

Effect of Peer-Tutoring and Brainstorming on Senior Secondary School Students' Achievement in Mathematics in Ogun State

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Abstract: This study investigated the effect of peer-tutoring and brainstorming on Senior Secondary (SS) students' achievement in mathematics in Sagamu Local Government Authority (LGA), Ogun State. Constructivism and learning theories and pre-test, post-test and control group design were employed. Multistage sampling procedure guided the study. Three education wards and six SSSs were randomly selected and intact classes with a total of 418 SS II students from Sagamu LGA, Ogun State participated. Two validated instruments: Mathematics Attitudinal Scale ($r = 0.78$) and Mathematics Achievement Test ($r = 0.68$) and seven hypotheses guided in data collection. Data obtained were analysed using Analysis of Covariance (ANCOVA) at 0.05 level of significance. Major findings show that there is a significant main effect of treatment (brainstorming and peer tutoring) on achievement in mathematics. ($F_{(2,414)} = 5.88$; $P < 0.05$, partial eta squared = 0.028); and a significant main effect of attitude exists on students' achievement in mathematics ($F_{(1,415)} = 59.78$; $P < 0.05$, partial eta squared = 0.126). However, the first and second order interaction effects of treatments and the two moderating variables (gender and attitude) were not significant. When teachers embrace teaching methods that ensure learners are given opportunities to work at their own pace and exhibit the right disposition to study, students' academic achievement in mathematics will improve maximally. The study recommended that teachers should be encouraged to deploy diverse teaching methods, to facilitate students' exposure to opportunities to work together during instruction, thereby, enhance students-centred classroom context and improve academic productivity.

Key words: Peer-tutoring, Brain-storming, Gender, Attitude, Mathematics-Achievement, Students

Word count: 250.

Introduction

Mathematics as one important subject for sustainable development has permeated all facets of human endeavor as it is required in learning across all subjects at the senior secondary school level. Mathematics is not only compulsory at the senior secondary school level but also a prerequisite for admission into science related disciplines in higher institutions for further studies. However, despite the central place of mathematics in secondary school learning, it has consistently recorded the highest level of annual failure in public examinations. The consistent poor performance of students in mathematics and very high failure rate in public examinations like the Senior Secondary Certificate Examination (SSCE) administered by the West African Examinations Council (WAEC), and the National Examinations Council (NECO) yearly, has become a serious concern to stakeholders in education (Attah, 2024). In like manner, Smith and Jones (2020) asserted that many students leave secondary school with a dislike for mathematics.

The academic achievement of students generally is the outcome or output of every educational programme. This is because it is an indicator of the extent educational objectives have been achieved and it is measured through continuous assessment tests and examinations. Students' achievement in the course work is very important as this is capable of determining whether the students are doing well or not. Parents, teachers, school administrator as well as curriculum planner attach so much importance to students' academic achievement, that if the students do not perform well academically, then they recognise all other efforts of the students in the educational programme as a waste and shift all the blame on the teachers (Attah, 2024). Academic achievement defines the totality of the learner in his or her school cycle. Contrary to the perception of the stakeholders in the education sector, literature reveal that there are many factors that influence students' academic achievement, most obvious among them are utilisation of instructional materials like social media, information communication technology, students' attitude and teaching effectiveness (Osei-Himah, Parker & Naah 2022).

Gender alone has no effect on academic achievement but acts in conjunctions with other variables to affect learning outcomes (Kaster and Judy, 2022), but the finding Eshetu, (2022) in his study, found that male participants achieved higher than the female and further buttressed his finding in line with researches that have argued that gender differences in social, personality and academic variables may actually be a function of gender orientation. Similarly, Eze, Ezenwafor & Obi, (2023) revealed that more males are found to be achieving better in the fields of mathematics than females because of their ability to reason mathematically. However, Gegbe, Sundai

& Sheriff (2023) found that gender has no effect on students' achievement but in the contrary, Berger, Mackenzie & Holmes (2020) asserted that girls under the age of fourteen usually perform better in English language than boys of the same age.

In addition, Kim (2022) reported however that, despite the fact that girls show a more adaptive cognitive-motivational pattern than the boys, the former do not obtain significantly higher marks in the subject of Mathematics. In summary, results suggest that differences exist in the cognitive-motivational functioning of boys and girls in academic achievement. Ganal & Guiab, (2024) asserted that there is no significant difference in scores for males and females with regard to their academic achievement. Since, the magnitude of differences in the average scores for each gender is small. Thus, males and females do not differ in their academic achievement significantly. Supporting the earlier discovery, Moliner & Alegre (2020) observed that there is a general belief that boys are superior to girls in terms of cognition and logical reasoning and even in academic performance. Supporting the earlier opinion, Sheldon (2021) asserted that factors that affect students' academic achievement in science subjects include gender role stereotype, masculine image and female socialization process and inability to withstand stress.

Attitude is a combination of feelings and beliefs which result in a predisposition to respond favourably towards persons, groups, ideas or objects. Attitudes are unconsciously learnt as people engage in everyday interaction processes. Asempapa (2022) noted that attitude is a human expression that is made up of three interrelated components; belief, feelings and behaviour. Even though most of the studies suggested that there was a positive relationship between attitude and academic achievement, there were other researchers who argued that students' attitude might not be a significant predictor of their academic achievement. In a study conducted by Moliner and Alegre, (2020) who stated that whether attitude could significantly predict one's academic achievement depends on a number of variables, particularly the socio-economic background. Attitude manifests in an individual when he/she forms an opinion (beliefs) about an object. One reason we can advance is that majority of students never get a true understanding of the real meaning of mathematics concepts which made them develop a nonchalant attitude towards mathematics subject.

Attitudes are learned over time by being in contact with the subject. Information about the subject is received through instructional strategies and methods used by the teacher and consequently, positive and/or negative attitude is developed by students (Junaid and Afolabi cited in Obafemi, 2022). For instance, if a person is favourably predisposed towards a learning package, that favourable disposition should lead to favourable behaviour that will influence high academic performance in the subject. Attitude has affective and behavioural components. The affective pertains to the emotions and feelings that accompany the encounter while the behavioural component pertains to the predisposition of readiness for action. Ashlame & Iwanger (2020) describes attitude as an individual response to tendency against any phenomenon or certain thing around him, which can either be positive or negative. This corroborates with Gongden, (2021) definition of attitude as the more or less stable way in which a person reacts to people, things, situations and problems.

Moreover, Longjohn & Osila (2022) defines attitude in relation to reading comprehension as a relatively stable tendency to respond in a favourable or unfavourable fashion to specific reading tasks. Students' attitude towards reading ranges from excitement to avoidance. The former is positive while the latter is negative. Shenoy, (2020) notes that "a learner's attitude to reading represents a significant factor influencing not only his motivation to read but also the manner in which he learns, the progress he makes and also his eventual ability to read". Students' attitude to reading at times serves as a guide to their behaviours and these affect their educational goals and the degree of their involvement in educational activities. Ycong, Barredo & Mamolo (2021) opines that the child's positive attitude is the foundation upon which his reading growth and development is built. However, Junaid and Afolabi (2017), in their study, found that there was a significant main effect of students' attitude on students' achievement in civic education. Hence, positive attitude of students led to higher academic achievement.

Literature reveals that many factors can be attached to worrisome poor achievement of students in Mathematics ranges from school, teachers' and students' factors but seems much empirical investigation have not been carried out on the effects of methodology adopted by the teachers in instructional delivery in relation to peer-tutoring and brainstorming teaching methodology in relation to students' achievement in Mathematics. Peer-tutoring instructional technique is a learner oriented instructional technique rooted in social constructivist theories. The nomenclature Peer tutoring instructional technique amounts to a tutoring arrangement with its success majorly on fast learning students helping the entire class to learn academic concept or carry out an academic assignment. This instructional technique is most apt for students with different ability levels, working together" Marsely (2020) "explains that this instructional technique involves students instructing each other on a material in which one is an expert and the other is a novice.

In this research, the peer-tutoring method encompasses pairings of high-performing students tutoring lower-performing ones in a class-wide setting under the supervision of a teacher. Likewise, Khaizaar & Hidayat (2022). opined that "students' pairings in peer tutoring instructional technique are based on ability levels and the selection of tutor is based on two criteria: (1) the tutors must demonstrate adequate knowledge of the subject to aid their low achieving cohorts in the learning process; (2) the tutors must possess

the quality of promoting low achievers to engage keenly in the learning process, wait for tutees to have a go at a question independently before offering help, encouragement as well as correct responses". Thus, peer tutoring instructional technique involves the use of more successful/experienced students to tutor less successful/experienced students in a collaborative learning experience in which all the students involve richly gain.

The adage that "teaching is learning twice", applies here because where one student may excel in a subject such as shorthand, another student may be top-notch in another subject like business communication. The paired students can work together to comprehend difficult concepts, while strengthening their competence in the subjects. Comprehension takes place via individual constructions and dealings with the natural and physical world and through a social manner of interacting with others. Peer tutoring instructional technique promises to address the intricate academic and social necessities of students with diverse learning abilities in a regular class without really affecting other students in the class. This is true when students supplement teachers' efforts to assist low achievers in a large classroom typical of the Nigerian situation (Hidayat, Zainuddin & Mazlan 2024).

Similarly, Evans and Field (2020) found that students taught via peer tutoring performed significantly better than their counterparts taught with the conventional method in school subjects and that there was no interaction effect between peer tutoring and students' gender in achievement in a school subject. Davadas & Lay (2020) concluded that partaking in peer tutoring has a significant effect on students' performance. Peer-tutoring is not the only innovative teaching method that can influence students' achievement, another teaching method to be considered as treatment in this study is brain-storming.

Brainstorming is an innovative strategy that involves organising students into groups, either large or small, to engage in activities that encourage focused tasks and the free flow of ideas. This approach fosters creative thinking by creating an environment where ideas are generated without criticism, allowing learners to challenge their thinking and expand their minds. According to Agustina, Masrukan & Walid (2022) brainstorming is an informal and relaxed method of problem-solving, thinking, and lateral performance. By organizing learners into small groups and promoting critical thinking, brainstorming facilitates the generation of ideas and encourages interaction with the teacher. When teachers incorporate brainstorming into their instructional approach, active listening becomes crucial. It provides learners with an opportunity to share their ideas and build upon each other's contributions, thereby expanding their existing knowledge (Dhawan, 2020), and this can only happen in an enabling classroom environment provided by school managers for teachers to be productive and stimulate all students to learn (Junaid, 2019).

Brainstorming is one of the methods of developing thinking and creativity in solving various scientific and life problems with the aim of increasing mental capabilities and processes. Brainstorming requires a challenge between the problem presented and the mind of the learner. This method allows the learners to more actively participate in the achievement of the lesson objectives by stimulating the learners, stimulating their talents and enhancing their mental abilities Ogunyebi, (2023) have shown that innovative and productive instructional strategies of teaching such as expeditionary learning, simulation method, brainstorming, inquiry strategies, concept mapping, and modeling are capable of improving students' achievement.

Many previous studies (Hong, Tsai, Liao, Chang and Chen, 2020). have claimed that the process involved in the idea generation task may potentially play an exceptional role in stimulating individuals' ability to produce creative solutions that can be further evaluated and, eventually, applied in practice. According to Morrison cited in Eze, Ezenwafor & Obi (2023), Brainstorming is an approach or technique that can be an effective way of generating many ideas on a specific issue which can then be filtered and reviewed to determine which idea or approach is the most appropriate. In the same vein, Salihu (2020) suggested that a brainstorming method is expected to be used in teaching and learning because students will actively participate in the teaching and learning process. Nevertheless, it seems there are limited empirical studies that tested the effects of brainstorming on students' academic achievement of SS II students in mathematics in Ogun State.

Statement of the Problem

Objectives of learning Mathematics subject are not only to ensure the acquisition of relevant knowledge, skills, and problem-solving abilities, but it includes developing in the students critical thinking skills that can engender development in the society. However, such laudable objectives have not reflected positively in the achievement of the students in Mathematics. Although, different teaching methods like play-way, demonstration and problem-solving have been put forward by different researchers in past studies not in relationship with gender and attitude, to improve students' achievement in Mathematics, however, the issue of low achievement still arises.

Observably, students appreciate one another's company through playing, chatting and different levels of discussion on any issue of life. It is in this spirit of teamwork that peer-tutoring and brainstorming approaches were explored in this study stressing the learning of Mathematics in groups, focusing on specific problems relating to daily living for better understanding and achievement in Mathematics. Also, it has been observed that students' attitude determines to a great extent their attitude. It is against this backdrop that the study investigated the moderating effects of gender and attitude. Therefore, the study explored effects of peer-tutoring and

brainstorming on senior secondary school students’ achievement in Mathematics in Sagamu Local Government Area, Ogun State. The investigation also ascertained the roles of gender and attitude in this regard.

Research Hypotheses

Based on the stated problem, the following hypotheses guided the study:

- Ho₁: There is no significant main effect of treatment (peer-tutoring and brainstorming) on students’ achievement in Mathematics in Sagamu Local Government Area, Ogun State.
- Ho₂: There is no significant main effect of gender on students’ achievement in Mathematics in Sagamu Local Government Area, Ogun State.
- Ho₃: There will be no significant main effect of attitude on students’ achievement in Mathematics in Sagamu Local Government Area, Ogun State.
- Ho₄: There will be no significant first order interaction effects of treatment (peer-tutoring and brainstorming) and gender on students’ achievement in Mathematics in Sagamu Local Government Area, Ogun State.
- Ho₅: There will be no significant first order interaction effects of treatment (peer-tutoring and brainstorming) and attitude on students’ achievement in Mathematics in Sagamu Local Government Area, Ogun State.
- Ho₆: There will be no significant first order interaction effects of gender and attitude on students’ achievement in Mathematics in Sagamu Local Government Area, Ogun State.
- Ho₇: There will be no significant second order interaction effects of treatment (peer-tutoring and brainstorming), gender and attitude on students’ achievement in Mathematics in Sagamu Local Government Area, Ogun State.

Methodology

Design and Sample Participants

The study adopted pretest – posttest control group design in a quasi-experimental research type. This design was considered appropriate because intact classes were used. The intact classes were randomly assigned to the treatment group. The 3x2x2 factorial design allows variables that are not manipulated to be included by building them into the research design. The design also provides the opportunity for determining how the independent variables combine to affect students’ achievement in Mathematics. That is, it provides an opportunity to determine the combined effects of the independent and moderator variables. Table 1 shows the factorial matrix of the treatment with respect to gender and attitude levels. Three dimensions of instructional methods were used: Peer-tutoring method (T₁), Brain-storming method (T₂) as treatment group and Lecture method (T₃) as control group. Gender operated at two levels (Male and female). Two dimensions of attitude were used (negative and positive).

Table 1: 3x2x2 Factorial matrix

Treatment (T)	Gender	Attitude	
		Positive	Negative
Peer-tutoring (Experimental) T ₁	Male		
	Female		
Brain-storming (Experimental) T ₂	Male		
	Female		
Lecture method (Control) T ₃	Male		
	Female		

In symbolic form, the design is shown as follows

O ₁	T ₁	X	O ₂
O ₁	T ₂	X	O ₂
O ₁	T ₃		O ₂

O₁, represents the pre-test before treatments.

T₁, T₂, T₃, represent treatments for all the groups.

X represents treatments for experimental groups.

O₂, represent post-test for immediate recall.

The population of the study consisted of all SSII Mathematics students in Sagamu Local Government Area of Ogun State. Multi stage sampling procedure was adopted in the selection of the sample for the study as follows: Sagamu Local Government Area has ten wards. Three wards and six schools that met the specified criteria were randomly selected from the LGA through the following criteria;

- i. The scope of work covered by the school.

- ii. Year of establishment (not less than 20 years).
- iii. Experienced mathematics teacher (10 years and above), to ensure that the research assistants are those with teaching qualifications with at least a B.Ed. degree in Mathematics.

At the school level, intact classes of SS II mathematics students were assigned to the treatment group. In all, 418 SS II Mathematics students from six selected schools in Sagamu LGA participated in the study. Two schools were selected for each treatment.

Population

The population of the study includes all the senior secondary school two (SS II) students in Sagamu Local Government Area of Ogun State.

Sample and Sampling Techniques

Sagamu Local Government Area has ten wards. Three wards (6, 10 and 13) with secondary schools were randomly chosen. Six schools that meet the specified criteria were randomly chosen from the Local Government Area using multi-stage sampling procedure. Selection criteria are;

1. The scope of work covered by the school.
2. Year of establishment (not less the 20 years). To ensure that the schools have the instructional Materials for teaching the subject.
3. Experienced Mathematics teacher (10 years and above).To ensure that the research assistants are those with teaching qualifications with at least a B.Ed. degree in Mathematics.

At the school level, intact classes were assigned to treatment group. In all, students in Senior Secondary School two (SSII) from the six schools in Ogun State participated in the research. Two schools for each treatment.

Instrumentation

Two instruments guided study, namely:

1. Mathematics Attitudinal Scale (MAS)
2. Mathematics Achievement Test (MAT).

Mathematics Attitudinal Scale (MAS)

The Mathematics Attitudinal Scale (MAS) was constructed by the researchers and it measured students' attitude towards mathematics. It comprises two sections: A and B. Section A is on students' personal data which consists of name of school, gender and age. Section B consists of twenty-five items on students' attitude towards mathematics. The Participants responded along a four-point Likert scale response options, which are: (Most of the time, Sometimes, Few times and Almost never) and 50% was set as bench mark for positive attitude towards mathematics. The instrument was validated by the researcher on a sample of thirty (30) similar respondents that were not included in the study. The reliability of this instrument was established using Cronbach Alpha and the resulting reliability coefficient was 0.78.

Mathematics Achievement Test (MAT)

Mathematics Achievement Test (MAT). The MAT was constructed by the researchers to measure acquisition of knowledge in some selected topics in SS II Mathematics before and after treatments have taken place. The test has two sections. Section A consists of a participant's personal profile such as name of school, class, gender age of students while Section B comprised 40 items of multiple-choice test that were chosen out of the initial draft containing 60 items with four options A-D. Participants are required to pick correct options from the alternatives provided. The validation was done among SS II students of a school in Sagamu Local Government Area, outside the schools selected for treatment. Questions in the instrument covered selected topics in SS II mathematics curriculum. Mathematics teachers in the school whose students were used for pilot testing assisted in the moderation of the questions to ensure a high standard and 50% was set as bench mark for achievement in Mathematics. Kuder Richardson formula 21 (KR21) was used to establish the internal consistency of the instrument and the resulting reliability co-efficient = 0.68. Data collected were analysed using Analysis of covariance (ANCOVA). LSD multiple classification analysis was used for the pairwise comparison of treatment groups. The hypotheses were tested at the 0.05 significance level ($P < 0.05$).

Procedure.

Firstly, pre-test was administered on Mathematics before treatments, followed by administration of Mathematics Attitudinal Scale. The three groups were exposed to the treatments. This was followed by administration of post-test.

There are three treatments packages:

Package I: Peer-tutoring method (T_1) on experimental group I

Package II: Brain-storming method (T_2) on experimental group II

Package III: Lecture method (T_3) control group.

The researcher used experienced teacher (with teaching qualification degree in Mathematics education) in each school that were selected for the study. Each teacher used one package. The rationale for six schools is to allow each package to be used by two teachers to eliminate the problem of teacher validity. Each of the treatments was mounted in different schools to eliminate the problem of infiltration that may result if all the treatments are available in one school. Treatments lasted for four (4) weeks and the entire field work lasted for six (6) weeks.

Package I: Peer-tutoring method

Step 1: Pairing the slow and fast learners discovered from the result of pre-test.

Step11: The teacher trained each tutor on the most appropriate strategies to use

Step11I: Then the teacher met with tutors regularly to ensure they were preparing for each session and to review their self-reflections.

Step 1V: The teacher met with tutees regularly to ensure they were making progress and were comfortable partnering with their tutor.

Step V: Troubleshooting as necessary when tutees were not making adequate progress or when tutor/tutee partnerships were not a good fit.

Step VI: Teacher finally examined students’ work in line with the topic to see whether the students’ equation solving abilities showed that they have acquired some Mathematics skills.

Package 11 Brain-storming method

Step 1: Assign a facilitator: Brainstorming session needs to have boundaries. Teacher chose someone who facilitated the session and provided guidelines for the thinking exercises that the group partook in.

Step 11: Establish context and ensure group understanding: The teacher exposed every member of the group to the meaning of brainstorming and what to expect from the brainstorming process.

Step 111: Define an objective: Here the teacher defined a clear objective and direct the use the session to reach your predetermined goal.

Step 1V: Set a time limit: The teacher set a define time limit on how long the session could run

Step V: Capture all ideas: The teacher sieved all the methods students used in solving the given equation.

Step VI: Teacher finally examined students’ work in line with the topic to see whether the students’ equation solving abilities show that they have acquired some Mathematics skills.

Package III Lecture

Step 1: The teacher reviewed the previous work by asking specific questions orally based on previous knowledge.

Step 11: The teacher talked while the students listen and sometimes took down notes.

Step 111: The teacher repeated and emphasized salient points and made use of illustrations.

Step 1V: Teacher sometimes asked and invites questions at intervals and devised suitable activities like working some equations.

Step V: Finally, the teacher provided clarity based on students’ questions through explanations. He gave summary on the chalkboard or dictated the note to students. The teacher moved round the classroom and ensured students copied the note given to then in summary/form by the teacher before leaving the class.

Data Analysis

Analysis of co-variance (ANCOVA) was used to analyse data gathered. This corrected initial differences among participants. Interaction effects of the independent variables were also revealed. The hypotheses were tested at the 0.05 significant level ($P < 0.05$).

Results and Discussions

The results are presented and discussed with respect to the respect to the hypotheses tested.

Ho₁: There is no significant main effect of treatment (peer-tutoring and brainstorming) on students’ achievement in Mathematics in Ogun State.

Table 2a: Tests of Between-Subjects Main Effect of Treatments and Students’ Achievement in Mathematics

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
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Corrected Model	21.206 ^a	3	7.069	5.657	.001	.039
Intercept	132.631	1	132.631	106.148	.000	.204
Pre-test	1.324	1	1.324	1.060	.304	.003
Treatment	14.707	2	7.353	5.885	.003	.028
Error	517.292	414	1.249			
Total	2442.000	418				
Corrected Total	538.498	417				

a. R Squared = .039 (Adjusted R Squared = .032)

Table 2b Estimate Marginal Means for Treatment

Treatment	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Brainstorming	2.203	.110	1.986	2.419
Peer Tutoring	2.381	.094	2.197	2.565
Lecture Method	1.627	.187	1.259	1.995

a. Covariates appearing in the model are evaluated at the following values: Pre_test = 61.85.

Table 2 shows that the main effect of treatment is significant on students’ achievement in mathematics $F_{(2,414)} = 5.88; P < 0.05$. Therefore, the null hypothesis H_{01} which stated that: there will be no significant main effect of treatment (peer-tutoring and brainstorming) on students’ achievement in mathematics in Ogun State was rejected. The partial eta squared of 0.028 implies that treatment accounts for 3% of the observed variance in the post-test scores of students’ achievement in mathematics.

Discussion

The finding from this study which reveals that treatment is significant on academic achievement in mathematics was revealed in this manner, as the innovative teaching method which emphasises learner-centred approach as more influential on achievement in mathematics nowadays. The finding buttresses some authors’ discovery and researchers’ findings. For instance, the result is in consonance with Pham (2022) who asserted that brainstorming helps promote thinking skills because, when students are asked to think of all things related to a concept, they are really being asked to stretch their thinking skills. Brainstorming promotes success for students with special needs as there is no one right answer (Pham 2022). Brainstorming in an expeditionary learning is a strategy that organises learners into participatory small or large groups that indulges in critical thinking that could enhance free flow of ideas among them as they interact with the teacher. In a task that involves the teacher in brainstorming, the teacher should emphasise on active listening during the session to provide an opportunity for learners to share ideas and expand their already built knowledge by building on one another’s contributions. At the end of a brainstorming session, if one goes through the results and evaluate the responses, attainment of best ideas will be observed and development of new ideas by the use of the ideas introduced during the session learning will take place (Bahar, Munadi and Rosnawati, 2023)

The result also reveals that peer tutoring is significant on students’ achievement in mathematics and the finding is in line with the discovery of Cheng and Ku, (2021) who asserted in his research on the impact of peer tutoring on the academic performance of junior secondary school students in sciences concluded that students taught using peer tutoring method, performed better than those taught sciences using the lecture method. The result also buttresses Hickey and Flynn. (2023) in their research affirmed that peer-tutoring pedagogy significantly aids the learning of keyboarding skills. This pedagogical approach reflects the improvement brought about by Peer tutoring instruction technique thus making it superior to the teacher-dominated instructional approach in enhancing students’ acquisition of the skill. Fuchs, Fuchs, Thompson, Stevenson and Yen (2002) investigated the effects of reciprocal peer tutoring on the academic achievement, self-efficacy and test anxiety of university students in Georgia. The result indicated that those exposed to peer tutoring performed better than those exposed to using lecture methods in academic achievement.

H₀₂: There is no significant main effect of gender on students’ achievement in Mathematics In Ogun State.

Table 3: Tests of Between-Subjects Main Effect of Gender and Students’ Achievement in Mathematics

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
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Corrected Model	11.357 ^a	2	5.678	4.470	.012	.021
Intercept	215.761	1	215.761	169.861	.000	.290
Pre-test	7.320	1	7.320	5.762	.017	.014
Gender	4.858	1	4.858	3.824	.051	.009
Error	527.141	415	1.270			
Total	2442.000	418				
Corrected Total	538.498	417				

a. R Squared = .021 (Adjusted R Squared = .016)

The table 3 also shows that the main effect of gender is not significant on students' achievement in mathematics $F_{(1,415)} = 3.82$; $P > 0.05$. Thus, the null hypothesis H_{02} which stated that: there will be no significant main effect of gender on students' achievement in mathematics in Ogun State was retained as the significant value is greater than 0.05.

Discussion

The finding from this research revealed that gender is not significant on mathematics achievement of SS II students. Which implies that both male and female performance in mathematics is equal. The result is in consonance with Karjanto (2022) who asserted that boys and girls in the early ages perform equally in all subjects including science and mathematics, and as they grow to higher classes, the girls begin to get more interested in arts and commercial, while the boys take more to sciences. For this reason, more boys than girls are found to offer sciences. Besides, the finding support Arslan Yavuz and Deringol-Karatas (2024) whose finding showed that there was no significant difference between male and female students' achievement in mathematics and science subjects irrespective of the gender.

H₀₃: There will be no significant main effect of attitude on students' achievement in Mathematics in Ogun State.

Table 4: Tests of Between-Subjects Main Effect of Attitude and Students' Achievement in Mathematics

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	73.479 ^a	2	36.740	32.788	.000	.136
Intercept	272.522	1	272.522	243.209	.000	.370
Pre_test	5.825	1	5.825	5.199	.023	.012
Mathematics attitude	66.980	1	66.980	59.776	.000	.126
Error	465.019	415	1.121			
Total	2442.000	418				
Corrected Total	538.498	417				

a. R Squared = .136 (Adjusted R Squared = .132)

In addition, table 4 further shows that the main effect of attitude is significant on students' achievement in mathematics $F_{(1,415)} = 59.78$; $P < 0.05$. Therefore, the null hypothesis H_{03} which stated that: there will be no significant main effect of attitude on students' achievement in Mathematics in Ogun State was rejected. The partial eta squared of 0.126 implies that attitude accounts for 13% of the observed variance in the post-test scores of students' achievement in mathematics.

Discussion

The significant result of attitude on students' achievement in mathematics establish the influence of positive disposition to learning on achievement and the finding is in line with many researchers' findings. For instance, the finding is in line with Tsuei (2024) who stated that considerable evidence demonstrates that attitudes play an important role in determining behaviour which is a potent tool for the determination of the extent of student learning in school subjects. Guner. (2022) asserted that the attitude of a learner towards a school subject would determine the measure of the learners' attractiveness or repulsiveness to such a subject. This will invariably influence the learners' choice and even learning outcome in the subject. In that regard, a positive attitude will lead to persistence and better achievement. Osborne cited in Veloo, Nor and Khalid (2023) proved that there existed a positive correlation between students' attitude toward science and achievement. Furthermore, the finding is in consonance with Zan, and Di Martino (2022) who found that students' attitude towards science have significant direct effect on student learning achievement in the subject.

Ho₄: There will be no significant first order interaction effects of treatment (peer-tutoring and brainstorming) and gender on students' achievement in Mathematics in Ogun State.

Table 5: Tests of between-Subjects First and Second Order Interaction Effects of Treatment, Gender and Attitude on Students' Achievement in Mathematics

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	97.522 ^a	12	8.127	7.464	.000	.181
Intercept	159.519	1	159.519	146.505	.000	.266
Pre-test	2.180	1	2.180	2.002	.158	.005
Treatment	15.320	2	7.660	7.035	.001	.034
Gender	2.681	1	2.681	2.462	.117	.006
Mathematics attitude	56.734	1	56.734	52.105	.000	.114
Treatment * Gender	2.145	2	1.073	.985	.374	.005
Treatment * Mathematics Attitude	2.052	2	1.026	.942	.391	.005
Gender * Mathematics Attitude	.012	1	.012	.011	.918	.000
Treatment * Gender * Mathematics Attitude	1.948	2	.974	.895	.410	.004
Error	440.976	405	1.089			
Total	2442.000	418				
Corrected Total	538.498	417				

a. R Squared = .181 (Adjusted R Squared = .157)

Further still, table 2 reveals that the first order interaction effects of treatment (peer-tutoring and brainstorming) and gender is not significant on students' achievement in mathematics $F_{(2,405)} = 0.985$; $P > 0.05$. Therefore, the null hypothesis Ho_4 which stated that: There will be no significant first order interaction effects of treatment (peer-tutoring and brainstorming) and gender on students' achievement in mathematics in Ogun State was retained.

Ho₅: There will be no significant first order interaction effects of treatment (peer-tutoring and brainstorming) and attitude on students' achievement in Mathematics in Ogun State.

Table 5 reveals that the first order interaction effects of treatment (peer-tutoring and brainstorming) and attitude is not significant on students' achievement in mathematics $F_{(2,405)} = 0.942$; $P > 0.05$. The result implies that gender interaction with the two innovative teaching methods adapted in this study, to the teaching-learning process did not influence achievement in mathematics. Thus, the null hypothesis Ho_5 : There will be no significant first order interaction effects of treatment (peer-tutoring and brainstorming) and attitude on students' achievement in mathematics in Ogun State was retained.

Ho₆: There will be no significant first order interaction effects of gender and attitude on students' achievement in Mathematics in Sagamu Local Government Area, Ogun State.

Table 5 reveals that the first order interaction effects of gender and attitude is not significant on students' achievement in mathematics $F_{(1,405)} = 0.011$; $P > 0.05$. Therefore, the null hypothesis Ho_6 : There will be no significant first order interaction effects of gender and attitude on students' achievement in mathematics in Ogun State was retained. The result implies that gender and attitude interaction did not influence achievement in mathematics.

Ho₇: There will be no significant second order interaction effects of treatment (peer-tutoring and brainstorming), gender and attitude on students' achievement in Mathematics in Ogun State.

Table 5 also shows that the second order interaction effects of treatment (peer-tutoring and brainstorming), gender and attitude is not significant on students' achievement in mathematics $F_{(2,405)} = 0.895$; $P > 0.05$. Therefore, the null hypothesis Ho_7 : There will be no significant second order interaction effects of treatment (peer-tutoring and brainstorming), gender and attitude on students' achievement in mathematics in Sagamu Local Government Area, Ogun State was retained. The result implies that treatment (peer-tutoring and brainstorming), gender and attitude interaction did not influence achievement in mathematics.

Discussion of Findings

The finding from this study which reveals that treatment is significant on academic achievement in mathematics was revealed in this manner, as the innovative teaching method which emphasises learner-centred approach as more influential on achievement in mathematics nowadays. The finding buttresses some authors' discovery and researchers' findings. For instance, the result is in consonance with Pham (2022) who asserted that brainstorming helps promote thinking skills because, when students are asked to think of all things related to a concept, they are really being asked to stretch their thinking skills. Brainstorming promotes success for students with special needs as there is no one right answer (Pham 2022). Brainstorming in an expeditionary learning is a strategy that organises learners into participatory small or large groups that indulges in critical thinking that could enhance free flow of ideas among them as they interact with the teacher. In a task that involves the teacher in brainstorming, the teacher should emphasise on active listening during the session to provide an opportunity for learners to share ideas and expand their already built knowledge by building on one another's contributions. At the end of a brainstorming session, if one goes through the results and evaluate the responses, attainment of best ideas will be observed and development of new ideas by the use of the ideas introduced during the session learning will take place (Bahar, Munadi and Rosnawati, 2023)

The result also reveals that peer tutoring is significant on students' achievement in mathematics and the finding is in line with the discovery of Cheng and Ku, (2021) who asserted in his research on the impact of peer tutoring on the academic performance of junior secondary school students in sciences concluded that students taught using peer tutoring method, performed better than those taught sciences using the lecture method. The result also buttresses Hickey and Flynn. (2023) in their research affirmed that peer-tutoring pedagogy significantly aids the learning of keyboarding skills. This pedagogical approach reflects the improvement brought about by Peer tutoring instruction technique thus making it superior to the teacher-dominated instructional approach in enhancing students' acquisition of the skill. Fuchs, Fuchs, Thompson, Stevenson and Yen (2002) investigated the effects of reciprocal peer tutoring on the academic achievement, self-efficacy and test anxiety of university students in Georgia. The result indicated that those exposed to peer tutoring performed better than those exposed to using lecture methods in academic achievement.

In addition, peer tutoring helps develop the skills of students to manage and plan learning experiences, work in association, give and receive responses about their activities and evaluate their own learning. At present, the significance of peer tutoring is increasing, and it has become an important part of many courses and disciplines in different countries (Bowman-Perrott, 2009). Moreover, peer tutoring is advantageous for students, as it provides opportunities for discussion which lead to learning in an affable environment. In the same way, peer tutoring builds up confidence and enhances cognitive levels of introvert students because it gives confidence to shy students (Sheldon, 2021) which may enable them to express themselves in front of the class or other gatherings (Calhoun and Fuchs, 2023).

The finding from this research revealed that gender is not significant on mathematics achievement of SS II students. Which implies that both male and female performance in mathematics is equal. The result is in consonance with Karjanto (2022) who asserted that boys and girls in the early ages perform equally in all subjects including science and mathematics, and as they grow to higher classes, the girls begin to get more interested in arts and commercial, while the boys take more to sciences. For this reason, more boys than girls are found to offer sciences. Besides, the finding support Arslan Yavuz and Deringol-Karatas (2024) whose finding showed that there was no significant difference between male and female students' achievement in mathematics and science subjects irrespective of the gender

However, the findings negate Alsagoafi, (2021) who discovered that males and females show great difference in their interest and career choice. These differences may be attributed to the psychological differences and cultural influences. Denga cited in Aldurayheem (2022) reported that many comparisons showed that boys and girls on the average are the same on general intelligence tests. Denga said that girls do a little better on verbal tests and on tests involving arithmetical ability. Davadas and Lay (2020) posited that no evidence is clear as to whether differences exist between males and females in academic achievement in sciences. Davadas and Lay (2020) likewise stated that, girls tend to do better than boys in social sciences while boys tend to outperform the girls in sciences and mathematics. Gender differences in academic performance cannot be assumed to be due to inherent biological differences between genders even if they exist but as a result of gender role stereotyping. Gender is a strong predictor of human conduct and many differences have been documented on attitude and behaviour that affect academic achievement in males and females (Ajai and Imoko, 2024).

The significant result of attitude on students' achievement in mathematics establish the influence of positive disposition to learning on achievement and the finding is in line with many researchers' findings. For instance, the finding is in line with Tsuei (2024) who stated that considerable evidence demonstrates that attitudes play an important role in determining behaviour which is a potent tool for the determination of the extent of student learning in school subjects. Guner. (2022) asserted that the attitude of a learner towards a school subject would determine the measure of the learners' attractiveness or repulsiveness to such a subject. This will invariably influence the learners' choice and even learning outcome in the subject. In that regard, a positive attitude will lead to persistence and better achievement. Osborne cited in Veloo, Nor and Khalid (2023) proved that there existed a positive correlation between students' attitude toward science and achievement.

Furthermore, the finding is in consonance with Zan, and Di Martino (2022) who found that students' attitude towards science have significant direct effect on student learning achievement in the subject. Moussa and Saali, (2022) opined that students' attitudes about the value of learning science may be considered as both an input and achievement variable because their attitudes towards the subject can be related to educational achievement in ways that reinforce higher or lower performance. This means that those students who do well in a subject generally have more positive attitudes towards that subject and those who have more positive attitudes towards a subject tend to perform better in that subject (Junaid & Afolabi, 2021). Kaster and Judy (2022) describes attitude as an individual response to tendency against any phenomenon or certain thing around him, which can either be positive or negative. Mubeen, Saled and Arif (2023) opines that the child's positive attitude is the foundation upon which his reading growth and development is built. Many factors influence students' attitude to a subject- the difficulty of a learning task, the occupational preference/choice, the instructional strategy (teaching method), the learning environment and many others. Mazana Montero and Casmir (2020) revealed that more males are found to be achieving better in the fields of mathematics than females because of their ability to reason mathematically. However, Moliner and Alegre (2020) found that gender has no effect on students' achievement.

Conclusion

Based on the findings of the study, it was observed that there was a significant main effect of treatment (Brainstorming and peer tutoring) on students' achievement in mathematics. Similarly, there was a significant main effect of attitude on students' achievement in mathematics. The findings of this research necessitate further investigation into more variable that can determine students' achievement in mathematics. Therefore, the researcher submitted that when teachers diversify their choices of teaching methods to ensure that learners are given the opportunities to work at their own pace and students exhibit the right disposition to their study, this will go a long way to improve the students' academic achievement in mathematics.

Recommendations

Based on the findings of the study, it is therefore recommended that:

1. Teachers should diversify in their choices of teaching methods to ensure that learners are given the opportunities to work together and enhance academic productivity.
2. Students should exhibit the right disposition to their study as this will go a long way to improve their academic achievement in mathematics and other subjects.
3. Mathematics teachers should enrich their classroom with peer tutoring teaching method to foster productive interaction among students.
4. Teachers should periodically employ brainstorming teaching method, as this will help in developing critical thinking skills that mathematics requires in the learners.
5. Government should periodically organise workshops and seminars for mathematics teachers on the new innovative teaching techniques, in order to enhance students-centre classroom context.

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