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IMPACT OF STUDENTS TEAM ACHIEVEMENT DIVISION STRATEGY ON ACADEMIC ACHIEVEMENT IN TRIGONOMETRY AMONG SENIOR SECONDARY SCHOOLS, MAIDUGURI METROPOLIS BORNO STATE

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ABSTRACT

This study investigates the impact of the Students Team Achievement Division (STAD) strategy on academic achievement in trigonometry among senior secondary schools in Maiduguri Metropolis, Borno State. The traditional method of teaching trigonometry leads to low academic achievement; therefore, this research investigates the impact of the STAD strategy. The research focuses on two research objectives and research questions, assessing the effectiveness of the STAD strategy in enhancing students' understanding and performance in trigonometry. The study aims to contribute valuable insights into the application of cooperative learning methods, specifically STAD, in the context of trigonometry education. The research employs a quantitative research design, utilizing pre-test and post-test assessments using the Trigonometry Achievement Test (TAT) to measure the academic achievement of students exposed to the STAD strategy. The sample was randomly selected which consists of four (4) senior secondary schools out of Sixteen (16) Senior Secondary Schools. Descriptive statistics in the form of mean ($\bar{x}$) and standard deviation (S.D) of the scores were used to answer the research questions while inferential statistics that is independent t-test was used to test the hypotheses, at $P \leq 0.05$ level of significance. The study hypothesizes that the implementation of the STAD strategy will lead to a significant improvement in students' academic achievement in trigonometry. The findings of this research have the potential to inform educational policies and practices, providing educators and policymakers with evidence-based insights into the effectiveness of cooperative learning strategies like STAD. Understanding how such strategies impact academic achievement in specific mathematical concepts can contribute to the development of more targeted and effective teaching methodologies, ultimately benefiting students in the learning process.

Keywords: Students Team Achievement Division, Academic Achievement, Trigonometry, Conventional teaching.

Introduction

Education is widely regarded as a basic human right, a key to enlightenment, a source of wealth and power, and a critical component of human and national development (Ondigi & Mugenda, 2011). According to Parankimalil (2012), Education is a systematic process through which a child or an adult acquires knowledge, experience, skill, and sound attitude, it makes an individual civilized, refined, cultured, and educated for a civilized and socialized society.

Science in its nature has a great deal of thought and research has gone into determining the Nature of Science. Despite this, consensus is lacking about the Nature of Science, there is competition among the groups of academics, who adhere to contrasting general positions. Scholars like Rationalists claim that reasoning combined with facts is essential in science. Naturalists, meanwhile, also recognize such influences as human psychology, sociology, etc. on knowledge building. Realists claim that products (such as laws & and theories) of knowledge-building represent reality (Science), while Anti-realists claim that knowledge is a convenient social construction (Bencze, 2001).

Mathematics has been identified as a very important science subject, and its importance in the scientific and technological development of any nation has also been identified and this has been widely reported (Edomwonyi and Avaa, 2011). It was as a result of the recognition given to the subject in the development of individuals and the nation that has made it a core subject among the sciences and other science-related courses in the Nigerian educational system (Federal Republic of Nigeria (FRN), 2004). It has been a prerequisite subject for offering most science-oriented courses in tertiary institutions (Adesoji and Olatunbosun, 2008). Mathematics is the Science of quantity and space. It is a systematized, organized, and exact branch of science. It is a creation of the human mind, concerned primarily with ideas, processes, and reasoning. Therefore, mathematics can be seen variously as a body of knowledge, a collection of techniques and methods, and the products of human activity itself, namely, the solving of problems (Edwards, et al, 2008). Mathematics is the science of space and quantity. Mathematics is a conglomeration of several different but related subjects, not a single subject (Edward et al, 2008). As asserted by (Edward et al, 2008), it is not a single subject, it has many branches such as Algebra, Geometry, and Trigonometry. Thus; Teaching Method: Different teaching strategies will lead to varied instructional outcomes and an instructor can choose the strategy which is appropriate to the subject and topic in teaching. A particular strategy may be better than another one for a given purpose. Yet a single strategy may not apply to all students and all types of subject matter. Consequently, the selection of strategies should be in accord with an individual population of students and the particular subject matter (Erdem, 2012). The choice of strategies and tactics relies upon the selected learning activities and thus; the key to (the teaching) method is to bring about the desired learning in students by selecting the proper strategies and tactics and consequently the proper content and techniques (Clark and Starr, 2001).

STAD which means Student Team Achievement Divisions, is one of the types of Cooperative Learning (CL) strategy in which a small group of learners with different levels of ability work together to accomplish a shared learning goal (Slavin, 2009). It was also developed by Robert Slavin and his associates in 2009 at Johns Hopkins University, according to them, students are assigned to four- or five-member learning teams that are mixed in performance level, gender, and ethnicity. It can unite the learning group to improve Mathematics achievements through concept comprehension and communication (Silbermann, 2006).

According to Cohen, Manion, and Morrison (2007), student team Achievement Division (STAD) is a strategy where students must work together in small groups in such a way that everyone can participate in a group task that has been assigned. Two components of Students Team Achievement Division (STAD) distinguish it from traditional group work: (a) positive interdependence which is the feeling that they cannot achieve their group goal without the joint efforts of team members. (b) Individual accountability that is each member of the group feels accountable for their performance.

Trigonometry, a fundamental branch of mathematics, plays a crucial role in various fields, including engineering, physics, and astronomy (Bekene & Machaba, 2022). However, many senior secondary school students find trigonometry challenging due to its abstract concepts and complex formulas (Abdullahi, 2022). To address this issue, educators have explored various teaching strategies to enhance student engagement, understanding, and achievement in trigonometry. One such strategy is the Student Team Achievement Division (STAD) approach (Tiantong & Teemuangsai 2013).

The mathematics learning outcomes of students whose learning process uses the Student Team Achievement Division (STAD) method are better than the mathematics learning outcomes of students whose learning process uses the expository method. In education in Indonesia, teacher upgrading is carried out, especially discussing the learning system that is suitable for use in the classroom. Among the existing learning systems is the Cooperative Learning system. A Cooperative Learning system is defined as a group learning activity organized by the principle that learning should be based on changes in social information among its members, and take responsibility for their learning and be encouraged to improve the learning of other members Arnas *et.al* (2022).

The implementation of the STAD strategy in trigonometry education offers several potential benefits. Firstly, it promotes active learning and student engagement by encouraging peer interaction, collaboration, and discussion (Anaduaka et al., 2021). Secondly, the STAD strategy fosters a sense of responsibility and accountability among team members, as each student's contribution directly impacts the team's overall success (Johnson et al., 2009).

Empirical research has demonstrated the effectiveness of the STAD strategy in improving student achievement in trigonometry. A study by Amin *et*.al (2023) found that students taught using the STAD approach significantly outperformed their counterparts in traditional lecture-based settings. Similarly, a study by Aliyu (2019) revealed that students taught using the STAD strategy achieved higher grades in trigonometry exams compared to those taught using conventional methods. These studies suggest that the collaborative learning environment, individual accountability, and shared rewards promoted by the STAD strategy contribute to improved academic performance in trigonometry.

Research studies have provided evidence supporting the efficacy of the STAD strategy in enhancing student Performance in

trigonometry. Lantajo J. (2022) conducted a study indicating that students exposed to the STAD approach exhibited significantly better performance compared to their peers in traditional lecture-based settings. Additionally, Aliyu (2019) found that students instructed through the STAD strategy achieved superior grades in trigonometry exams compared to those taught through conventional methods. These findings suggest that the collaborative learning atmosphere, individual accountability, and shared rewards fostered by the STAD strategy contribute to an overall improvement in academic performance in trigonometry.

In addition to academic achievement, the STAD strategy can also positively influence students' perceptions of trigonometry. A study (Asnan, 2018) found that students taught using the STAD approach reported increased enjoyment of the subject, enhanced self-efficacy, and improved attitudes toward teamwork and collaboration. Similarly, Ling *et* al (2016) investigated the effect of applying the Student Team Achievement Division (STAD) cooperative learning model on student learning outcomes. The research uses quantitative methods, The research results indicate that students' learning outcomes using the Student Team Achievement Division (STAD) cooperative learning model are in the very good category. Thus, there is a significant effect between the use of the Student Team Achievement Division (STAD) cooperative learning model on students' learning outcomes. It indicates that there is a significant positive effect from the use of the Student Team Achievement Division (STAD) cooperative learning model on students' learning outcomes.

Statement of the Problem

The implementation of traditional lecture-based teaching methods in trigonometry education often fails to adequately engage students and foster a deep understanding of the subject's complex concepts. This lack of engagement and understanding can lead to low academic achievement, negative perceptions of trigonometry, and a lack of motivation to pursue further studies in mathematics-related fields. Therefore, this study investigates the impact of students' team achievement division strategy (STAD), thereby engaging students and fostering a deep understanding of trigonometry among senior secondary Schools in Maiduguri Borno State.

Research Questions

The following research questions were raised to guide this study.

1. What are the mean academic achievement scores of students in Trigonometry when exposed to the Students Team Achievement Division (STAD) strategy and conventional teaching method?
2. What are the mean academic achievement scores of students in Trigonometry, by gender, when exposed to the Students Team Achievement Division (STAD) strategy?

Hypotheses

H_{01}: There is no significant difference in the mean of academic achievement scores of students taught trigonometry using the Students Team Achievement Division (STAD) and those taught with conventional teaching methods.

H_{02}: There is no significant difference in the academic achievement of male and female students taught trigonometry using the Students Team Achievement Division (STAD) strategy.

Research Method

The design used in this study was quasi-experimental as introduced by Campbell and Stanley (1963) which involves a pretest and post-test. In quasi-experiment design, there must be two groups (experimental and control), both were tested before and after treatment. A pretest was administered to both groups from the beginning to determine the equivalence in the ability of the groups whereas, a posttest was also administered to both groups after six (6) weeks of treatments to evaluate the effectiveness of the treatment in enhancing students' academic achievement and perception in Trigonometry. The experimental group was exposed to the Students Team Achievement Division (STAD) strategy while the control group was taught with the conventional method, both for six consecutive weeks. This design is illustrated as follows:

EG = → Q1 → X1 → Q2
CG = → Q1 → X2 → Q2

Key: **EG** = Experimental Group, **CG** = Control Group, **Q1** = Pre-test, Q**2** = Post-test
X1 = Treatment (Students Team Achievement Division strategy)
X2 = No treatment (conventional teaching method)

The target population for this study comprised sixteen (16) public senior secondary schools in Maiduguri Metropolis, Borno State, four (4) are male and four (4) female single-sex schools while Eight (8) are coeducation schools. The total population is Thirty-six thousand Seven hundred and Fifty-Eight (36,758), consisting of seventeen thousand Nine hundred and Nine (17909) males and Eighteen thousand Eight hundred and forty-nine (18849) females. The average age of the population was seventeen (17+) years old. The selection of SS2 students for this study was because the trigonometry topic is in the SS II syllabus. The sample size of this study was four (4) schools, selected from homogeneous (same-sex) Schools. The population was divided into three strata, stratum one (4 male Schools), stratum two (4 female schools), and stratum three (8 mixed Schools). Thus, two (2) schools were randomly selected from stratum 1&2 respectively, which are; A, C, E, and F. Four (4) intact classes of SS II were selected, that is one from each school, making two male and two female classes. The two homogeneous classes were assigned as one experimental and one control. All the students of each intact class despite their ability levels were used as samples for the study. A stratified random sampling technique was used in selecting the Sample size, the population was divided into three strata, stratum one consists of four male Schools, stratum two also consists of four female schools and stratum three consists of eight mixed Schools. Two (2) schools were randomly selected from each of stratum 1&2 which gave four (4) Schools. Furthermore, one intact class from each of the four (4) schools was randomly selected to have a total of four (4) classes as samples, in each of the

two (2) male and female schools. One class was assigned as an experimental class while the other one was a control class. Those in the experimental class were taught trigonometry using the Students Team Achievement Division (STAD) strategy while those in the control class were taught trigonometry using the conventional teaching method for six (6) weeks.

The instruments for this study were two (2), questionnaires on Students' level of Perception (SLP) toward Trigonometry and Trigonometric Achievement Test (TAT). The questionnaire has two (2) sections (section A and section B). In section A, general information about the student and school such as; type of school and Gender was required while in section B, which consists of 18 items questions on students' perception towards trigonometry with four (4) Likert given options. The options are: strongly agree (SA), Agree (A), Disagree (D), or Strongly Disagree (SD). A modified 4-point Likert scale response mode of strongly agreed (SA) coded as 4, Agreed (A) coded as 3, disagree (DA) coded as 2, and strongly disagree (SD) coded as 1 was adopted for Students' level of perception in Trigonometry questionnaire. The Likert scale's invention is attributed to Likert Rensis (1931), who described this technique for the assessment of attitudes and described the Likert scale as a set of items, composed of approximately an equal number of favorable and unfavorable statements concerning the attitude object, is given to a group of subjects and they are asked to respond to each statement in terms of their degree of agreement or disagreement (McIver & Carmines, 1981).

The designed Trigonometry Achievement Test (TAT) also consists of two (2) sections (section A and section B). In section A, general information about the student and school was required, such as; type of school and gender. Its section B contains forty (40) items of multiple choices (A, B, C & D). The items were drawn carefully within the scope of the mathematics (trigonometry) SSII syllabus, at least eight questions were drawn from each of the selected topics to have a total of forty (40) items. The students were required to select the correct answer from the four options lettered A-D. Each question carries two and a half (2.5) marks, 40 items multiplied by 2.5 will be equal to 100 marks. The Trigonometric Achievement Test (TAT) was to measure the student's academic achievement in multiple-choice lettered A-D form with forty (40) questions, each question carries two and a half (2.5) marks for both pre-test and post-test.

The data of the study were analyzed using descriptive statistics (Mean and S.D) to answer the research questions (1, & 2) while inferential statistics (independent sample t-test) was used to test the hypotheses (1, and 2) at $\alpha = 0.05$ level of significance, using Statistical Package for Social Sciences (SPSS) version 26.

Presentation of Results

The data obtained from the questionnaire were analyzed using Descriptive Statistics to answer the research questions while the data obtained from the Trigonometry Achievement Test (TAT) were analyzed using inferential statistics (t-test) at $P \leq 0.05$ level of significance and results were presented as follows.

Research Question 1: What are the mean academic achievement scores of students in Trigonometry when exposed to the Students Team Achievement Division (STAD) strategy and conventional teaching method?

The results obtained from the pre-test and Post-test of students in the experimental and control groups were presented in Table 1

Table 1: Analysis of the Pre-test and Post-test Means and Standard Deviations Scores of the Experimental and Control Groups

Groups	Pre-Test		Post-Test	
	Mean	SD	Mean	SD
Experimental	25.42	6.899	75.08	14.762
Control	25.41	8.638	26.89	10.005

Table 1 presents the analysis of pre-test and post-test mean scores along with their corresponding standard deviations for both the Experimental and Control Groups. In the Experimental Group, the mean pre-test score is 25.42 with a standard deviation of 6.899, while the mean post-test score is 75.08 with a standard deviation of 14.762. This suggests a substantial increase in scores from the pre-test to the post-test in the Experimental Group, indicating a positive impact of the STAD in teaching trigonometric. On the other hand, in the Control Group, the mean pre-test score is 25.41 with a standard deviation of 8.638, and the mean post-test score is 26.89 with a standard deviation of 10.005. The minimal change in scores in the Control Group suggests that any observed changes in the Experimental Group may be attributed to the specific treatment (STAD) or intervention introduced to that group rather than natural variability. Therefore, the table provides a detailed overview of the comparative pre-test and post-test performance in both the Experimental and Control Groups, facilitating the evaluation of the effectiveness of the intervention.

Null hypothesis 1 (H_{01}): There is no significant difference in the mean of academic achievement scores of students taught trigonometry using the Students Team Achievement Division (STAD) and those taught with conventional teaching methods.

Table 2: Independent Sample t-test on the Impact of STAD on Students' Academic Achievement in Trigonometric in Senior Secondary Schools in Maiduguri

Pre-Test						
Group	**N**	**Mean**	**SD**	**DF**	**T**	**p-value**
Control	96	25.41	8.638	210	-0.015	0.988
Experimental	116	25.42	6.899			
Post-Test						
Control	96	26.89	10.005	210	-27.223	0.000
Experimental	116	75.08	14.762			

Table 2 reveals the pre-test of the Control Group (N = 96) has a mean score of 25.41 with a standard deviation (SD) of 8.638, while the Experimental Group (N = 116) has a similar mean score of 25.42 with a lower standard deviation of 6.899. The independent sample t-test yields a t- value of -0.015 with 210 degrees of freedom, resulting in a non-significant p-value of 0.988. This suggests that there is no significant difference between the pre-test scores of the Control and Experimental groups, which indicates that the results did not reject the null hypothesis.

In contrast, for the post-test, the Control Group (N = 96) has a mean score of 26.89 with a standard deviation of 10.005, while the Experimental Group (N = 116) demonstrates a considerably higher mean score of 75.08 with a larger standard deviation of 14.762. The independent sample t-test reveals a highly significant t-value of -27.223 with 210 degrees of freedom and an extremely low p-value of 0.000. This significant difference indicates that the post-test scores between the Control and Experimental groups are statistically distinct, suggesting that the STAD instructional method has had a substantial impact on students' academic achievement in trigonometry. This indicates that the result tallies with the alternative hypothesis.

Research Question 2: What are the mean academic achievement scores of students in Trigonometry based on gender when exposed to the Students Team Achievement Division (STAD) strategy?
The results obtained from the pre-test and Post-test of students in the experimental group were presented in Table 3.

Table 3: Analysis of the Pre-test and Post-test Means and Standard Deviations Scores of the Experimental Group based on gender

Pre-Test			Post - Test	
Gender	**Mean**	**SD**	**Mean**	**SD**
Male	25.06	6.45	74.35	13.80
Female	25.90	7.50	76.04	16.03

Table 3 reveals an analysis of pre-test and post-test means and standard deviations for an experimental group, categorized by gender. In the pre-test, both male and female participants had relatively similar mean scores, with males having a mean of 25.06 and females having a mean of 25.90. The standard deviations (SD) indicate some variability in the scores within each gender group. In the post-test, there is an increase in mean scores for both genders, reaching 74.35 for males and 76.04 for females. This significant improvement suggests a positive impact of the experimental intervention. The standard deviations in the post-test show increased variability, especially among females reflecting diverse responses to the intervention. Therefore, the table implies that the experimental group experienced a marked improvement from the pre-test to the post-test, with both male and female participants

showing increased scores, indicating positive outcomes related to the intervention.

Null hypothesis 2 (H_{02}): There is no significant difference in the academic achievement of male and female students taught trigonometry using the Students Team Achievement Division (STAD) strategy and Conventional.

Table 4: Independent Sample t-test on gender difference in students' academic achievement when taught using STAD based on gender in Senior Secondary Schools in Maiduguri

Pre-Test						
Group	**N**	**Mean**	**SD**	**DF**	**t**	**p-value**
Male	66	25.06	6.45			
				114	-0.647	0.519
Female	50	25.90	7.49			
Post-Test						
Male	66	74.35	13.80			
				114	-0.609	0.543
Female	50	76.04	16.03			

Results from Table 4 revealed that, in the pre-test, male students (N = 66) have a mean score of 25.06 with a standard deviation (SD) of 6.45, while female students (N = 50) show a slightly higher mean score of 25.90 with a higher SD of 7.49. The independent sample t-test results in a non-significant t-value of -0.647 with 114 degrees of freedom and a p-value of 0.519, indicating that there is no statistically significant gender difference in pre-test scores when taught using the STAD method.

For the post-test, male students (N = 66) exhibit a mean score of 74.35 with a standard deviation of 13.80, while female students (N = 50) demonstrate a slightly higher mean score of 76.04 with a larger standard deviation of 16.03. The independent sample t-test yields a non-significant t-value of -0.609 with 114 degrees of freedom and a p-value of 0.543. This suggests that there is no significant gender difference in post-test scores when students are taught using the STAD method.

Discussion of Results

This study employed a mixed-methods approach to assess the effectiveness of the Students Team Achievement Division (STAD) strategy in teaching trigonometry compared to conventional teaching methods. Descriptive statistics were utilized for questionnaire data, and inferential statistics (t-test) were employed for the Trigonometry Achievement Test (TAT) data. The study aimed to answer two research questions and test two null hypotheses.

For Research Question 1, comparing mean academic achievement scores of students in trigonometry between the STAD strategy and conventional teaching, the pre-test and post-test results for the experimental and control groups were analyzed. Table 1 demonstrated a significant increase in post-test scores for the experimental group, indicating a positive impact of the STAD strategy. The independent sample t-test in Table 2 further supported this, showing a highly significant difference in post-test scores between the experimental and control groups.

For Research Question 2, exploring gender differences in academic achievement when exposed to the STAD strategy, Table 3 displayed an increase in mean scores for both male and female participants from the pre-test to the post-test. The independent sample t-test in Table 4 indicated no significant gender differences in academic achievement when using the STAD method, as both pre-test and post-test t-values were non-significant.

Therefore, the study provided robust evidence supporting the efficacy of the STAD strategy in improving trigonometry academic achievement, particularly highlighted by the significant differences observed in post-test scores between the experimental and control groups. The findings contribute valuable insights into effective teaching strategies in the context of trigonometry education.

Conclusion

In conclusion, the study investigated the impact of the Students Team Achievement Division (STAD) strategy on trigonometry academic achievement compared to conventional teaching methods. The results, as revealed through descriptive and inferential statistical analyses, consistently demonstrated the efficacy of the STAD strategy in enhancing students' understanding of trigonometric concepts. The substantial increase in post-test scores for the experimental group, as opposed to minimal changes in the control group, underscored the positive influence of the STAD strategy. Furthermore, the study explored potential gender differences and found no significant disparities in academic achievement between male and female students when exposed to the STAD method. These findings contribute valuable insights into effective pedagogical approaches in trigonometry education, emphasizing the importance of cooperative learning strategies such as STAD in fostering enhanced academic outcomes.

Recommendations

1. Since Students Team Achievement Division (STAD) strategy has significant effect on Students' Academic Achievement in Trigonometry, the Mathematics teachers should use the strategy when teaching Mathematical concepts to improve the Students' Achievements in mathematics. The following; FME, SME, NCM, MAN and STAN should organize regular workshops on Students Team Achievement Division (STAD) strategy.
2. Ministry of Education should encourage teachers to use Students Team Achievement Division (STAD) strategy in their schools in teaching Mathematical concepts, to curtail the gender gaps or gender differences in the subject.
3. The Mathematics Curriculum Development (MCD) should incorporate teaching of trigonometry with Students Team Achievement Division (STAD) strategy into curriculum design. When implemented the difficulties faced by both Teachers and Students in teaching and learning of trigonometry will be stress-free.
4. Textbook authors should emphasize on the use of STAD and Jigsaw in teaching mathematics in secondary schools.

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