

Different Paths, Same Destination? Comparing Students' Mathematics Achievement under Team-Based and Lecture Methods in Delta Central Senatorial District

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Abstract: *This study compared students' mathematics achievement under team-based and lecture methods in Delta Central Senatorial District of Delta State. A pretest-posttest planned variation quasi-experimental design was adopted. The study involved 361 SSII Mathematics students selected from six public secondary schools through multistage sampling. Data were collected using a 50-item Mathematics Achievement Test (MAT), which had a reliability coefficient of 0.81 established using the Kuder-Richardson Formula 21. Mean and standard deviation were used to answer the research questions, while analysis of covariance (ANCOVA) and independent-samples t-test were used to test the hypotheses at the 0.05 level of significance. Results showed that students taught using team-based learning obtained a higher posttest mean achievement score (61.35) than those taught using lecture method (50.34). The ANCOVA revealed a significant effect of instructional method on students' mathematics achievement, $F(1, 358) = 61.146, p < .001$. Male students taught using team-based learning had a slightly higher mean score (63.06) than females (60.04), but the difference was not significant, $t(184) = 1.557, p = .121$. Similarly, male students under lecture method scored higher (52.27) than females (48.31), but the difference was not statistically significant, $t(173) = 1.970, p = .050$. The study concluded that team-based learning was more effective than lecture method, while sex did not significantly differentiate students' achievement under either method.*

Keywords: team-based learning, lecture method, mathematics achievement, sex.

Introduction

Mathematics occupies a central position in formal education because of its contribution to logical reasoning, quantitative understanding and problem-solving. In Nigeria, its importance is reflected in its prominent place within the school curriculum and external assessment programmes, including the West African Senior School Certificate Examination (WASSCE) (Federal Republic of Nigeria, 2013; West African Examinations Council [WAEC], 2020, 2021, 2022, 2023, 2024). However, the place accorded mathematics in the curriculum does not by itself determine the quality of students' learning, since classroom experiences and instructional practices shape how learners engage with mathematical ideas.

Mathematics learning requires opportunities for students to interpret concepts, explain their reasoning, examine alternative solutions and apply knowledge to problems. Such processes are closely associated with interaction and shared participation in learning. Dillenbourg (2017) emphasised the importance of interaction in collaborative learning, while Vygotsky (1978) highlighted the role of social interaction in cognitive development. Similarly, Kyndt et al. (2017) and Gillies (2016) reported evidence of the relationship between collaborative learning and academic outcomes. These perspectives draw attention to the organisation of classroom learning as an important consideration in mathematics instruction.

Team-based learning represents one structured approach to organising such participation. It involves purposeful preparation, team activities and application-oriented tasks through which learners work collectively to engage with course content (Michaelsen & Sweet, 2016; Sibley et al., 2018). Research has associated team-based learning with student engagement and learning outcomes (Bleske et al., 2016; Kim et al., 2018), while mathematics-focused studies have examined its relationship with students' attitudes, engagement and achievement (Clark et al., 2018; Lewis & Estis, 2020). These findings provide a basis for considering team-based learning within the broader search for effective ways of organising mathematics instruction.

Evidence from mathematics education also suggests that collaborative approaches can be associated with students' achievement and attitudes. Veloo et al. (2016) examined cooperative learning in relation to achievement and attitude in mathematics, while Sadeghi and Khezlrou (2019) investigated collaborative learning and students' attitudes and achievement. Roka and Khatri (2024) similarly reported on collaborative learning and mathematics achievement. However, the potential value of collaborative approaches does not eliminate the relevance of established instructional practices, particularly the lecture method, which remains widely used for presenting and explaining subject content (Kapur, 2020). This makes comparison between instructional approaches more meaningful than assuming the value of either approach in isolation.

Team-based learning and lecture instruction also involve substantially different patterns of classroom participation. While team-based learning emphasises structured interaction among learners, lecture instruction places greater emphasis on teacher-

directed presentation. Comparative studies have examined students' perceptions of team-based and traditional lecture-based learning (Frame et al., 2016), while Huggins and Stamatel (2019) compared team-based learning with traditional instruction in relation to students' attitudes. Nevertheless, the outcomes associated with team-based learning may depend on how effectively its collaborative processes are organised and supported, since teachers' instructional practices influence the quality of student collaboration (Webb et al., 2019). This suggests that claims concerning instructional effectiveness require evidence from particular learning contexts.

The issue of context becomes more important because much of the established literature on team-based learning has emerged from higher education and professional disciplines (Fatmi et al., 2017; Reimschisel et al., 2017). Although such studies provide useful evidence, their findings cannot automatically be transferred to secondary school mathematics classrooms. Furthermore, the achievement of male and female students may warrant attention because research has examined the interaction between collaborative learning and gender-related outcomes (Li & Lam, 2020). These considerations point to the need for context-specific evidence on achievement under different instructional arrangements.

Accordingly, the present study was undertaken to provide empirical evidence on students' mathematics achievement under team-based and lecture methods and to examine achievement differences between male and female students within each instructional condition in Delta Central Senatorial District of Delta State. Rather than assuming the superiority of either approach, the study provides a basis for comparing their achievement outcomes within the same educational context. The evidence generated is expected to clarify the extent to which the two instructional pathways are associated with students' mathematics achievement and whether achievement patterns within each approach differ by sex.

Statement of the Problem

Mathematics remains an important subject in secondary education, yet students' achievement continues to be a concern. The problem may not be attributed solely to the difficulty of mathematical concepts, but also to how learning experiences are organised in the classroom. While the lecture method remains widely used, it provides relatively limited opportunities for sustained peer interaction and shared problem-solving. Team-based learning offers a different arrangement in which students participate more actively in structured learning activities. However, the availability of an alternative approach does not establish that it will necessarily produce better achievement.

The concern is further heightened by the need to know whether male and female students achieve differently under each instructional approach. Without context-specific evidence, teachers may have limited empirical basis for deciding how best to organise mathematics instruction or whether achievement patterns vary across the two approaches. The problem of the study, therefore, is: What difference exists in students' mathematics achievement under team-based and lecture methods, and does achievement differ between male and female students within each method in Delta Central Senatorial District of Delta State?

Purpose of the Study

The study aimed to compare students' mathematics achievement under team-based learning and lecture method in Delta Central Senatorial District of Delta State. Specifically, the study sought to:

1. determine the effects of team-based learning and lecture method on students' mean achievement scores in mathematics;
2. determine the difference between the mean achievement scores of male and female students taught mathematics using team-based learning; and
3. determine the difference between the mean achievement scores of male and female students taught mathematics using lecture method.

Research Questions

The following research questions guided the study:

1. What are the effects of team-based learning and lecture method on students' mean achievement scores in mathematics?
2. What is the difference between the mean achievement scores of male and female students taught mathematics using team-based learning?
3. What is the difference between the mean achievement scores of male and female students taught mathematics using lecture method?

Hypotheses

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

1. There are no significant effects of team-based learning and lecture method on students' mean achievement scores in mathematics.
2. There is no significant difference between the mean achievement scores of male and female students taught mathematics using team-based learning.
3. There is no significant difference between the mean achievement scores of male and female students taught mathematics using lecture method.

Methods

The study adopted a pretest-posttest planned variation quasi-experimental design to compare team-based learning and lecture method. The independent variable was instructional method, with team-based learning and lecture method as the two levels, while sex was the moderating variable and mathematics achievement was the dependent variable. The population comprised 9,146 SSII Mathematics students in 195 public secondary schools in Delta Central Senatorial District of Delta State during the 2025/2026

academic session. A sample of 361 students, comprising 171 males and 190 females, was selected from six public secondary schools using a multistage sampling procedure. Three LGAs were randomly selected, followed by the random selection of two schools from each LGA. The six schools were subsequently assigned to the two instructional conditions, with three schools receiving team-based learning and three receiving lecture method.

Data were collected using a 50-item Mathematics Achievement Test (MAT) adapted from past WASSCE Mathematics questions. The items covered the Mathematics content taught during the six-week treatment, and each correct response attracted two marks, giving a maximum score of 100. The instrument was validated by three experts, while its content coverage was guided by a table of specification. Reliability was established using KR-21, which yielded a coefficient of 0.81.

The treatment lasted six weeks. Before treatment, the MAT was administered as a pretest. Students in the team-based learning group were organised into heterogeneous teams and engaged in readiness assurance activities, feedback, application exercises, peer evaluation and teacher-supported collaborative tasks. Students in the lecture group received teacher-directed instruction involving content presentation, demonstration, questioning, note-taking and individual exercises. Regular Mathematics teachers served as research assistants and were trained to ensure consistency in treatment implementation. At the end of the treatment, the MAT was administered as a posttest, with the items rearranged to minimise test familiarity.

Mean and standard deviation were used to answer the research questions. ANCOVA was used to compare posttest achievement under the two instructional methods while controlling for pretest scores, whereas independent-samples t-test was used to examine differences between male and female students within each instructional condition. The hypotheses were tested at the 0.05 level of significance using SPSS.

Results

Table 1: Mean Achievement Scores by Method

Group	Testing	N	$\bar{x}$	MD	SD
Team-based learning	Pretest	186	16.27	45.08	5.64
	Posttest	186	61.35		13.18
Lecture method	Pretest	175	16.86	33.48	5.71
	Posttest	175	50.34		13.41

Table 1 shows that students taught using team-based learning obtained a higher posttest mean achievement score (61.35) than those taught using lecture method (50.34). Although both groups improved from pretest to posttest, the higher posttest performance of the team-based learning group suggests that team-based learning was more effective than lecture method in enhancing students' mathematics achievement.

Table 2: ANCOVA of Achievement by Method

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	10996.215 ^a	2	5498.108	31.070	.000
Intercept	122760.782	1	122760.782	693.720	.000
Pretest	62.324	1	62.324	.352	.553
Method	10820.329	1	10820.329	61.146	.000
Error	63351.685	358	176.960		
Total	1207116.000	361			
Corrected Total	74347.900	360			

Table 2 shows that instructional method had a statistically significant effect on students' mathematics achievement, $F(1, 358) = 61.146, p < .001$. This means that the observed difference in achievement between the two instructional methods was unlikely to have occurred by chance. Since students taught using team-based learning recorded the higher adjusted achievement, team-based learning was more effective than lecture method. Thus, H_{01} was rejected. The result implies that the way mathematics learning is organised can make a meaningful difference in students' achievement, with the team-based approach providing a more favourable learning outcome in this study.

Table 3: Team-Based Learning Achievement by Sex

Sex	N	$\bar{x}$	MD	SD
Male	81	63.06	3.02	13.79
Female	105	60.04		12.60

Table 3 shows that male students taught using team-based learning obtained a higher mean achievement score (63.06) than female students (60.04), giving a mean difference of 3.02. However, this descriptive difference alone does not establish a statistically meaningful sex difference.

Table 4: t-Test of Team-Based Learning Achievement by Sex

Method	N	$\bar{x}$	MD	SD	df	t_{cal}	Sig.(2-tailed)
Male	81	63.06	3.02	13.79	184	1.557	0.121
Female	105	60.04		12.60			

Table 4 shows that the difference between the mean achievement scores of male and female students taught using team-based learning was not statistically significant, $t(184) = 1.557$, $p = .121$. Therefore, H_{02} was not rejected. The result implies that team-based learning supported comparable mathematics achievement among male and female students, despite the slightly higher mean score recorded by male students.

Table 5: Lecture Achievement by Sex

Sex	N	$\bar{x}$	MD	SD
Male	90	52.27	3.96	10.39
Female	85	48.31		15.80

Table 5 shows that male students taught using lecture method obtained a higher mean achievement score (52.27) than female students (48.31), with a mean difference of 3.96. As with the team-based learning group, the descriptive difference requires statistical testing before any conclusion can be drawn.

Table 6: t-Test of Lecture Achievement by Sex

Method	N	$\bar{x}$	MD	SD	Df	t_{cal}	Sig.(2-tailed)
Male	90	52.27	3.96	10.39	173	1.970	0.050
Female	85	48.31		15.80			

Table 6 shows that the difference between male and female students' mean achievement scores under lecture method was not statistically significant at the 0.05 level, $t(173) = 1.970$, $p = .050$. Therefore, H_{03} was not rejected. The result implies that male and female students achieved comparably under lecture method, although male students recorded a somewhat higher mean score.

Discussion

The study found that team-based learning produced higher mathematics achievement than lecture method. Students taught using team-based learning recorded a higher posttest mean score than those taught using lecture method, while the ANCOVA showed that the difference was statistically significant. This finding suggests that the structured interaction, shared problem-solving and active participation associated with team-based learning provided learning experiences that were more conducive to mathematics achievement than the predominantly teacher-directed lecture approach. The finding is consistent with earlier evidence that collaborative and team-based learning can enhance students' academic outcomes through active engagement and interaction (Gillies, 2016; Kyndt et al., 2017). It also agrees with findings reported by Bleske et al. (2016) and Kim et al. (2018), which associated team-based learning with improved learning outcomes. The present finding further supports mathematics-related evidence reported by Veloo et al. (2016) and Roka and Khatri (2024), who found positive learning outcomes associated with collaborative approaches. The implication is that the structure through which mathematics learning takes place can be an important consideration in improving students' achievement.

The significant difference between the two instructional methods may also be explained by the opportunities provided for students to engage actively with mathematical ideas. Team-based learning requires learners to prepare, interact with peers, discuss solutions and apply concepts to tasks, whereas lecture method places greater emphasis on teacher presentation and individual reception of information. The finding is therefore consistent with the view that meaningful peer interaction can support learning by enabling students to explain, question and refine their understanding through social engagement (Dillenbourg, 2017; Vygotsky, 1978). It also corresponds with research showing that the quality of teacher-supported collaboration is important to productive student learning (Webb et al., 2019). However, the result should not be interpreted to mean that lecture method is inherently ineffective; rather, within the conditions of this study, team-based learning was associated with significantly higher mathematics achievement.

The study further revealed that male students taught using team-based learning obtained a slightly higher mean achievement score than their female counterparts, but the difference was not statistically significant. This finding indicates that the higher mean score of male students was not sufficiently large to establish a meaningful sex-based difference in achievement under team-based learning. The result suggests that the collaborative structure of team-based learning provided broadly comparable achievement opportunities for male and female students. This finding is noteworthy because research on collaborative learning has continued to examine whether learner characteristics interact with instructional approaches to produce different outcomes (Li & Lam, 2020). The present finding therefore provides evidence that, within this study, sex did not significantly differentiate mathematics achievement among students exposed to team-based learning.

Similarly, male students taught using lecture method recorded a higher mean achievement score than female students, but the difference was not statistically significant at the 0.05 level. Although the result approached the conventional significance threshold, the obtained p -value of .050 was treated as not significant in accordance with the decision rule adopted for the study. Thus,

the finding does not provide sufficient evidence to conclude that male and female students differed significantly in mathematics achievement under lecture method. Taken together with the result for team-based learning, the findings indicate that the significant achievement difference observed in the study was associated with instructional method rather than sex. This reinforces the importance of examining the instructional condition itself when considering students' mathematics achievement.

Conclusion

The study concluded that team-based learning was more effective than lecture method in promoting students' mathematics achievement. Although students taught using both methods improved between pretest and posttest, those exposed to team-based learning achieved significantly higher posttest scores. The study also concluded that male and female students did not differ significantly in mathematics achievement under either team-based learning or lecture method. Thus, the findings suggest that instructional method was more consequential for students' achievement than sex within the conditions of the study.

Recommendations

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

1. Mathematics teachers should incorporate team-based learning into classroom instruction, particularly when teaching concepts that require discussion, application and collaborative problem-solving.
2. School administrators should provide opportunities for mathematics teachers to receive practical training on the planning and implementation of team-based learning activities.
3. Curriculum planners and teacher educators should give greater attention to structured collaborative instructional approaches in mathematics education to complement conventional teacher-directed methods.
4. Mathematics teachers should ensure that both male and female students are given equitable opportunities to participate actively in team-based and other classroom learning activities, since no significant sex difference in achievement was established under either instructional method.

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