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EFFECT OF STUDENTS' TEAM ACHIEVEMENT DIVISION STRATEGY ON PERCEPTION IN TRIGONOMETRY AMONG SENIOR SECONDARY SCHOOLS IN MAIDUGURI, BORNO STATE

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ABSTRACT
This study examines the effect of team achievement division strategies on trigonometry perception among senior secondary school students in Maiduguri, Borno State. Trigonometry, a fundamental branch of mathematics, often poses challenges for students due to its abstract nature and complex concepts. Collaborative learning approaches, particularly team achievement division strategies, have been proposed as effective methods to enhance students' understanding and perception of trigonometry. This study uses quasi–experimental design. Through a quantitative research design, four schools were randomly selected out of sixteen schools, and data was collected from four senior secondary school students in Maiduguri utilizing structured questionnaires. The analysis involved assessing students' perceptions of trigonometry before and after implementing team achievement division strategies. Descriptive statistics, including mean ($\bar{x}$) and standard deviation (S.D), were employed to address the research inquiries, while inferential statistics, specifically the independent t-test, were utilized to examine the hypotheses, with significance set at $P \leq 0.05$. Results indicated a significant improvement in trigonometry perception among students who participated in collaborative team activities. Findings suggest that integrating team achievement division strategies into trigonometry instruction can positively influence students' perception and comprehension of the subject. Implications for teaching practices and curriculum development are discussed, highlighting the importance of collaborative learning methodologies in enhancing mathematics education in senior secondary schools.

Keywords: Team Achievement Division, Perception, Trigonometry, Conventional teaching.

Introduction

Trigonometry, a branch of mathematics dealing with the relationships between the angles and sides of triangles, is a fundamental subject in the high school and college curriculum. As educators continually seek innovative teaching methods to enhance students' learning experiences, the implementation of collaborative strategies, such as the Students Team Achievement Division (STAD) strategy, has gained attention. This literature review explores the existing research on the effect of the STAD strategy on students' perceptions of

trigonometry, focusing on its impact on academic achievement, engagement, and overall learning experience.

Trigonometry, a mathematical concept, is now a fixture in high school math curricula, particularly within trigonometric functions. It serves as a cornerstone of mathematical education, encompassing various subjects like geometry, functions, and calculus (Weber 2008). Trigonometric functions, derived from the ratios of right-triangle sides within a unit circle, are integral to calculus courses. However, numerous studies suggest that traditional teaching methods fall short of conveying the essence of trigonometric functions effectively (Kamber & Takaci, 2017; Orhun, 2001; Weber, 2005). These methods often focus on procedural instruction, emphasizing definitions, theorems, proofs, and problem-solving within the limited context of right-triangle ratios.

A study was conducted to determine the effects of cooperative learning on students' mathematics achievement in secondary school students in Pekanbaru, Indonesia. In addition, the study also determined students' perceptions concerning cooperative learning. Content analysis data revealed that students in the cooperative group were able to increase their understanding and develop their self-confidence. (Zakaria et al, 2013).

Collaborative learning has been widely acknowledged as an effective pedagogical approach to promote student engagement and enhance academic outcomes. (Johnson and Johnson, 1989) introduced the STAD strategy as a structured cooperative learning method that emphasizes positive interdependence among team members. The strategy involves individual accountability within a team setting, promoting collective responsibility for learning outcomes.

Student engagement is a crucial factor in the learning process, influencing academic performance and the overall educational experience. (Jamaludin and Moktar, 2018) explored the relationship between the STAD strategy and student engagement in trigonometry classrooms. Further suggested that students participating in STAD teams exhibited higher levels of motivation and engagement compared to those in traditional, non-collaborative settings. The team-based structure of STAD fosters a supportive learning environment, encouraging active participation and collaboration among students.

The adoption of the STAD strategy in trigonometry education presents numerous potential advantages. Firstly, it stimulates active learning and student involvement through the encouragement of peer interaction, collaboration, and discourse (Anaduaka et al., 2021). Secondly, the implementation of the STAD strategy cultivates a culture of responsibility and answerability within teams, where each student's input directly influences the collective achievement of the team (Johnson et al., 2009).

STAD, an abbreviation for Student Team Achievement Divisions, represents a form of Cooperative Learning (CL) tactic wherein a small cohort of students with varying skill levels collaborate towards achieving a common learning objective

(Slavin, 2012). This strategy was devised by Robert Slavin and his colleagues in 2012 at Johns Hopkins University. Their model involves assigning students to teams of four or five members, deliberately mixing performance levels, genders, and ethnicities. The application of STAD has the potential to enhance mathematical attainment by fostering comprehension of concepts and promoting effective communication within the learning group (Silbermann, 2006).

Ziziumiza et al (2022) explored the impact of Student Teams-Achievement Divisions (STAD), a collaborative learning approach where diverse groups of students work collectively towards a common objective. This research focused on assessing the efficacy of STAD within the context of vocational and technical engineering (VTE) students. Findings revealed a notable improvement in students' mathematics skills and overall learning outcomes, as evidenced by the substantial differences in scores before and after the implementation of STAD.

Aliyu (2019) conducted research that demonstrated higher academic achievement in trigonometry exams among students instructed using the STAD strategy compared to those taught through conventional means. The findings suggest that the collaborative learning environment, individual responsibility, and collective incentives inherent in the STAD approach contribute to the observed improvements in academic performance.

The findings of Masha et al. (2023) bear significant implications for educators, policymakers, and curriculum developers. By demonstrating the clear advantages of incorporating the STAD cooperative learning strategy into trigonometry education, this research advocates for a pedagogical shift towards more interactive and student-centered teaching methodologies. As educational stakeholders seek to enhance mathematical achievement and foster a deeper understanding of complex concepts, the adoption of evidence-based strategies like STAD could pave the way for more effective and engaging mathematics instruction.

Effective teaching in classrooms is the dynamic interaction between teachers and students, which significantly impacts teaching quality and student outcomes. The nature and caliber of this interaction form the cornerstone of student engagement. The research delves into the correlation between teacher-student relationships and student achievement in mathematics within high school settings. It advocates for students to cultivate positive rapport with their mathematics instructors through active participation, demonstrating respect, and maintaining consistent communication. Additionally, it underscores the importance of mathematics educators nurturing personal connections with their students, as doing so has the potential to bolster academic success (Byiringiro, 2024).

Among the Educational theories, a major theoretical issue was that of the perception theory which happens to be ambiguous, to the extent that it either relies directly on the information present in the stimulus or not. Some argue that perceptual processes are not direct, but depend on the perceiver's expectations and previous knowledge as well as the information

available in the stimulus itself. To receive information from the environment we are equipped with sense organs e.g. eye, ear, nose, etc. Each sense organ is part of a sensory system that receives sensory inputs and transmits sensory information to the brain. This controversy is discussed concerning (Gibson, 1966) who has proposed a direct theory of perception which is a "bottom-up" theory and (Gregory, 1980) who has proposed a constructivist (indirect) theory of perception which is a "top-down" theory.

Gregory viewed the theory of perception from different educational points of view, such as perceptions as hypotheses, and the constructivist theory of perception which is a 'top-down' theory. He proposed that perceiving is an activity resembling hypothesis formation and testing. He says that signals received by the sensory receptors trigger neural events, and appropriate knowledge interacts with these inputs to enable us to make sense of the world, (Gregory, 1980).

In this research work, perception is also a keyword or variable of the objectives, for this reason, attention was focused on it. Perception according to (Gregory, 1980) is like hypothesis formation and testing which activities have to do with sensory nerves equipped with sense organs (ear, eye, nose, tongue, and skin). His theory is called down-top theory. (Gibson 1966) also proposed a theory known as top-down. The researcher categorically opined that no student's academic achievement would be better without a clear perception of what is under study (work). As a result of that, the theories of (Gregory, 1980) and (Gibson, 1966) were incorporated into the main work (Students Team Achievement Division strategy) to determine the students' perception of trigonometry.

Understanding students' perceptions of trigonometry is essential for evaluating the effectiveness of teaching strategies. Brown et al. (1989) conducted a qualitative study examining students' perceptions of trigonometry instruction within the context of STAD. The results indicated that students appreciated the collaborative nature of STAD, noting increased confidence, a sense of belonging, and a positive attitude toward trigonometry. While this study generally supports the positive impact of the STAD strategy on trigonometry learning, it is essential to acknowledge potential challenges and considerations. Some studies. Davidson, (1996) have highlighted the importance of effective team management, ensured equal participation, and addressed potential conflicts within STAD teams.

Mangal (2007) defines perception as an individual's experience that involves the organization of objects, events, or relationships leading to the process of interpreting sensory input. According to Cai and Knuth (2005) research on 18 Unconventional Essays on the Nature of Mathematics, mentioned that Students' level of perceptions of mathematics, particularly nowadays has a major influence on the development of school mathematics and its applications in our society. This happens as a result of the rapid growth of mathematics and its applications over the past 50 years has led to several scholarly essays that examine its nature and importance (mathematics). According to Dunlap (2004),

Students' perception of mathematics is due to low self-esteem and math phobia in mathematics learning seems to result in confused thinking, disorganization, avoidance behavior, and passivity. He also mentioned that Students' attitude towards math seems to be shaped by how students define mathematics, and what they consider the role of mathematics is in their life. For instance, students who consider mathematics as a bunch of symbols and procedures tend to treat mathematical concepts as a set of memorization facts because they perceive it negatively. These students will not put any effort into understanding the subject (mathematics) and if students do not think mathematics is important then they will not consider the mathematics course as worthy enough to spend time on, as a result, the motivation factors of these students would be very low. Then it will be difficult to have students learn mathematics meaningfully and with understanding because of the negative perception toward it. This means one needs to address students' attitudes and behaviors before introducing mathematical concepts and expecting meaningful learning in class.

Genders' achievement in mathematics; Right from the word go till today much research has been done in gender, such as; the concept of gender difference and gender gap being taken as an important issue in socioeconomic development and social well-being, in addition to its impact in student's achievement in mathematics Bashir et al (2023). Gender differences in secondary mathematics are a prominent issue that has been the focus of many studies, with reported differences in mathematics achievement between boys and girls as contentious. Gender as a discipline has developed certain terms and concepts that are used while studying the phenomenon of gender to understand the meaning, implications, and academic achievement that allow us to see and connect various aspects of it (Ahmed and Bora, 2011). Gender refers to the socially constructed roles, behaviors, activities, and attributes that a given society considers appropriate for men and women. Gender emphasizes that masculinity and femininity are products of social, cultural, and psychological factors and are acquired by an individual in the process of becoming a man or woman (Javillonar, 2022).

This study provides substantial evidence supporting the positive effects of the Students Team Achievement Division (STAD) strategy on students' perceptions of trigonometry. The collaborative nature of STAD enhances academic achievement, student engagement, and overall positive attitudes toward learning trigonometry. Educators can consider incorporating STAD as a viable strategy to create an interactive and supportive learning environment in trigonometry classrooms.

Statement of the Problem

In contemporary educational settings, the pedagogical landscape is evolving, and educators are continually exploring innovative strategies to enhance student learning experiences. Trigonometry, a fundamental branch of mathematics taught at the senior secondary school level, poses unique challenges for students. This research aims to investigate the effect of

implementing a Students Team Achievement Division (STAD) strategy on students' perception and understanding of trigonometric concepts in senior secondary schools. The central concern revolves around whether the incorporation of collaborative learning through the STAD approach influences students' attitudes, motivation, and overall comprehension of trigonometry. This study addresses the gap in the existing literature by examining the impact of the STAD strategy on students' perceptions of trigonometry, offering valuable insights for educators and policymakers seeking effective instructional methods in mathematics education.

Objectives of the study

The objectives of this study aim to determine:

1. The effect of Students Team Achievement Division (STAD) strategy on students' level of perception in Trigonometry.
2. The level of Perception of male and female students in Trigonometry when taught using the Students Team Achievement Division (STAD) strategy

Research Questions

1. What are the mean scores of students' level of perception in Trigonometry when taught using the Students Team Achievement Division (STAD) strategy and conventional teaching method?
2. What are the mean scores of students' level of perception 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 scores of students' level of perception between those exposed to trigonometry using the Students Team Achievement Division (STAD) strategy and those taught using the conventional teaching method.

H_{02}: There is no significant difference in the mean scores of students' level of perception by gender when exposed to the Students Team Achievement Division (STAD) strategy.

Research Method

The methodology employed in this investigation was a quasi-experimental design, incorporating pretest and post-test assessments. Within this quasi-experimental framework, there were two distinct groups: an experimental group and a control group, each subjected to assessments both before and after the intervention. Initially, a pretest was administered to ensure the comparability of the groups in terms of their baseline abilities. Subsequently, a posttest was conducted after six weeks of treatment to gauge the efficacy of the intervention in improving students' academic performance and perception of Trigonometry. The experimental group received instruction using the Students Team Achievement Division (STAD) strategy, while the control group received conventional teaching methods, both over six weeks. This design is depicted as follows:

Figure 1: Research Design

Experimental Group (EG): Pretest (Q1) ---------- Treatment (X1: STAD strategy) ---------- Posttest (Q2)

Control Group (CG): Pretest (Q1) -----No Treatment (X2: conventional teaching method) --- Posttest (Q2)

Key:

EG = Experimental Group, CG = Control Group

Q1 = Pre-test Q2 = Post-test

X1 = Treatment (Students Team Achievement Division strategy)

X2 = No treatment (conventional teaching method)

Study Population and Sample

Study Population and Sampling

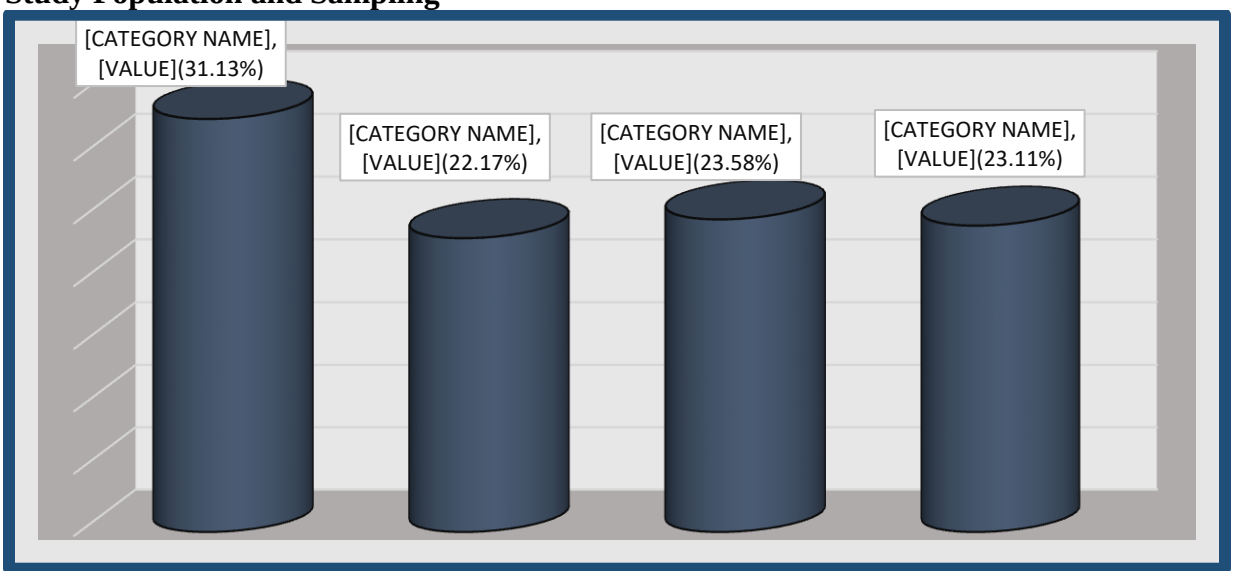


Figure 1: Bar chart showing the distribution of the students by schools

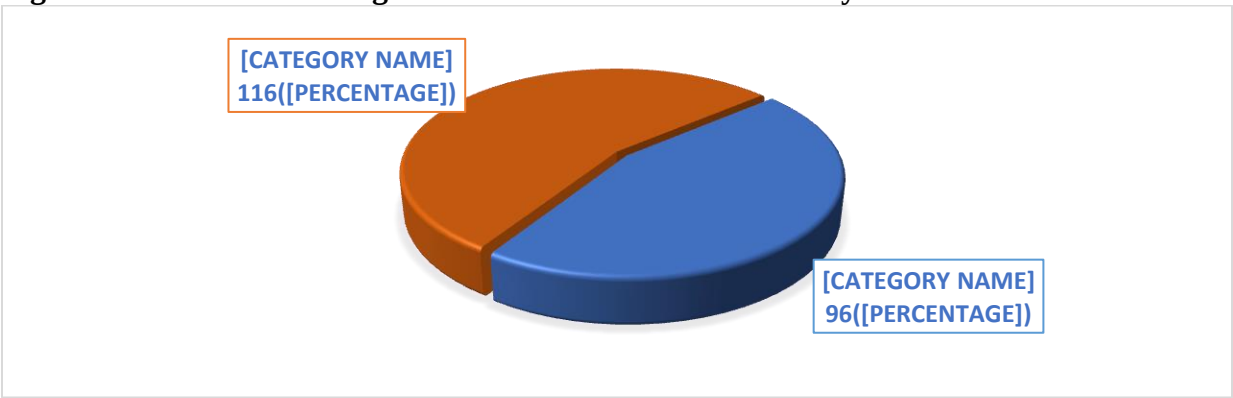


Figure 2: Distribution of the respondents based on group (Experimental and Control group)

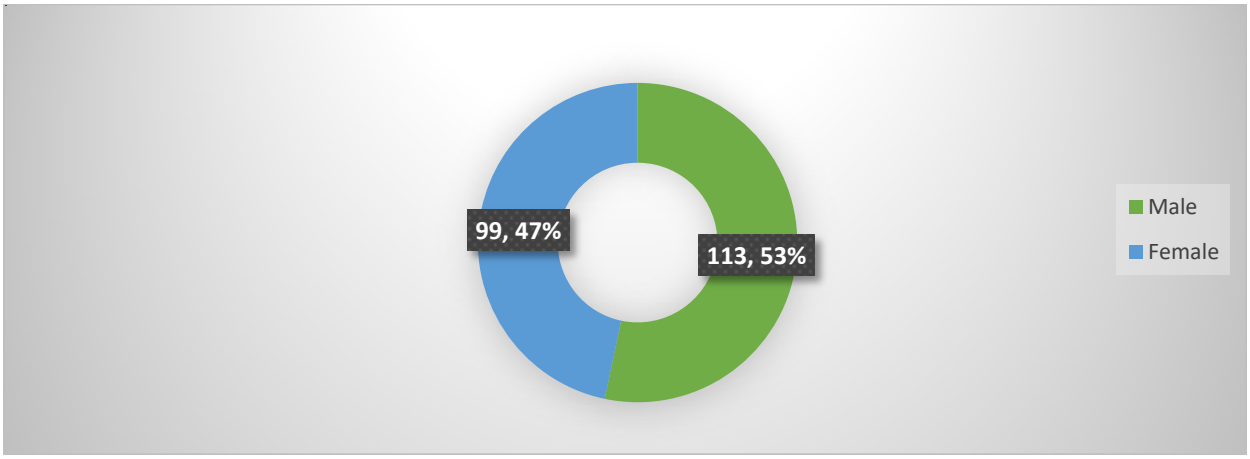


Figure 3: Distribution of students based on gender

The study focused on sixteen public senior secondary schools in Maiduguri Metropolis, Borno State, comprising four single-sex schools for males, four single-sex schools for females, and eight coeducation schools. The total population was 36,758 students, with 17,909 males and 18,849 females, and the average age was seventeen years old. The selection of SS2 students was because trigonometry is covered in the SS II syllabus.

Four schools were chosen for the study at random, each from single-sex schools. The population was divided into three strata: four male schools, four female schools, and eight mixed schools. Two schools were randomly selected from each stratum, resulting in four schools being chosen. From each selected school, one intact SS II class was randomly chosen, resulting in four classes overall, two male and two female. One class from each pair was designated as the experimental group, taught trigonometry using the Students Team Achievement Division (STAD) strategy, while the other class was the control group, taught using conventional methods. The study utilized two instruments: a questionnaire on Students' Level of Perception (SLP) toward Trigonometry and a Trigonometric Achievement Test (TAT). Following the intervention, the same questionnaire was administered to assess any changes in perception. The SLP questionnaire consisted of two sections, gathering general information about students and schools in section A, and assessing students' perceptions toward trigonometry with 18 Likert-scale (Likert Rensis 1931) items in section B. The Likert scale ranged from strongly agree (coded as 4) to strongly disagree (coded as 1), the Likert-scale items were used to measure students' attitudes, confidence, and understanding of trigonometry concepts. Intervention. The TAT consisted of two sections, gathering general information in section A and containing 40 multiple-choice questions in section B, each question worth 2.5 marks, designed to cover the SSII syllabus. Data collection was carried out in a classroom

setting, ensuring confidentiality and anonymity of responses. The intervention involved implementing team achievement division strategies during trigonometry instruction. This included group problem-solving activities, collaborative projects, peer tutoring, and cooperative learning tasks. The intervention was conducted over a specified period, with regular assessments to monitor students' progress.

Descriptive statistics (Mean and S. D) were used to analyze the data to address research questions, while inferential statistics (independent sample t-test) was used to test the hypotheses at $\alpha = 0.05$ level of significance, employing Statistical Package for Social Sciences (SPSS) version 26. Ethical approval was obtained from the relevant authorities before data collection began. Informed consent was obtained from all participants, and their anonymity and confidentiality were ensured throughout the study. Potential limitations of the study included sample size constraints, the generalizability of findings beyond Maiduguri, and the influence of external factors on students' perceptions. This methodology aimed to provide a systematic approach for investigating the effect of team achievement division strategies on trigonometry perception among senior secondary school students, contributing valuable insights to mathematics education research.

Results and Discussion

Research Question One: What are the mean scores of students' level of perception in Trigonometry when taught using the Students Team Achievement Division (STAD) strategy and conventional teaching method?

Table 1: Mean difference in students' level of perception between those taught trigonometry using STAD and those taught using the conventional method in Senior Secondary Schools in Maiduguri.

Study Group	N	Mean	SD	Mean Difference
Experimental	166	41.92	1.73	
				23.85
Control	96	18.07	1.69	

Table 1 outlines the mean difference in students' perception levels when learning trigonometry through the STAD (Student Teams Achievement Division) method compared to the conventional teaching approach in Senior Secondary Schools in Maiduguri. In the experimental group, comprising 166 students, the mean perception level was 41.92, with a standard deviation of 1.73. The control group, consisting of 96 students, had a lower mean perception level of 18.07, accompanied by a standard deviation of 1.69. The mean difference in perception levels between the experimental and control groups was notably large at 23.85. This substantial mean difference, reflected in the elevated t-value, suggests a significant disparity in students' perception levels based on the teaching methods employed. The findings imply that the STAD method has a considerable positive impact on students' perception of

trigonometry compared to the conventional teaching method in this educational setting.

Research Question Two: What are the mean scores of students' level of perception in Trigonometry, by gender, when exposed to the Students Team Achievement Division (STAD) strategy?

Table 2: Mean difference of students' level of perception in Trigonometry, by gender, when exposed to the Students Team Achievement Division (STAD) strategy

Group	N	Mean	SD	Mean Difference
Female	50	41.82	1.65	
				1.88
Male	66	39.94	1.22	

Table 2 provides insights into the mean difference in students' perception levels in trigonometry, categorized by gender when exposed to the Students Team Achievement Division (STAD) strategy. Among the female students (N = 50), the mean perception level was 41.82, with a standard deviation of 1.65. The male students (N = 66) had a slightly lower mean perception level of 39.94, accompanied by a standard deviation of 1.22. The mean difference in perception levels between female and male students was 1.88. This indicates that, on average, female students exhibited a higher perception level in trigonometry when utilizing the STAD strategy compared to their male counterparts. While the difference is relatively modest, it suggests a gender-based variation in the effectiveness of the STAD strategy on students' perception of trigonometry, highlighting the importance of considering gender-specific instructional approaches in educational settings.

Hypotheses One: There is no significant difference in the mean scores of students' level of perception between those exposed to trigonometry using the Students Team Achievement Division (STAD) strategy and those taught using a conventional teaching method.

Table 3: Independent Sample T-Test on mean difference in students' perception of trigonometry when taught using STAD and those taught using the conventional method in Senior Secondary Schools in Maiduguri

Group	N	Mean	SD	df	t	p-value	Effect Size	Remark
Experimental	166	41.92	1.73					
				260	83.14	0.000	13.82	Reject H_{01}
Control	96	18.07	1.69					

Table 3 presents the results of an independent sample t-test examining the mean difference in students' perception of trigonometry when taught using the Students Team Achievement Division (STAD) method compared to the conventional teaching approach in Senior Secondary

Schools in Maiduguri. The results indicated that there was a significant difference, with the Experimental group having a mean perception of 41.92 compared to the Control group's mean of 18.07. The t-test yielded a highly significant t-value of 13.82 with a p-value of 0.000, leading to the rejection of the null hypothesis. This implies that there is a statistically significant and practically meaningful difference in students' perception of trigonometry when taught using STAD compared to the conventional method, as evidenced by the large effect size of 13.82.

Hypothesis Two: There is no significant difference in the mean scores of students' level of perception by gender when exposed to the Students Team Achievement Division (STAD) strategy.

Table 4: Independent Sample T-Test on the mean difference of students' level of perception in Trigonometry, by gender, when exposed to the Students Team Achievement Division (STAD) strategy

Group	N	Mean	SD	df	T	p-value	Effect Size	Remark
Female	50	41.82	1.65	210	19.62	0.97	2.30	Reject H_{02}
Male	66	39.94	1.22					

Table 4 presents the outcomes of an Independent Sample T-Test investigating the mean difference in students' perception of Trigonometry based on gender and exposure to the Students Team Achievement Division (STAD) strategy. The results indicate that female students, with a mean perception score of 41.82, show a higher perception compared to their male counterparts (mean of 39.94). The t-value of 2.30 suggests a moderate effect size, but the p-value of 0.97 exceeds the conventional significance level of 0.05, leading to the acceptance of the null hypothesis.

Discussion

The results of the study indicate a significant difference in students' perception of trigonometry when taught using the Students Team Achievement Division (STAD) strategy compared to conventional teaching methods. The mean perception level in the experimental group (STAD) was substantially higher (41.92) than in the control group (conventional teaching), with a mean of 18.07. The highly significant t-value of 13.82 and a p-value of 0.000 from the independent sample t-test confirm this difference, leading to the rejection of the null hypothesis. These findings underscore the effectiveness of the STAD strategy in enhancing students' perception of trigonometry, suggesting its potential as a valuable instructional approach in mathematics education.

Furthermore, the study explored gender-based differences in students' perception of trigonometry when exposed to the STAD strategy. While female students exhibited a slightly higher mean perception level (41.82) compared to male students (39.94), the statistical analysis revealed no significant difference in perception by

gender when utilizing the STAD strategy. Although the effect size was moderate, the p-value of 0.97 exceeded the conventional significance level of 0.05, leading to the acceptance of the null hypothesis. This implies that the STAD strategy's effectiveness in enhancing the perception of trigonometry is consistent across genders, highlighting its potential as an inclusive instructional approach.

Research such as Dessy (2018), found that when students learn together in groups using cooperative methods, they are more active and do better in Mathematics. Cooperative learning also helps improve relationships between different ethnicities and races, boosts social skills, and makes friendships stronger. Being part of a team makes students feel like they belong, creating a stress-free atmosphere for learning.

This study also aligns with Yamarik (2007), which found that cooperative learning in Math leads to better outcomes compared to traditional methods. This is because students interact more with each other and with their teachers, creating a relaxed atmosphere for learning. They feel more comfortable asking questions as a group rather than individually. As a result, when students study together, they improve their understanding of the material, which is an advantage when it comes to examinations.

The findings of this research are also supported by Soomro and Arain (2023) who stated that students' Mathematics achievement has become better when using cooperative methods as opposed to conventional methods. In the cooperative learning method, students can compete and cooperate until the students become active and creative in the learning process. This directly affects and influences the students' Mathematic achievement.

Conclusion

The study supports the adoption of the STAD strategy in secondary school mathematics education to improve students' perception of trigonometry. Recommendations include integrating STAD into the mathematics curriculum, providing training for teachers on incorporating emotional intelligence into teaching and advocating for the use of instructional materials that promote emotional intelligence in education. These efforts can contribute to enhancing students' learning experiences and performance in trigonometry and mathematics as a whole.

Recommendations

1. The secondary school mathematics curriculum should be reviewed to reflect STAD as recommended teaching strategies.
2. Teachers should be able to consider the emotional intelligence of students in teaching and learning.
3. Educational planners should emphasize the use of emotional intelligence in teaching and learning for better performance and retention of students in trigonometry in particular and mathematics in general.
4. The Ministry of Education in collaboration with the Mathematics Improvement Project should

organize workshops aimed at educating teachers on how to use the emotional intelligence of students in teaching.

5. Parent teachers Associations and Non-Governmental Organizations should be able to provide instructional materials that contain the guidelines and procedures for the use of emotional intelligence in teaching.

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Conflict of interest

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