = 57.33, SD = 9.88) under the blended learning approach. This finding suggests that, within this sample, male students responded more positively to the blended learning instructional strategy than female students.

Although the difference is statistically significant, the mean difference of 3.11 points may be considered moderate in educational practical terms. These results highlight that sex may influence the degree of benefit derived from blended learning, suggesting the need for tailored instructional strategies to ensure equitable outcomes across genders.

In summary, while blended learning positively impacts achievement overall, male students exhibited slightly higher performance than female students in this context, indicating that gender differences should be considered in implementing digital-enhanced teaching approaches.

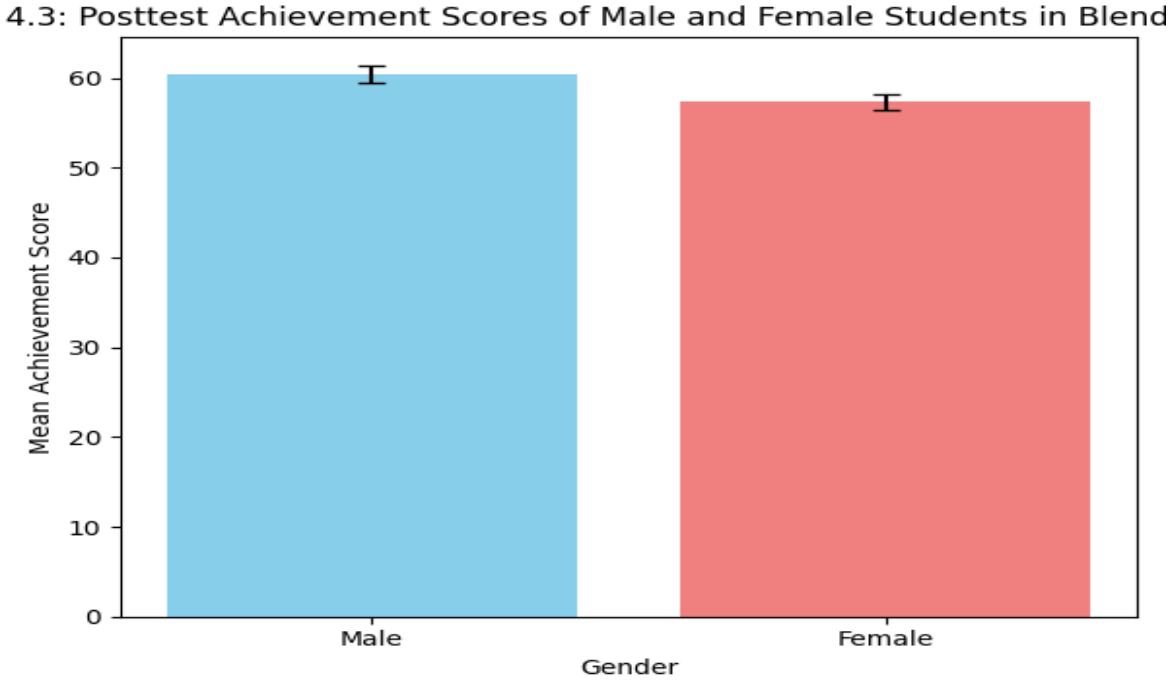

Figure 2

Figure 2 illustrates the posttest achievement scores of male and female students exposed to the blended learning approach. The chart shows that male students (M = 60.44, SD = 10.12) achieved slightly higher scores than female students (M = 57.33, SD = 9.88).

The difference between the groups is statistically significant, as confirmed by the t-test ($t(223) = 2.321$, $p = .021$), indicating that male students benefited more from the blended learning intervention than their female counterparts within this sample. The error bars representing standard error show minimal overlap, supporting the presence of a measurable difference between sexes.

These findings suggest that while blended learning is generally effective in improving Mathematics achievement, sex-related variations in response may exist. This highlights the potential influence of gender-specific learning preferences or engagement patterns

in digital-enhanced instructional environments. Educators may therefore need to consider differentiated strategies to optimize outcomes for all learners.

In summary, Figure 2 provides visual evidence of a modest but statistically significant advantage for male students under the blended learning approach, reinforcing the importance of considering sex as a variable in instructional design and evaluation.

Hypothesis 3: There will be no significant interaction effect of instructional method and sex on students' mean achievement scores.

Table 3: Analysis of Covariance (ANCOVA) on the interaction effect of instructional methods and sex on students' mean achievement scores

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	8729.582[a]	4	2182.396	34.098	.000	.383
Intercept	42844.480	1	42844.480	669.410	.000	.753
Pre	3989.978	1	3989.978	62.340	.000	.221
Sex	76.953	1	76.953	1.202	.274	.005
Instructional Method	2027.357	1	2027.357	31.676	.000	.126
Sex * Instructional Method	.851	1	.851	.013	.908	.000
Error	14080.747	220	64.003			
Total	800264.000	225				
Corrected Total	22810.329	224				

a. R Squared = .383 (Adjusted R Squared = .371)

The results presented in Table 3 indicate that the interaction effect of instructional method and sex on students' achievement scores was not statistically significant, $F(1, 220) = 0.013$, $p = .908$, with a negligible effect size (partial $\eta^2 = .000$). Since the p-value exceeds the alpha level of 0.05, the null hypothesis is retained.

This indicates that the effect of instructional method on academic achievement was consistent across male and female students. In other words, both sexes responded similarly to the blended learning and lecture methods, and the type of instructional approach did not differentially benefit one gender over the other. The covariate (pretest scores) was significant ($F = 62.34$, $p < .001$, $\eta^2 = .221$), confirming that initial differences in prior knowledge were controlled, which strengthens the internal validity of the analysis. The main effect of instructional method was significant ($F = 31.68$, $p < .001$, $\eta^2 = .126$), indicating that blended learning improved achievement regardless of sex, while

the main effect of sex alone was not significant ($F = 1.202$, $p = .274$). The model explained 38.3% of the variance in posttest scores ($R^2 = .383$, Adjusted $R^2 = .371$), reflecting a moderate-to-strong explanatory power in predicting Mathematics achievement.

In summary, the findings suggest that while blended learning significantly enhances students' performance, its effectiveness does not depend on sex, reinforcing its applicability as a universally effective instructional strategy.

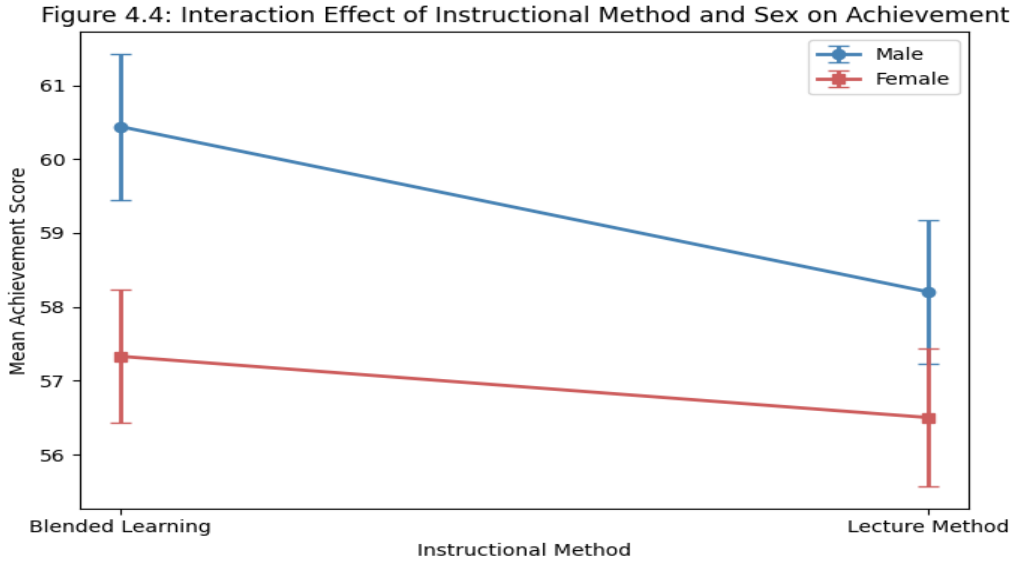

Figure 3

Figure 3 illustrates the interaction between instructional method (blended learning vs. lecture) and sex (male vs. female) on students' posttest achievement scores. The plot shows parallel trends for both sexes across instructional methods, indicating that **male and female students responded similarly to the blended learning and lecture approaches**.

Male students consistently scored slightly higher than female students across both instructional methods, but the differences were minimal. The parallel lines and overlapping error bars visually reinforce the statistical finding from Hypothesis 3, which showed **no significant interaction effect** ($F(1, 220) = 0.013$, $p = .908$, $\eta^2 = .000$).

This indicates that the **effectiveness of the instructional method is independent of sex,** confirming that blended learning improves achievement uniformly across male and female students. The error bars, representing standard error, demonstrate that variability within each group is relatively small, further supporting the reliability of the observed patterns.

In summary, Figure 3 provides clear visual evidence that **blended learning enhances academic achievement regardless of gender,** making it a robust and universally effective instructional strategy in the Mathematics classroom.

DISCUSSION OF FINDINGS

The study investigated the effect of the blended learning approach on students' academic achievement in Mathematics in Delta North Senatorial District, considering sex as a moderating factor. The findings provide empirical evidence on the effectiveness of blended learning relative to the traditional lecture method, as well as insight into gender-related performance patterns.

Effect of Instructional Method on Achievement

Hypothesis one examined whether there would be a significant difference in the academic achievement of students exposed to blended learning versus the lecture method. The results (Table 1; Figures 4.1 and 4.2) showed a statistically significant difference in posttest scores ($F(1, 223) = 89.76$, $p < .001$, $\eta^2 = .287$), with students in the blended learning group outperforming those taught using the lecture method. This large effect size suggests that blended learning substantially enhances students' understanding of mathematical concepts. The result aligns with prior studies indicating that technology-integrated instruction facilitates active engagement, immediate feedback, and self-paced learning, which collectively contribute to higher achievement (Lateef & Adewale, 2021; Suleman, Hussain, Din, & Iqbal, 2017; Tseng, Kano, & Hsu, 2014).

The enhanced performance in the blended learning group may be attributed to the combination of face-to-face instruction and digital learning tools, which supports the cognitive, motivational, and metacognitive needs of students. Features such as interactive simulations, multimedia tutorials, and adaptive assessments enable students to internalize abstract concepts in Algebra and Probability, resulting in higher mean gains.

Effect of Sex on Achievement

Hypothesis two tested whether male and female students exposed to blended learning differed in academic achievement. The independent samples t-test revealed a significant difference ($t(223) = 2.321$, $p = .021$), with male students performing slightly higher than female students (Figure 4.3). While the difference was modest (mean difference = 3.11 points), it suggests that sex may influence how students engage with blended learning environments. These findings corroborate studies indicating that males may exhibit slightly higher performance in mathematics when using technology-enhanced instructional approaches (Anikweze & Shaluko, 2020; Ojaleye & Awofala, 2018).

However, the practical significance of the sex difference is limited. The blended learning approach still benefited both males and females, suggesting that equitable

access to digital resources and interactive content can reduce, but not entirely eliminate, minor gender disparities. This underscores the importance of adopting inclusive instructional practices that accommodate diverse learning preferences.

Interaction Effect of Instructional Method and Sex

Hypothesis three examined whether instructional method and sex interactively influence achievement. The ANCOVA results (Table 3; Figure 3) indicated no significant interaction effect ($F(1, 220) = 0.013$, $p = .908$, $\eta^2 = .000$). The interaction plot shows parallel lines for males and females across both instructional methods, confirming that the effectiveness of blended learning does not depend on sex. This finding aligns with research suggesting that, when provided with structured, technology-integrated instructional support, both male and female students achieve similar learning outcomes (Li & Wang, 2022; Adegbija & Fakomogbon, 2021).

The absence of interaction emphasizes the robustness and universal applicability of blended learning as a teaching strategy in secondary school Mathematics. It demonstrates that the observed gains in achievement are primarily attributable to the instructional method rather than inherent sex differences. The significant main effect of instructional method alongside the nonsignificant main effect of sex highlights that blended learning enhances learning outcomes across all students, supporting its adoption in the broader educational system.

Implications

These findings reinforce the critical role of instructional design in Mathematics education. The study confirms that blended learning, through its integration of digital tools and conventional classroom instruction, offers superior learning outcomes compared to the traditional lecture method. Educators and policymakers should consider scaling blended learning strategies to improve academic achievement, while also ensuring equitable access for both male and female students.

The results further suggest that minor sex-based differences in achievement can be mitigated through targeted support, adaptive learning, and inclusive content delivery. Overall, the study provides compelling evidence for the adoption of blended learning as a pedagogical approach capable of enhancing Mathematics achievement while remaining effective across genders.

CONCLUSION

Based on the findings of this study, it was concluded that:

There was a significant difference in students' mean achievement scores between students exposed to blended learning approach, and lecture method. Those exposed to

blended learning approach performed better than those exposed to lecture methods. Also, there was a significant difference in students' mean achievement scores between male and female students exposed to blended learning approach. Therefore, blended learning has a positive effect on academic achievement

RECOMMENDATIONS

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

1. Blended learning approach should be practiced thoroughly in Delta north by Mathematics teachers as the method has been proven effective in enhancing students' Mathematics academic achievement.
2. Mathematics teachers should minimize the use of lecture method in teaching Mathematics to enhance students' academic achievement.
3. Mathematics teachers should make the teaching and learning of Mathematics interactive and activity–based for the students using blended learning approach.
4. Government should encourage Mathematics teachers by providing the needed resources and enabling environment for teaching and learning in blended learning approach.
5. Government should conduct periodically, regular workshops for Mathematics teachers on the effective use of blended learning approach.

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