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Research paper

Enhancing Mathematics Interest and Retention Through Student Teams Achievement Division (STAD): A Quasi-Experimental Study in Nigerian Secondary Schools

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ABSTRACT

Mathematics interest, achievement, and retention remain persistent challenges in secondary school education, particularly in developing contexts where instructional practices often rely on teacher-centred approaches. This study investigated the effectiveness of the Student Teams Achievement Division (STAD) strategy, a cooperative learning approach, in enhancing students' interest and retention in mathematics. This study adopted a quasi-experimental pretest–posttest–follow-up design. The sample comprised 93 Senior Secondary Two (SS II) students from two public schools in Ekiti State, Nigeria. Participants were divided into an experimental group taught using STAD and a control group taught with conventional methods. Data were collected using the Mathematics Performance Test (MPT) and the Student Mathematics Interest Scale (SMIS) (KR-21 = 0.83; $\alpha = 0.87$) and analysed using ANCOVA, repeated-measures ANOVA, and t-tests at the 0.05 level. Findings revealed a significant main effect of instructional strategy on mathematics interest, with students exposed to STAD demonstrating significantly higher interest scores than those taught using the conventional method ($F=92.846$; $p<0.05$; $\eta^2 =.513$). No significant gender differences were found in mathematics interest ($F=.237$; $p=.628$; $\eta^2 =.003$). Similarly, findings revealed a significant main effect of instructional strategy on mathematics retention, with students exposed to STAD demonstrating higher retention scores than those taught using the conventional method ($F = 403.496$, $p < .05$, $\eta^2 = .816$). No significant gender differences were found in mathematics retention ($t = 0.389$, $p = .699$). STAD effectively enhances mathematics interest and long-term retention regardless of gender, supporting its integration into secondary school mathematics instruction.

Keywords: student teams achievement division (STAD), mathematics interest, knowledge retention, gender differences, mathematics achievement

Mathematics proficiency remains a cornerstone of innovation in science and technology, underpinning every aspect of modern advancement. Often described as the language of science, mathematics provides the logical and analytical framework through which discoveries and inventions are made possible. Mathematics plays an influential role in day-to-day life; it is essential for acquiring knowledge in all fields and lines of work (Kolawole & Popoola,

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2009). One purpose of mathematics learning in schools is to develop competent individuals who can apply the knowledge acquired to solve challenges in their daily lives. Mathematics instruction, therefore, aims to develop learners who can apply mathematical reasoning to practical, real-life challenges. This educational objective aligns with the broader societal need for mathematically literate citizens who can contribute meaningfully to the problem-solving demands of modern economies. In the Nigerian educational context, mathematics holds a pivotal position within the curriculum, helping students develop vital skills such as critical thinking and problem-solving (Falebita et al., 2022; Salami & Spangenberg, 2024). Mastery of mathematics is widely recognised as a basic component required for academic success and a gateway to professional careers in science or technology-related fields, which are indispensable in today's innovation-driven world (Kohen & Nitzan, 2022; Wang et al., 2017). Students aspiring to advance academically or professionally must attain a strong foundation in mathematics, as it strengthens their capacity to understand scientific concepts and engage effectively with complex societal problems (Maass et al., 2019; Popoola & Falebita, 2016). In Nigeria, this recognition is reflected in the national requirement that candidates must achieve a secondary school mathematics credit pass at the graduating level to gain admission into tertiary institutions. However, despite its importance, many students continue to perceive mathematics as difficult or uninspiring, a sentiment that has persisted over time and been noted by Nardi and Steward (2003) and Russo and Minas (2020). This perception highlights the need for instructional approaches that make mathematics more engaging, meaningful, and accessible to learners.

Given the importance of mathematics, research has revealed unimpressive student performance in internal and external examinations. Research indicates that a lack of interest in mathematics significantly correlates with lower achievement levels, creating a cycle of disinterest that can persist throughout a student's educational journey (Hidi & Renninger, 2006). Addressing students' interest is therefore critical, as enhanced interest and improved retention are closely associated with better academic outcomes and increased learner confidence. When students demonstrate poor performance in mathematics, blame is often directed at various stakeholders, including the government, students, teachers, and even parents. However, closer examination suggests that instructional practices within the classroom play a significant role in shaping students' learning experiences (Ayebale et al., 2020; Falebita, 2019). Research explicitly addressing issues around student retention and interest in secondary school mathematics in the Nigerian setting is noticeably inadequate, despite the field's acknowledged value in education and its vital role in developing analytical thinking and the ability to solve problems. Some studies have explored various aspects of mathematics education; however, few have holistically examined how enhancing student interest can simultaneously improve retention rates in mathematics. This gap is especially worrisome considering the significant impact that mathematics proficiency has on academic progress and career opportunities in STEM fields. Addressing this gap is essential for developing effective instructional strategies that not only engage students but also sustain their interest and retention in mathematics throughout their educational journey. Students find it difficult to understand many concepts in Mathematics because teachers adopt only one method in teaching all the topics in Mathematics, and fail to bring dynamism into the teaching of Mathematics (Asanre et al., 2026; Bature, 2020; Waswa & Al-kassam, 2023). Teacher-centred teaching methods are used in which the teacher maintains active control while the students sit quietly and listen, rendering the class inactive for the students (Serin, 2018). These instructional approaches have been criticised for being largely unengaging (Falebita, 2019; Oyinloye & Popoola, 2013). Consequently, there is a growing need to adopt student-centred strategies that actively involve learners in the teaching and learning of mathematics. One promising approach to address these challenges is the Student Teams Achievement Division (STAD) instructional approach, which points out cooperative learning and collaborative engagement among students.

Cooperative learning is a vital teaching strategy that fosters social interaction and enhances students' understanding of mathematics (Falebita, 2019). Students are encouraged to collaborate in diverse teams as part of STAD's cooperative learning initiative, which promotes a sense of belonging and shared accountability for learning (Slavin, 1995). In a STAD classroom, students are assigned to diverse teams or groups of five or seven members, each collaborating on learning objectives, with each member taking on specific roles to ensure accountability and participation. Responsibilities are distributed among team members, such as a recorder, reporter, and checker, allowing each student to contribute their strengths while supporting their peers in mastering the content (Falebita & Salami, 2021; Falebita, 2019; Slavin, 1995). After the teacher introduces the topic for the day, the students are presented with specific tasks to complete as a group. The students then work together to find solutions to the given tasks under the coordination of the team leader. As students engage in group discussions and practice, they enhance their understanding and help their teammates, fostering a cooperative learning environment that promotes mutual success (Kagan, 2010). Engaging in these structured roles and interactions is expected to make the learning of mathematics more interesting and meaningful for students.

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LITERATURE REVIEW

Theoretical foundation

This research is grounded in the social learning theory of Albert Bandura. According to this theory, social context-based modelling, imitation, and observation are how student learning occurs (Bandura, 1986). Social learning theory indicates that when students work and interact together, they often learn from each other by watching how tasks are performed, which improves their teamwork skills as well as their understanding and retention of the learned concepts (Gambari & Yusuf, 2014; Petersson McIntyre, 2021; Webb, 2026). Bandura argued that nearly all kinds of learning can occur through observing others' actions and their effects. He also emphasized that the process of observational learning is guided by four main stages: attention, retention, reproduction, and motivation (Bandura, 1986). Attention involves selectively observing and gathering information from ongoing activities. Cooperative learning relies on individual learners paying attention to the teacher and peers, especially by watching how others solve specific problems, which has been shown to produce positive results (Alenizi, 2016). Retention refers to organizing information into rules and ideas, which are stored in memory for later use. It emphasizes how well the behaviours a person has observed are remembered; if someone notices behaviour but does not remember it, they may be less likely to imitate it. Cooperative learning can enhance the retention of taught concepts because students' attention during class activities may be captured by interactions with peers, motivating them to exert more effort (Tran, 2014; Spence, 2026). Reproduction is the act of performing the behaviour that the learner has observed. At this stage, the individual reproduces an action based on what they have seen. The ability to replicate the behaviour demonstrated by the model involves physical skills and self-assessment of the reproduction (Bandura, 2023). This stage strengthens understanding through practice and feedback, thereby supporting long-term retention (Bandura, 2005). Motivation is the desire or willingness to perform the behaviour, influenced by the reward or punishment following it, as perceived by the observer. Bandura (2001) argued that for learning to be effective, the learner must be motivated to imitate the behaviour.

Bandura's Social Learning Theory provides a robust explanatory lens for understanding how the STAD instructional strategy enhances mathematics learning and retention. Within STAD, students' *attention* is captured through structured peer interaction, group discussions, and shared problem-solving activities that promote sustained cognitive engagement. The *retention* process is strengthened as learners repeatedly observe peers' solution strategies, verbal explanations, and corrective feedback, facilitating the encoding and consolidation of mathematical concepts. STAD also supports *reproduction* by providing opportunities for learners to practice observed strategies during team tasks, quizzes, and individual accountability exercises, thereby translating observed behaviours into demonstrable performance. Finally, *motivation* is reinforced through group rewards, peer recognition, and a supportive learning environment, which collectively enhance learners' willingness to persist and apply learned mathematical skills over time. By integrating attention, retention, reproduction, and motivation within collaborative classroom environments, social learning theory provides a strong theoretical justification for the use of cooperative learning strategies such as STAD to enhance students' interest and retention in mathematics.

'Student teams achievement division (STAD)' strategy

One cooperative learning technique that promotes student participation and collaboration is the Student Teams Achievement Division (STAD). According to Odutayo and Fonseca (2024), students learn from one another with teachers serving primarily as facilitators. Individual accountability, fair opportunity for success, and team rewards constitute the core elements of STAD (Slavin, 1995). Team rewards motivate collective effort, while individual accountability ensures that each student contributes meaningfully to group success (Shafiee Rad et al., 2023). Groups typically consist of four or five heterogeneous students organised by ability, gender, and background (Hidayah et al., 2023; Sulami et al., 2022). Teachers provide structured guidance, after which students collaboratively read, discuss, and synthesise learning materials (Sa'adiah et al., 2021). Group learning outcomes are assessed through presentations and quizzes, with combined scores reflecting academic progress (Aslan Berzener & Deneme, 2021; Falebita & Salami, 2021; Luthfi & Murtiyasa, 2024). This structure aligns with social learning theory by fostering peer modelling, shared responsibility, and motivational reinforcement, all of which are critical for enhancing interest and retention in mathematics learning.

Impact of STAD on students' mathematics learning outcomes

The STAD learning strategy has been widely applied and found to enhance various learning outcomes, including achievement, analytical thinking, problem-solving, and critical reasoning across educational levels (Bakir & Banikhalaf, 2025). Empirical studies demonstrate improvements in algebra performance (Odutayo & Fonseca, 2024), analytical thinking (Kamid et al., 2022), geometry problem-solving (Luthfi & Murtiyasa, 2024), numerical ability (Sa'adiah et al., 2021), and critical thinking (Amalia et al., 2025). While these studies collectively suggest that

STAD positively influences mathematics learning outcomes, most emphasise cognitive achievement measures, often overlooking affective outcomes such as sustained interest and long-term retention**.** Harefa (2023) highlighted that meaningful and enjoyable learning experiences enhance motivation and engagement, which are essential for effective learning. Eze (2024) further demonstrated that STAD improves students' retention of mathematical concepts. Additionally, comparative studies indicate that students taught using STAD outperform those taught with traditional instructional methods (Gupta & Jain, 2014; Khun-inkeeree et al., 2018; Odutayo & Fonseca, 2024). STAD has been shown to enhance performance across topics such as scale drawing (Njoroge & Githua, 2013), algebra (Odutayo & Fonseca, 2024), and geometry and numeration (Khun-inkeeree et al., 2018). However, a significant proportion of these studies were conducted outside the Nigerian secondary school context, limiting contextual generalisation.

Students' interest, retention, and STAD

Interest plays a crucial role in effective learning interaction (Acar et al., 2025). Students who demonstrate interest are more likely to persist, engage actively, and retain learned content (Ginting, 2021). Sariani et al. (2021) emphasised that interest stimulates motivation and improves academic performance. Studies by Ismanto and Hartono (2014), Tiwow et al. (2020), and Suripah (2015) found that STAD enhances students' interest in mathematics more effectively than conventional instructional approaches. Despite these findings, empirical studies examining students' interest and retention concurrently, particularly at the secondary school level in Nigeria, remain scarce**.** Existing studies tend to examine either interest or achievement in isolation, leaving a gap in understanding how instructional strategies like STAD support sustained engagement and long-term retention simultaneously. This limitation necessitates further research focused on both interest and retention outcomes within the Nigerian context.

Gender, STAD, and student learning outcomes in mathematics

Gender differences in mathematics learning have been widely debated. While mathematics has historically been perceived as male-dominated (Scafidi & Bui, 2010), recent evidence presents a more nuanced picture. Mejía-Rodríguez et al. (2021) reported modest male advantages in mathematics achievement, whereas Eriksson (2020) found that female students in many contexts demonstrate higher interest in mathematics (Lee et al., 2023). Cooperative learning strategies such as STAD have been identified as effective in promoting equitable learning conditions. Studies by Adi and Odula (2024), Njoroge and Githua (2013), and Odutayo and Fonseca (2024) found no significant gender differences in achievement or interest when students were taught using STAD. However, limited studies have examined gender differences in students' long-term retention and sustained interest within cooperative learning environments**,** particularly in Nigerian secondary schools.

The reviewed literature establishes STAD as an effective cooperative learning strategy for enhancing mathematics achievement and engagement. However, several gaps remain evident. First, few studies have simultaneously examined students' interest and long-term retention in mathematics using STAD. Second, empirical evidence within Nigerian secondary schools remains limited, despite contextual differences in instructional practices. Third, gender-related effects of STAD on sustained interest and retention are underexplored. This study addresses these gaps by empirically investigating the effects of STAD on students' interest and retention in mathematics, as well as examining gender differences in these outcomes.

Hypotheses

Alternative and null hypotheses were proposed to provide a clear direction for the study and statistical testing as follow:

Hypothesis 1:

H_0: The STAD learning strategy does not significantly have effects on students' interest in mathematics.
H_1: The STAD learning strategy significantly has effects on students' interest in mathematics.

Hypothesis 2:

H_0: Students' interests do not significantly differ by gender when exposed to the STAD learning strategy.
H_1: Students' interests significantly differ by gender when exposed to the STAD learning strategy.

Hypothesis 3:

H_0: The STAD learning strategy does not significantly have effects on students' retention in mathematics.
H_1: The STAD learning strategy significantly has effects on students' retention in mathematics.

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Hypothesis 4:

H_0: Students' retention does not significantly differ by gender when exposed to the STAD learning strategy.
H_1: Students' retention significantly differs by gender when exposed to the STAD learning strategy.

METHODOLOGY

Research design

This study used a quasi-experimental design with pretest and posttest control groups to investigate how STAD enhanced students' interest in and recall of mathematics. The study was classified as quasi-experimental because it involved non-randomised groups, comprising a control group that received conventional instruction and an experimental group that engaged in the STAD approach.

Sample and sampling technique

The population in this study was all Senior Secondary Two (SS II) (Grade 11) students in public senior secondary schools in Ekiti State. This study involved a total of 93 SS II students drawn from two different public secondary schools. A multistage sampling technique involving stratified and cluster sampling was employed. At the first stage, using stratified random sampling, Ekiti State was divided into two strata based on senatorial regions (Ekiti North and Ekiti South). One school was then randomly selected (simple random sampling) from each stratum to ensure the sample represented geographic diversity. At the next stage, using cluster sampling, from each selected school, one intact SS II class was selected as a cluster for the study. From the selected schools, the SS II has more than one arm, therefore, the entire classes were selected using simple random sampling. These whole classes were then designated as experimental and control groups. To minimize validity threats such as treatment diffusion, the two selected schools were from different regions to minimize interaction between students from different groups. Throughout the study, the researchers ensured that the intervention (STAD) was only administered to the experimental group and that all groups were taught separately.

Instrumentation

Two primary research instruments were employed to gather data: the Mathematics Performance Test (MPT) and the Student Mathematics Interest Scale (SMIS). The MPT was created to assess students' performance and is composed of two sections. Demographic information was sought in the first section, while the second included 25 multiple-choice questions adapted from previous Senior School Certificate Examination (SSCE) papers, focusing on geometry topics. The SMIS, a two-part questionnaire, was used to measure students' interest in mathematics. Section A collected personal information, and a 4-point Likert scale was used to rate 10 statements in Section B, enabling the researchers to measure students' interest levels effectively. The questionnaire items were adapted from Zhang and Wang (2020) by modifying them to suit the study's context. Using a sample of 30 SSS II students who did not later join the main groups, we verified both instruments and assessed their reliability through a pilot study. The validity of the research instruments was confirmed through a thorough review process involving content validity and expert assessments. Content validity was ensured by having subject matter experts and educators evaluate the MPT and SMIS, confirming that the items accurately represented the intended constructs. Additionally, pilot testing these tools with a student sample allowed necessary adjustments to improve clarity and relevance. The data from the pilot study were analyzed statistically: the MPT data were analyzed using the Kuder-Richardson (KR-21) formula, and the SMIS data were analyzed with the Cronbach Alpha method. The reliability coefficients were 0.83 for the MPT and 0.87 for the SMIS, both considered acceptable for this research. This approach enabled us to measure academic performance and examine how teaching methods influence students' interest in mathematics, offering valuable insights into effective educational practices. Consequently, the instruments were deemed suitable for assessing students' performance and interest in mathematics within this study.

Procedure

To collect baseline data, the experimental and control groups administered pre-tests of the Student Mathematics Interest Scale (SMIS) and the Mathematics Performance Test (MPT). The experimental group engaged in learning using the STAD technique, which emphasised collaboration and active participation in mathematics classes, following the preliminary evaluation. In contrast, the control group received instruction utilising conventional teaching techniques, ensuring that both groups studied the same mathematics topics (such as circle geometry). For the STAD method, the teacher serves as a facilitator, introducing the day's topic to students, explaining the concepts, and then dividing them into small groups. Students collaborate in their groups to complete a task designed by the teacher based on the lesson goals. Groups are formed considering their current ability levels, mixing students of different abilities and genders to promote peer learning. Next, students work to clarify their ideas for one another. Conversely, the conventional group used the typical learning approach. Students participated in 15 lessons over five weeks, each lasting 40 minutes. During this time, two topics from the SSII syllabus were covered: circle geometry and algebraic fractions. This structured approach ensured consistent content delivery for both groups, allowing for a fair comparison of the teaching methods' effectiveness. After the five-week intervention, both groups were re-evaluated with the same tests, the MPT and SMIS, to measure any changes in students' performance and interest in mathematics due to the different instructional strategies. Additionally, to assess retention, the MPT was readministered after six weeks, and performance scores were recorded.

Data analysis

The data collected were analyzed using various statistical methods to test the four research hypotheses. The analysis was conducted using SPSS version 29 software at a significance level of $\alpha = 0.05$. The data analysis techniques used are described as follows:

Analysis of Covariance (ANCOVA): This technique was used to test Hypothesis 1 (the effect of STAD on mathematics interest) and Hypothesis 3 (the effect of STAD on mathematics retention). ANCOVA was chosen because it allows comparing posttest scores between the experimental and control groups while controlling for any differences in pretest scores that may have existed prior to the treatment. Thus, the difference in the posttest can be more reliably attributed to the treatment effect.

For Hypothesis 1: An ANCOVA was run with the SMIS post-test score (interest) as the dependent variable and the SMIS pre-test score as the covariate.

For Hypothesis 3: An ANCOVA was run with the MPT retention score (test after 6 weeks) as the dependent variable and the MPT pre-test score as the covariate.

Independent Samples t-test: This technique was used to test Hypotheses 2 (gender-based differences in interest in the STAD group) and Hypothesis 4 (gender-based differences in retention in the STAD group). The independent t-test was conducted by comparing retention scores (MPT after 6 weeks) between male and female students only in the experimental group (STAD).

Repeated Measures ANOVA: This technique was used as a complementary analysis to examine the pattern of change in mathematics ability over time (from pre-test, post-test, to follow-up test) within each group. This analysis provides additional insight into retention dynamics, particularly for Hypothesis 3.

Estimated Marginal Means and Pairwise Comparisons: These two analyses are not the primary analysis techniques, but rather post-hoc procedures generated after running an ANCOVA or Repeated Measures ANOVA. Estimated Marginal Means show the post-test means adjusted for covariates (pre-test), while Pairwise Comparisons are used to identify significant differences between groups when the ANCOVA results indicate a significant effect.

This comprehensive analysis approach ensures robust and precise testing of all research hypotheses.

RESULTS

Table 1 presents the descriptive statistics of students' performance in the conventional and STAD instructional groups across three measurement points: pretest, posttest, and follow-up. In the pretest, the conventional group (M = 32.09, SD = 1.93) and the STAD group (M = 31.83, SD = 2.04) had comparable mean scores, indicating similar baseline performance. For the posttest, the conventional group recorded a mean of 48.91 (SD = 6.29), while the STAD group achieved a higher mean of 63.46 (SD = 4.18). At the follow-up stage, the conventional group had a mean score of 40.64 (SD = 4.60), whereas the STAD group maintained a mean of 63.48 (SD = 3.74). Overall, the table shows changes in performance across the three tests for both groups, with differences in means and variability observed between the instructional methods.

Table 1

Descriptive statistics of students' mathematics performance in pretest, posttest, and follow-up across instructional groups

Test	Group	n	M	SD
Pretest	Conventional	47	32.09	1.93
	STAD	46	31.83	2.04
Posttest	Conventional	47	48.91	6.29
	STAD	46	63.46	4.18
Follow-up	Conventional	47	40.64	4.60
	STAD	46	63.48	3.74

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Hypothesis 1:

H_0: The STAD learning strategy does not significantly have effects on students' interest in Mathematics.
H_1: The STAD learning strategy significantly have effects on students' interest in Mathematics.

Table 2 reveals that the students' interest in mathematics does not differ significantly ($F = 0.583$; $p = 0.447$) at the commencement of the experiment, establishing the homogeneity of the group before the administration of treatments. This implies that changes or differences in interest could come from the treatment administered to the students. Also, the table shows that treatment has a significant effect ($F=92.846$; $p<0.05$; partial $\eta^2 =.513$) on the interest of students in mathematics. The alternative hypothesis was retained after the null was rejected. The partial Eta square value of .513 indicates that the treatment contributed 51.3%. The Estimated Marginal Mean and the Bonferroni Multiple Comparison analysis were employed to determine the extent of the effects of STAD and conventional learning strategies. The results show that the conventional group had an estimated marginal mean of 24.876, while the STAD group had 31.195 (*see* Table 3). The STAD group's mean difference of 6.319 was determined to be significant at the 0.05 level of significance based on the Bonferroni multiple comparison of the two groups (*see* Table 4). This suggests a strong correlation between students' interest in mathematics and the STAD learning approach. Hence, the STAD learning strategy significantly has effects on students' interest in Mathematics.

Table 2
ANCOVA of students' interest in mathematics for STAD and conventional learning strategy group and by gender

Source	SS	df	MS	F	p	Partial η^2
Corrected Model	919.520a	4	229.880	23.213	.000	.513
Intercept	492.688	1	492.688	49.751	.000	.361
PreInterest	5.777	1	5.777	.583	.447	.007
GROUP	919.458	1	919.458	92.846	.000	.513
Gender	1.691	1	1.691	.171	.680	.002
GROUP * Gender	2.344	1	2.344	.237	.628	.003
Error	871.469	88	9.903			
Total	74647.000	93				
Corrected Total	1790.989	92				

a. R Squared = .513 (Adjusted R Squared = .491)

Table 3
*Interest estimated marginal mean GROUP * GENDER*

GROUP	GENDER	Mean	S.E	95% CI	
				LB	UB
Conventional	Male	24.898a	.647	23.612	26.184
	Female	24.854a	.657	23.548	26.161
	Total	24.876a	.460	23.963	25.790
STAD	Male	30.899a	.630	29.647	32.151
	Female	31.491a	.692	30.117	32.866
	Total	31.195a	.467	30.268	32.122

Table 4
Interest pairwise comparisons of STAD and conventional groups

(I) GROUP	(J) GROUP	MD (I-J)	S.E	Sig.b	95% CI for Differenceb	
					LB	UB
Conventional	STAD	-6.319*	.656	.000	-7.622	-5.015
STAD	Conventional	6.319*	.656	.000	5.015	7.622

**. significant at the .05 level. (MD – Mean Difference)*
b. Adjustment for multiple comparisons: Bonferroni.

Hypothesis 2:

H_0: Students' interests do not significantly differ by gender when exposed to the STAD learning strategy.
H_1: Students' interests significantly differ by gender when exposed to the STAD learning strategy.

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Table 2 shows that the students' interest in mathematics does not significantly differ by gender (F=.171; p=.680; partial η^2=.002). Also, the student's interest in mathematics does not significantly differ by gender across groups (F=.237; p=.628; partial η^2=.003). Table 3 shows that the Estimated Marginal means of male and female students in the STAD group are 30.899 and 31.491, respectively, which is not significant. The fact that the null hypothesis was not rejected suggests that the alternative hypothesis was not retained. Therefore, Students' interests do not significantly differ by gender when exposed to the STAD learning strategy.

Hypothesis 3:

H_0: The STAD learning strategy does not significantly have effects on students' retention in Mathematics.
H_1: The STAD learning strategy significantly have effects on students' retention in Mathematics.

Table 5 shows that at the commencement of the experiment, the students' achievement in mathematics does not differ significantly (F = 2.882; p = 0.093), establishing the homogeneity of the group before the administration of treatments. This implies that changes or differences in retention could come from the treatment administered to the students. Also, the table shows that treatment has a significant effect (F=690.997; p<0.05; partial η^2=.887) on the retention of students in mathematics. The alternative hypothesis was retained after the null was rejected. The partial Eta square value of .887 indicates that the treatment contributed 88.7%. The Estimated Marginal Mean and the Bonferroni Multiple Comparison analysis were employed to determine the extent of the effects of STAD and conventional learning strategies on the students' retention. The results show that the conventional group had an estimated marginal mean of 40.587, while the STAD group had 63.558 (*see* Table 6). The STAD group's mean difference of 22.971 was determined to be significant at the 0.05 level of significance based on the Bonferroni multiple comparison of the two groups (*see* Table 7). This suggests a strong correlation between students' Mathematics retention and the STAD learning approach. Hence, the STAD learning strategy significantly has effects on students' Mathematics retention.

Table 5

ANCOVA of students' retention in mathematics for STAD and conventional learning strategy group and by gender

Source	SS	df	MS	F	p	Partial η^2
Corrected Model	12181.979a	4	3045.495	173.170	.000	.887
Intercept	524.686	1	524.686	29.834	.000	.253
Pretest	50.677	1	50.677	2.882	.093	.032
GROUP	12152.388	1	12152.388	690.997	.000	.887
Gender	1.674	1	1.674	.095	.758	.001
GROUP * Gender	3.890	1	3.890	.221	.639	.003
Error	1547.634	88	17.587			
Total	264578.000	93				
Corrected Total	13729.613	92				

a. R Squared = .513 (Adjusted R Squared = .491)

Table 6

*Retention estimated marginal mean GROUP * GENDER*

GROUP	GENDER	Mean	S.E	95% CI	
				LB	UB
Conventional	Male	40.656a	.862	38.942	42.370
	Female	40.519a	.876	38.778	42.259
	Total	40.587a	.612	39.370	41.805
STAD	Male	63.217a	.840	61.549	64.886
	Female	63.900a	.922	62.068	65.731
	Total	63.558a	.622	62.323	64.794

Table 7

Retention pairwise comparisons of STAD and conventional groups

(I) GROUP	(J) GROUP	MD (I-J)	S.E	Sig.b	95% CI for Difference[b]	
					LB	UB
Conventional	STAD	-22.971*	.874	.000	-24.708	-21.234
STAD	Conventional	22.971*	.874	.000	21.234	24.708

**. significant at the .05 level. (MD – Mean Difference)*
b. Adjustment for multiple comparisons: Bonferroni.

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To further affirm the retention effects, a 3×2 repeated measures ANOVA was conducted to examine the effect of instructional strategy (STAD vs. conventional) on students' mathematics achievement across three time points (pre-test, post-test, and follow-up). The result is presented in **Table 8**.

Table 8

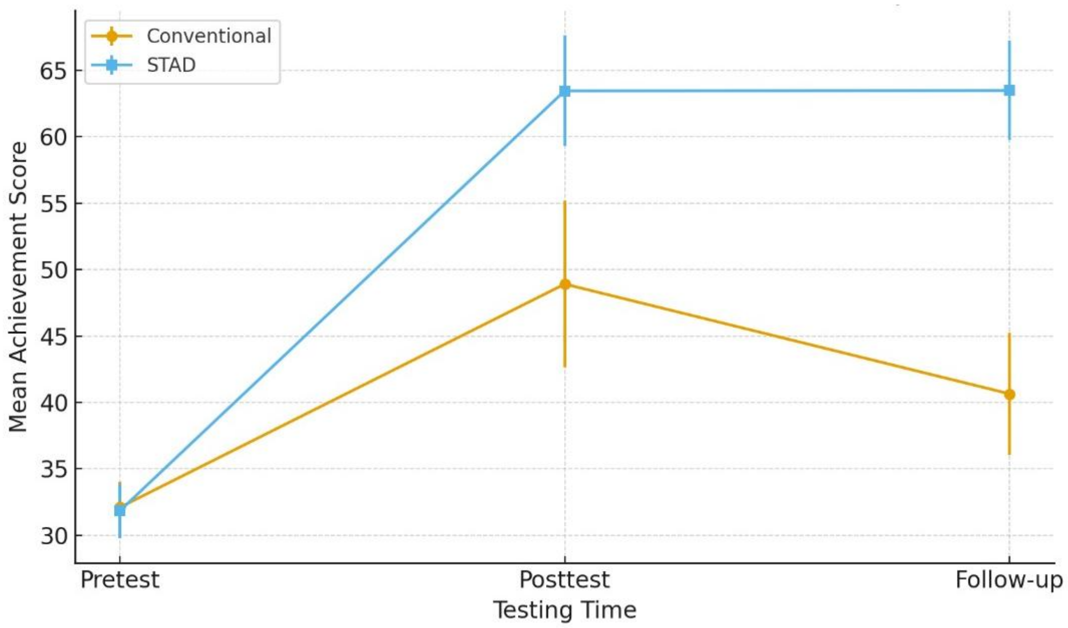
Repeated measures ANOVA analysis showing the effect of STAD and conventional methods on students' retention in mathematics

Source	SS	df	MS	F	p	Partial η^2
Within-Subjects Effects						
Time (factor1)	31,252.192	2	15,626.096	1323.221	< .001	.936
Time × Group	6,365.769	2	3,182.884	269.527	< .001	.748
Error (Time)	2,149.263	182	11.809			
Between-Subjects Effects						
Group	10,678.926	1	10,678.926	403.496	< .001	.816
Error	2,408.407	91	26.466			

The results of the repeated measures ANOVA analysis presented in **Table 8** indicate significant effects of both instructional methods, STAD and conventional methods, on students' retention in mathematics among the sampled groups. The within-subjects effects reveal a significant main effect of time, $F(2,182) = 1323.221, p < .05$, with a large effect size (Partial η^2 = .936). This suggests that students' retention in mathematics improved significantly over the measured time points. The interaction effect between time and group was also significant, $F(2,182) = 269.527, p < .05$, indicating that the impact of time on retention varied depending on the instructional method used, with a substantial effect size (Partial η^2 = .748). In terms of between-subjects effects, the analysis shows a significant effect of group, $F(1,91) = 403.496, p < .05$, with a large effect size (Partial η^2 = .816). The alternative hypothesis was retained after the null was rejected. Hence, the STAD learning strategy significantly has effects on students' retention in Mathematics. This finding suggests that students taught through the STAD method retained significantly more mathematical knowledge compared to those taught using conventional methods. **Figure 1** further illustrates the significant differences in student Mathematics achievement scores between the STAD and conventional groups. Initially, both groups had similar low scores (STAD = 31.83, Conventional = 32.09) at the pretest. However, by the posttest, the STAD group surged to an average score of 63.46, while the conventional group only reached approximately 48.91. This stark contrast highlights the effectiveness of the STAD method in enhancing student retention of mathematical concepts. Moreover, the follow-up scores indicate that the STAD group maintained their higher achievement levels (STAD = 63.48, Conventional = 40.64), suggesting that the benefits of cooperative learning (STAD) extend beyond immediate results.

Figure 1

Student retention by instructional strategies



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Hypothesis 4:

H_0: Students' retention does not significantly differ by gender when exposed to the STAD learning strategy.

H_1: Students' retention significantly differs by gender when exposed to the STAD learning strategy.

In the STAD group, the follow-up retention scores for 'male and female students' in mathematics were compared using an independent samples t-test, as shown in **Table 9**. The analysis included 25 male students and 21 female students. The mean retention score for male students was 63.28 (SD = 3.76), while female students had a slightly higher mean score of 63.71 (SD = 3.80). No significant gender differences were found in mathematics retention (t = 0.389, p = .699). This indicates that male and female students exhibited comparable retention levels following the instructional intervention. Also indicated by Cohen's d, the effect size was 0.115, implying a small effect. This shows that the alternative hypothesis was not retained since the null hypothesis was not rejected. Hence, students' retention does not significantly differ by gender when exposed to the STAD learning strategy. These findings indicate that, despite the observed difference in means, gender did not significantly influence retention scores in mathematics among students using the STAD method. This suggests that the STAD instructional approach may be equally effective for both male and female students in enhancing retention in mathematics.

Table 9

t-Test comparing male and female students' follow-up (Retention) scores in mathematics in the STAD group

Test	Gender	n	M	SD	df	t	p	Cohen's d
Follow-up	Male	25	63.28	3.76	44	0.389	.699	.115
	Female	21	63.71	3.80				

DISCUSSIONS

The STAD strategy has been recognized as a learning approach that encourages collaborative learning and peer tutoring, where students learn from each other (Bandura, 1986; Camacho-Minuche et al., 2021). This approach fosters important social skills such as leadership, teamwork, and communication; its benefits extend beyond academic achievement. The study shows that the STAD learning strategy enhances students' interest in Mathematics significantly. For the reason that students have the chance to interact within groups, they can discuss freely without fear of reprimand, making the interaction more enjoyable. When students feel comfortable, they understand what they are gaining from the experience and have a solid grasp of the course material. The findings align with those of Ismanto and Hartono (2014), Tiwow et al. (2020), and Suripah (2015), who all found that compared to conventional learning methodologies, STAD is more effective in enhancing students' interest in Mathematics. This confirms that the STAD instructional strategy has the potential to enhance mathematics learning and help students enjoy classroom instruction.

Additionally, this study reveals that students' interests do not differ significantly by gender after being introduced to the 'STAD learning approach'. This finding suggests that the STAD learning strategy benefits both male and female students in enhancing their interest in mathematics. It also suggests that gender does not impact the effectiveness of this instructional method. This outcome implies that the STAD strategy is equally effective for both male and female students in stimulating and sustaining their interest in mathematics. In essence, the cooperative and inclusive nature of the STAD model appears to create a level playing field, where all learners, regardless of gender, benefit from active engagement, mutual support, and shared responsibility for learning outcomes. This indicates that gender does not serve as a determinant of how students respond to the STAD method, suggesting that the strategy transcends traditional barriers that often influence classroom participation and learning motivation. The implication of this finding is profound. It suggests that the 'STAD learning approach' can be leveraged as a powerful tool to rekindle enthusiasm for mathematics among students who have historically shown disinterest or low motivation toward the subject. By encouraging teamwork, discussion, and peer mentoring, STAD helps learners to see mathematics as a collaborative and interactive experience rather than an isolating or intimidating one. This finding resonates with the conclusions of Njoroge and Githua (2013) and Odutayo and Fonseca (2024), who also reported that students' interest in mathematics does not vary significantly by gender when exposed to cooperative learning models like STAD. The likely explanation is that STAD's emphasis on peer tutoring, shared goals, and group accountability nurtures a supportive learning environment where all students can thrive, irrespective of gender differences. Thus, the approach holds great promise for promoting inclusivity and enhancing students' overall engagement and interest in mathematics learning.

Furthermore, this study demonstrates that the 'STAD learning strategy' has a significant impact on students' retention in Mathematics, suggesting cooperative learning's efficacy in fostering long-term understanding. This aligns with the findings of Eze (2024), Khun-inkeeree et al. (2018), and Odutayo and Fonseca (2024), which indicate that STAD enhances performance across various mathematical topics, including algebra and geometry,

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while aiding in the retention of learned concepts. The success of STAD can be closely linked to Bandura's Social Learning Theory, particularly the retention and reproduction stages. According to Bandura, retention involves the ability to remember and internalize information, which is critical for effective learning. STAD reinforces this stage by encouraging students to work collaboratively, discuss their problem-solving approaches, and actively participate. This collaborative process enables learners to internalize mathematical concepts more effectively, making them more accessible for future recall. Furthermore, the social dynamics inherent in STAD contribute to improved retention by fostering a supportive classroom environment. In such settings, students feel comfortable asking questions and sharing diverse perspectives, which enhances their understanding of the material. Bandura emphasizes that social interactions play a crucial role in learning, as they provide repeated exposure to key concepts. This repetition, combined with peer discussions, is crucial for solidifying knowledge in long-term memory. Moreover, as shown in previous studies by Gupta and Jain (2014), the combination of teamwork and structured peer interactions not only enhances immediate learning outcomes but also promotes long-term retention. The STAD strategy aligns with Bandura's notion that effective modeling and observation in a social context can lead to the successful reproduction of learned behaviours and concepts.

The study also shows that students' retention in mathematics does not significantly differ by gender when using the STAD learning strategy. This highlights the efficacy of cooperative learning in achieving equitable learning outcomes. The absence of a statistically significant gender difference in mathematics retention suggests that the STAD instructional strategy supported sustained learning outcomes equally for male and female students. This finding aligns with Bandura's Social Learning Theory, which emphasizes shared learning experiences, peer modeling, and reinforcement as mechanisms that benefit all learners regardless of gender. The result is consistent with findings from studies by Adi and Odula (2024), Njoroge and Githua (2013), and Odutayo and Fonseca (2024), which reported minimal or no gender differences in performance and retention among students taught using STAD. Overall, the findings indicate that STAD fosters inclusive learning environments by promoting teamwork and shared responsibility, thereby providing equal opportunities for academic success across genders.

CONCLUSIONS

Employing a quasi-experimental design, the study compared the outcomes (Mathematics interest and retention) of an experimental group using the STAD strategy with those of a control group exposed to traditional instructional methods. The findings revealed that the STAD model significantly enhanced students' interest in Mathematics, as evidenced by a substantial increase in engagement levels. Furthermore, the STAD group exhibited markedly higher retention rates, indicating that this cooperative learning approach not only facilitates immediate academic performance but also supports long-term mastery of mathematical concepts. Crucially, the study found no significant differences in interest and retention between male and female students within the STAD group, underscoring the strategy's potential to promote gender equity in learning outcomes. This is particularly relevant in contexts where gender disparities in academic performance in STEM subjects are prevalent. In addition, the study extends Bandura's Social Learning Theory by empirically demonstrating how structured cooperative learning strategies such as STAD operationalize the theory's mechanisms of attention, retention, reproduction, and motivation in mathematics classrooms. This theoretical alignment explains not only immediate performance gains but also sustained retention of mathematical concepts across instructional contexts. Overall, the STAD technique proves to be a strong and successful teaching method for enhancing secondary school students' interest in and retention of mathematics. Students of all genders are engaged in an inclusive and cooperative learning environment.

RECOMMENDATIONS

The following recommendations are put forth considering the study's findings:

1. *Mathematics teachers*: Mathematics teachers are encouraged to integrate the STAD strategy into regular classroom instruction to promote active participation, peer-assisted learning, and collaborative problem-solving. Given that mathematics is often perceived as challenging, the use of STAD can enhance conceptual understanding by encouraging the exchange of ideas and shared responsibility for learning. Teachers should also ensure balanced group composition to maximise interaction and engagement among all students.
2. *School administrators*: School administrators should support the implementation of cooperative learning strategies by fostering inclusive classroom environments that value participation from all students, irrespective of gender. Providing adequate instructional resources and scheduling time for collaborative activities can help optimise the effectiveness of STAD. Administrators are also encouraged to create school-wide initiatives that promote inclusive and participatory teaching practices in STEM subjects.
3. *Policy makers*: Educational policymakers should incorporate cooperative learning approaches such as STAD into curriculum guidelines and teacher education programmes. Policies that support continuous professional development in learner-centred and cooperative instructional strategies can strengthen teachers' capacity to

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implement STAD effectively. Additionally, policy frameworks should emphasise equity-oriented teaching practices to promote gender-inclusive learning outcomes in mathematics education.

4. *Future researchers*: Future studies are recommended to examine the long-term effects of STAD across different educational levels and subject areas using larger and more diverse samples. Researchers may also explore the influence of moderating variables such as school context, group composition, and learner motivation on the effectiveness of STAD. Employing mixed-methods or longitudinal designs could further enrich understanding of how cooperative learning strategies support sustained achievement and retention.

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Ethical statement

Ethical clearance and informed consent were obtained from the leadership of all participating schools, and from the participants and their parents/guardians.

Competing interests

The authors declare no conflict of interest.

Author contributions

Falebita and Popoola conceptualized the study; Falebita, Popoola, Talasi and Akinwamide contributed to the writing of the manuscript; Falebita analyzed the data; Falebita, Talasi and Akinwamide revised the manuscript; Popoola supervised the project.

Data availability

Data that support the findings of this study are available from the corresponding author upon reasonable request.

AI disclosure

Grammarly was used to improve the manuscript's sentence structure.

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