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EXPLORING PEER-TUTORING AS INSTRUCTIONAL STRATEGY FOR DEVELOPING CREATIVITY IN SENIOR SECONDARY SCHOOL STUDENTS AND PROMOTING ACHIEVEMENT IN GEOMETRY IN THE STATE OF TARABA STATE

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ABSTRACT

Evidence from research has indicated that classroom practices across Nigeria in general and Taraba State in particular are dominated by teacher-centered activities. Teacher centeredness has been shown to be a major cause of under-achievement by geometry or mathematics students. This is because in this approach, students are made to learn in passivity and the major actor (the teacher), emphasizes routine arithmetic characterized by memorization and repetition. As a result, students merely develop the ability to carry out straight forward computational procedures and tend to have only a small understanding of mathematical ideas. This leads to poor achievement in the subject. Furthermore, research evidence has it that when students are made to be the focus of instruction, they are made to think and take active part in the teaching/learning process. Consequent upon this, they achieve well. This investigation explored peer-tutoring as a strategy for making students think and take active part in the teaching/learning process. In particular, the study subjected students to working in small groups comprising of peers to

Introduction

Undoubtedly, being creative is a powerful asset in the economic life of a country. When the citizens of a country, especially the young, able-bodied ones or a good number of them are creative, the country has significantly great potential for strong economic growth. The world of today, more than ever before, is a world of creativity. It therefore becomes pertinent for us to, as well meaning citizens of our great country, Nigeria, not only embark on talent search in our young ones at high school but also strive to develop these talents into creativity. Inspired by this, the current researcher got the motivation to embark on the study of creativity.

Can creativity be promoted by prevailing classroom practices

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think and actively make sense of the properties of geometric figures like rectangles, trapezia, triangles and so on. The quasi-experimental design was employed for the conduct of the study. One hundred and sixty (160) Senior Secondary two students ((80 males and 80 females) were randomly sampled for the study, using the cluster random sampling method. Six (6) research questions were asked to guide the conduct of the investigation and three (3) null hypotheses were formulated for testing at the 5% (0.05) level of significance. Two instruments called the Properties of Plane Shapes Test (PPST) and the Geometry Achievement Test (GAT) were used to obtain information. Gathered data were analyzed using mean, standard deviation and t-test statistic. Recommendations were proffered based on finding.

Keywords: Exploring, Peer-tutoring, Instructional Strategies, Developing, Creativity.

In the study area (i.e Taraba state)? It is evident from research that majority of geometry teachers in our classrooms handle geometry teaching by using teacher-centered approaches. Teacher-centered approaches subject learners to being passive listeners with little or no contribution made to the teaching/learning process. In this approach, the major actor (the teacher), emphasizes routine arithmetic characterized by memorization and repetition as a result of which geometry students merely develop the ability to use straight-forward procedures for computing and tend to have only a small understanding of mathematical ideas (Balasa, 2021). This leads to under-achievement (poor achievement) in the subject. On the other hand, when students are the central focus of instruction, opportunities are created for them to think and to actively participate in the teaching/learning process. In other words, student-centered approaches create opportunities for these geometry students to exhaust all processes through critical thinking and active participation. Hence, they learn meaningfully and achieve well. This informed the current researcher's investigation of student-centered teaching approach i.e peer-tutoring.

Peer-tutoring is an accredited student-centered teaching approach. In this approach, a student teaches another or other students who are peers under the guidance and supervision of the geometry teacher in the classroom. That peer-tutoring is student-centered is obvious since students teach and learn themselves. To bring improvements to students' learning outcomes, geometry teachers need to use student engaging and participatory methods that involve activities that provoke critical thinking and opportunities for working together collaboratively to solve geometric problems. A teaching approach which has the potential for all these teaching/learning ingredients is peer-tutoring, an instructional strategy where-in student partnership links high achieving students to collaborate with others during geometry or mathematics sessions. Additionally, peer-tutoring has the capacity to:

i. Promote retention of learnt material;
ii. Raise students' self-esteem;
iii. Increase rates of students' response and feedback;
iv. Create opportunities for students' response to practice specific skills;
v. Help the student tutor to have a greater understanding of a geometry topic by teaching it to peer students;
vi. Motivate students to develop positive attitudes to learning geometry;
vii. Help students develop self-confidence; and
viii. Improve students' achievement

The current researcher was prompted by these to study the potentials peer-tutoring has for developing creativity in high school students.

Every nation, Nigeria inclusive, desires and strives to develop economically and must as a strategy, make advances in science and technology in order to achieve this. Indeed during the late Yar'aduwa's administration, Nigeria had a vision plan called vision 20-20. In this vision, Nigeria had a desire to become one of the 20 most developed economies by the year 2020. A section of the vision document reads, "By 2020, Nigeria will be one of the 20 largest economies in the world, able to consolidate its leadership role in Africa and establish itself as a significant player in the global economic and political arena" (Federal Ministry of Education, 2005). For Nigeria's desire for becoming one of the 20 top- most economies to become a reality, it must according to Ayagi (2008), provide for the following:

a. A reliable and a steady source of power generation, transmission and distribution;
b. A strong industrial base; and
c. Improvements in agriculture, health, education, mining and other vital sectors of the national economy. These pre-requisites are hardly met without the continuous application of science and technology.

Developments in science and technology are facilitated by having a mathematically literate citizenry. Wilson (2005) observed that the subject mathematics does not only facilitate the intellectual development of an individual, it is also the foundation upon the much needed scientific and technological development of the individual's country stands. Mathematics is an effective tool for developing the capacities of individuals for clear logical thinking with a view to finding scientific solutions to problems. Geometry is an aspect of mathematics which attracts lots of critical and logical thinking. Hence the focus of this study on geometry as a medium for developing critical thinking in high school students and improving their achievement in the subject.

A primary goal of teaching and learning of geometry is to develop on students, the ability to carry out a wide variety of complex geometry learning. Geometers and mathematicians have traced the role of task-accomplishment in geometry and have

illustrated that it has a rich history. To many geometrically literate people, studying geometry is synonymous with doing tasks-solving word problems, creating patterns, discerning situations, interpreting figures, using theorems, etc. indeed, learning to solve problems is the principal reason for studying geometry and mathematics (U.S National Council of Supervisors of Mathematics, 2008). This is a motivating factor for the current researcher to embark on the study of task-accomplishment in geometry.

The teaching and learning of geometry are essential activities in the study of mathematics in Nigeria. This statement is made in recognition of the fact that geometry enjoys a highly significant presence in the national mathematics curriculum. Again, in evaluating, the frequency with which examination councils set questions in geometry is high, thus attracting investigations into the subject area of geometry. For instance, 35% , 38%, 40%, 42% and 32% of the multiple choice items prepared by the West African Examinations council (WAEC) for 2012, 2013, 2014, 2015 and 2016 respectively, were all drawn from geometry. Further, WAEC chief examiner's report for the May/June 2015 West African School Certificate Examination included geometry among areas of weakness of candidates. WAEC's acts of setting questions frequently in geometry (WAEC 2012, 2013, 2014, 2015, 2016) and its declaration of geometry as a difficult subject and one in which learners are generally weak (WAEC Chief Examiner, 2015), are sources of inspiration for the researcher to focus investigation on geometry.

To achieve means to succeed (in doing something, to reach a goal) (DeJager-Haum, 2000). Achievement therefore is measured by the scores testees are able to make on a test. With this in our minds, the geometry achievement of participating students in this study will be measured by the scores they are able to make on the PPST and GAT. In this investigation, peer-tutoring as a strategy for developing critical thinking in high school students and promoting their achievement in geometry in the state of Taraba was explored.

Statement of the Problem

School geometry, a great component of the high school mathematics, enjoys a highly significant presence in the national mathematics curriculum. Through the study of geometry, students have worthwhile opportunities for solving word problems, creating patterns, discerning situations, interpreting figures, using theorems, and doing some other scientifically inclined activities that enhance critical thinking and problem-solving. Unfortunately, however, these laudable scientific features promoted by the study of geometry, are being challenged by the seeming fears exhibited by students while studying the subject. In support of this argument, Eraikhuemen (2013), declared, "Geometry is an aspect of school mathematics which students dislike because they feel it is not only difficult, it is also not easy to understand". Teachers need to not only have special competence and perseverance to handle the teaching of geometry but also to use innovative and sound instructional strategies to make students have the motivation to

study the subject and make significant achievement. Research evidence exists linking peer-tutoring as teaching strategy with students' creativity and achievement in geometry. The problem of this study is to investigate with a view to finding out whether peer-tutoring has an influence on students' creativity and achievement in geometry. Posed as a question, is peer-tutoring as an instructional strategy having any influence on students' creativity and achievement in geometry?

Purpose (Objective) of the Study

The general purpose of this study was to determine the influence of peer-tutoring as a strategy of instruction on students' creativity and achievement in geometry. In specific terms, the purpose of the study was to determine the influence of:

i. Peer-tutoring teaching method on creative thinking of geometry students;
ii. Peer-tutoring teaching method on students' achievement in geometry;
iii. Peer-tutoring teaching method on male students' achievement in geometry;
iv. Peer-tutoring teaching method on female students' achievement in geometry;
v. To determine the difference, if any, between the mean achievement scores of geometry students in the peer-tutoring class and those of geometry students in the conventional lecture class.

Research Questions

The following research questions were asked to guide the conduct of the study:

i. What is the mean score of students learning geometry in the peer-tutoring classroom?
ii. What is the mean score of students learning geometry in the lecture classroom?
iii. What is the mean score of male students learning geometry in the peer-tutoring classroom?
iv. What is the mean score of female students learning geometry in the peer-tutoring classroom?
v. How much critical thinking is observed among geometry students in the peer-tutoring classroom?
vi. How much critical thinking is observed among geometry students in the lecture classroom?

Research Hypotheses

Three statements of null hypotheses were formulated for testing at the 5% (0.05) level of significance. They are:

Ho_1: peer-tutoring technique has no significant influence on students' achievement in geometry

Ho_2: male students' geometry achievement is not significantly different from that of their female counterparts in the peer-tutoring classroom

Ho_3: peer-tutoring has no significant influence on students' creative thinking in learning school geometry.

Methods

In set-up, this investigation was experimental, as such the investigator employed the use of 2x 2 factorial quasi-experimental design, involving two classes of participating students, one experimental and the other control. This design was used to explore the influence of peer-tutoring instructional strategy on developing creativity in Senior Secondary School students and promoting their achievement in geometry. The experimental class worked in small groups comprising of four (4) students, (2 boys and 2 girls), with one of the four adjudged to be a high achiever, teaching the others. The control class was subjected to whole – class teaching by the geometry teacher. The choice of the 2 x 2 factorial quasi-experimental design was predicated on the fact that the study would find the influence of peer-tutoring on students creativity and achievement in geometry. It is felt that the choice of this design was very apt. A sample of one hundred and sixty (160) Senior Secondary two (SS2) students was randomly taken and used for the study. The sampling was done in stages. In the first stage, four (4) out of the one hundred and eighteen (118) Public Secondary Schools were randomly sampled and used. This random choice of four (4) schools was done by using cluster random sampling method. In other words, all the Public Senior Secondary Schools in the state were clustered into four, with each cluster comprising of four local government areas. A school was chosen from each of these 4 clusters through randomization by balloting. Each of these 4 randomly chosen schools was named schools 1,2,3 and 4. For the selection of participating students, the researcher used simple random sampling technique to select two intact classes from each of the four randomly chosen schools. In all, 8 intact classes were chosen for the study and this marked the end of the first stage of the sampling exercise. Table 1 (below) shows the distribution of participating students according to the chosen schools at the end of stage 1 of sampling.

Table 1: Distribution of Learner-participants According to Schools

Schools	1		2		3		4		
Classes	A	B	C	D	E	F	G	H	Total
Males	19	17	18	19	16	15	16	17	137
Females	13	12	12	12	13	11	12	13	98
Total	32	29	30	31	29	26	28	30	235

Source: Field Survey, 2024

In the second and final stage of sampling, a proportionate sampling of 10 male and 10 female students was made in each of the classes A,B, C, D, E, F, G and H. At the end of the second stage of sampling, the following distribution of participating students emerged:

Table 2: Distribution of Actual Participant in the Study

Schools	1		2		3		4		
Classes	A	B	C	D	E	F	G	H	Total
Males	10	10	10	10	10	10	10	10	80
Females	10	10	10	10	10	10	10	10	80
Total	20	20	20	20	20	20	20	20	160

Source: Field Survey, 2024

A look at the distribution in table 2 (above) shows that there emerged two important sub-samples – a sub-sample for male students numbering 80 and a sub-sample for female students also numbering 80. Together, both the male and female sub-samples added up to the major sample of 160.

Further, the investigator randomly assigned the participating students to either the experimental (treatment) group or control (whole-class) group. Accordingly, and through random sampling by balloting, the classes B, E, G and H (in table 2 above), got assigned to the treatment group while classes A, C, D and E had their random assignment done to the control group. The participants in the experimental classroom were given treatment by a well experienced teacher with wealth of training who used exemplary classroom practices to handle instructions. In the treatment, participating students were made to work in small groups of 4 with one of them leading their interactions. They were exposed to a variety of hands-on manipulatives (concept cards bearing the shapes of triangles and quadrilaterals) for them to explore and verbalize their understanding of and their thinking about these geometrical shapes and their properties. The geometry teacher here played the role of creating the enabling environment, providing the manipulatives, guiding and facilitating the discussion and observing and assessing students' behaviors as they worked and discussed. In the control classroom on the other hand, students received instructions from a well-trained and experienced teacher too, in a whole-class teaching. Two sets called the Properties of Plane Shapes Test (PPST) and the Geometry Achievement Test (GAT), developed by the researcher, were administered. Data gathered from the test administration helped the researcher in two respects: Data from the PPST helped the researcher determine the level of creativity developed by the students. On the other hand, data from the GAT helped the researcher determine how much geometry was learnt by these students, depending on the level of creative thinking and creativity developed. Validity of the two instruments (the PPST and GAT), was determined by four mathematics teachers one each from the 4 participating schools, and by 3 respected mathematics (geometry) educators, one each from the College of Education, Zing; Taraba State University, (TSAU) Jalingo and Modibbo Adama University (MAU), Yola. The test retest reliability approach was used to estimate the reliability of the two tests. Using Pearson's Product Moments Correlation Coefficient method,

reliability coefficients of 0.83 and 0.79 were obtained for PPST and GAT respectively, indicating that PPST and GAT were reliable instruments.

Experimental Procedure

For data to be generated on which to base investigational findings, the researcher subjected the participating students to two kinds of instructions – instruction in an experimental set-up and instruction in a whole – class set-up. Participating students in experimental classroom (EC) were exposed to instructions in which exemplary classroom practices were used with a wide variety of rich instructional materials that created environments and opportunities for learners to explore geometrical figures and to express their understanding of and thinking about these figures and their properties. With this, opportunities were created for the researcher to observe and assess informally, learners' thoughts about these figures, how critical thinking gradually springs up and how it is developed into creativity. For participants in control classroom (CC) on the other hand, their instructions were delivered through the usual lecture in a whole-class setting. Treatment teachers (teachers in the experimental classrooms), received grooming, enablement and advice to use exemplary classroom practices and assorted instructional materials to maximize opportunities for students to be critical in thinking and develop creativity. To ease the handling of this treatment, these quasi-experimental teachers were subjected to a two week training exercise during which the dynamics of peer-tutoring were carefully explained. Research conditions, the making and skillful handling of instructional materials (concept cards and models) were equally exhaustively explained. Control teachers (teachers in the control classrooms) were simply groomed to be able to handle lecture as a method of instruction. Also, SS 2 students in both treatment and control classrooms received experimental and control instructions respectively. This four week session of instructions was followed by a session of test administration in which two tests were administered which were:

i. The Properties of Plane Shapes Test (PPST) used to measure creative thinking and development of creativity by geometry students; and
ii. The Geometry Achievement Test (GAT), an instrument used to measure the achievement level of geometry students (level of geometry content learnt).

The researcher prepared the marking guide (scheme) that was used for marking students' answer scripts. Data generated were analyzed by using mean and standard deviation. Research questions which guided the conduct of the study were answered by these means and standard deviations. The stated null hypotheses were tested at the 0.05 significance level by means of the t-test statistic.

Results

This subsection of the research report is given to presentation of results, closely followed by their analyses. Tables are used for the presentation, each table is preceded by a

research question and the content of the table answers the research question. A statement of hypothesis follows each research question for testing at the 5% (0.05) level of significance. The t-test statistic was employed for the hypothesis testing. A statement follows each summary of results, accepting or rejecting the stated null hypothesis.

Research Questions 1 and 2

1. What is the mean score of students learning geometry in the peer-tutoring (treatment) classroom?
2. What is the mean score of students learning geometry in the lecture (control) classroom?

Table 3 below presents mean and standard deviation scores of students learning geometry in the peer-tutoring (treatment) and lecture (control) classrooms.

Table 3: Mean and Standard Deviation Scores for Treatment and Control Students

Groups	N	Mean	Standard Deviation
Treatment	80	6.06	4.50
Control	80	5.19	3.94
Difference		0.87	0.56

Source: Field Work, 2024

From table 3 (above), it is clearly seen that the treatment students (students who studied geometry in the peer-tutoring classroom) have a mean score of 6.06 while the control students (those who studied geometry in a whole-class setting) have a mean score of 5.19, leading to a difference in mean of 0.87. Again, from the table, the treatment students have a standard deviation score of 4.5 while the control students have a standard deviation score of 3.94, leading to a difference of 0.56. These differences in mean and standard deviation (0.87 and 0.56 respectively), are clear indications that the treatment students' achievement on the geometry achievement test (GAT) was superior to that of the control students.

HO_1: Peer-tutoring teaching strategy has no significant influence on students' achievement in geometry.

The summary of the t-test analysis of SS2 students' achievement on the GAT is shown in table 4 below:

Table 4: Summary of t-test analysis of SS2 Students' Achievement on GAT

Groups	N	Mean	Std. Dev.	t-cal.	t-crit.	Df.	Inference
Treatment	80	9.47	6.07	21.8	1.96	158	Significant
Control	80	8.70	4.42				

Source: Field work, 2024.

Evidently from table 4, students in the treatment group where various forms of interaction occurred, had higher mean score than that of students in the control group where there were lectures and passivity. As can be seen further, the calculated value of t- (21.8) far exceeds that of the critical value of t (1.96). on this note, the stated null hypothesis is rejected. This is a disconfirmation of the statement that peer-tutoring teaching strategy has no significant influence on students' achievement in geometry. It is rather confirmed that the strategy has significant influence on students' achievement.

Research Questions 3 and 4

3. What is the mean score of male students learning geometry in peer-tutoring classroom?
4. What is the mean score of female students learning geometry in the peer-tutoring classroom?

The mean and standard deviation scores of male and female students learning geometry in the peer-tutoring classroom are depicted in table 5 (below):

Table 5: Mean and Standard Deviation Scores of Male and Female Treatment Students

Sex	N	Mean	Standard Deviation
Male	40	4.56	3.50
Female	40	3.79	2.61
Difference		0.77	0.89

Source: Field work, 2024

Clearly, table 5 shows that the mean score of male treatment students is 4.56 and their standard deviation score is 3.50. Also, the mean score of female treatment students is 3.79 while their standard deviation score is 2.61. The difference in mean between male and female treatment students stands at 0.77 while the difference in standard deviation between male and female treatment students is 0.89. Obviously, the male students are superior in achievement to their female counterparts due to these observed differences in mean and standard deviation.

HO_2: Male students' geometry achievement is not significantly different from that of their female counterparts in the peer-tutoring classroom

Results in table six (6) below present the summary of the t-test analysis of SS2 male and female treatment students' achievement on the GAT

Table 6: Summary of t-test Analysis of SS2 Male and Female Treatment Students' achievement on GAT

Sex	N	Mean	Std. Dev.	t-cal.	t-crit.	Df.	Inference
Male	40	8.52	5.51	18.3	1.96	78	Significant
Female	40	6.07	3.13				

Source: Field work, 2024

Evidence from table 6 (above) indicates that male students in the treatment group recorded a mean score of 8.52 on the GAT, which was higher than the female mean of 6.07. Again the calculated value of t in the analysis (18.3) far exceeded that of the critical t (1.96). As a result, the researcher's decision was that of rejection of the stated null hypothesis. It was concluded that male treatment students' geometry achievement in the GAT was significantly different from that of their female counterparts.

Research Questions 5 and 6

5. What is the mean score of male students learning geometry in the lecture classroom?
6. What is the mean score of female students learning geometry in the lecture classroom?

Questions 5 and 6 (above) are answered by the mean and standard deviation scores of male and female students learning geometry in the lecture classroom presented in table 7 (below);

Table 7: Mean and Standard Deviation Scores of Male and Female Control Students:

Sex	N	Mean	Standard Deviation
Male	40	3.89	3.01
Female	40	2.77	1.99
Difference		1.22	1.02

Source: Field work, 2024

As can be seen, table 7 (above) clearly discloses that male control students had higher mean score (3.89) than female control students who had 2.77. They also had higher standard deviation score (3.01) than that of the females (1.02). There are thus differences of 1.12 and 1,02 in mean and standard deviation scores respectively. This clearly points to the fact that the male students' achievement on the GAT was superior to that of their female counterparts.

Ho_3: Male students' geometry achievement is not significantly different from that of their female counterparts in the lecture classroom.

The table that follows, (table 8) bears the summary of t-test analysis of SS2 male and female lecture students' achievement on the GAT.

Table 8: Summary of t-test analysis of SS2 male and female lecture students' achievement on GAT

Sex	N	Mean	Std. Dev.	t-cal.	t-crit.	Df.	Inference
Male	40	7.12	4.03	15.51	1.96	78	Significant
Female	40	5.73	2.62				

Source: Field work, 2024

It is evidently seen from table 8 that the mean calculated for male control students (7.12) was greater than that of females (5.73). it is also evidently seen that the computed value of t (15.51) was much larger than the value of t lifted from the table (1.96). This guided the researcher to reject the stated null hypothesis that male students' geometry achievement is not significantly different from that of their female counterparts in the lecture classroom.

Research Question 7

7. How much critical thinking is observed among students in the peer-tutoring classroom?

To answer research question 7, the researcher qualitatively observed the behaviours of the participants, listened to and took note of their utterances, and asked them questions, (where necessary), and received responses as these participants worked in small groups to accomplish geometrical tasks. The following are the researchers' observations regarding participating students' activities in this interactive peer-tutoring classroom:

i. Students worked collaboratively in small groups to accomplish geometrical tasks using concept cards bearing geometrical shapes and their properties;
ii. In the collaboration, they asked questions about shapes and their properties, reasoned together and answered the questions collectively;
iii. Many of the questions asked were logical and were reasonably deep in thoughts;
iv. They questioned one another's arguments, revised positions and took decisions;
v. Sometimes, they moderated early decision(s) when new convincing reason(s)/evidence(s) emerged;
vi. Lots of thinking about properties of geometrical shapes, sometimes reasonably deep, were injected into their arguments;
vii. Each small group appeared to be led by a participant who appeared to be playing both academic and leadership roles, probably the peer-tutor;
viii. Students worked in a very friendly atmosphere with greater freedom than elsewhere-freedom to ask, freedom to respond, etc.;
ix. At intervals, the instructor/researcher had to bring the participants to order due to the rowdy nature of the interactions;
x. Geometrical tasks accomplished were based on the properties of geometrical shapes, (which promoted reasoning) learnt as a result of the interactions; and
xi. A lot of critical thinking (creativity) was developed in this peer-tutoring classroom.

Research Question 8:

8. How much critical thinking is observed among students in the lecture classroom?

In similar respect, research question 8 was answered by the researcher doing the same thing he did to answer question 7. Qualitatively, the researcher observed the behaviours

of control students who were to accomplish geometrical tasks in a whole-class setting by listening to lectures. The following observations were reported:

i. Students passively listened to explanations about geometrical shapes and their properties from the teacher/researcher for the greater period of the instruction;
ii. Students were only shown concept cards briefly at demonstration without having opportunities to handle them and work with them to describe their shapes and argue about their properties;
iii. Students were given small opportunities to ask questions about geometrical shapes and their properties, only a few questions were asked mostly bearing shallow level of thinking;
iv. Very small opportunities were created for the students to respond to a few questions at evaluation time, many of the responses to the few questions were incorrect;
v. No opportunities were observed in which students think critically about shapes and their properties, argue with reason(s), bring new evidence , revise initial position(s) and finally take decision(s);
vi. Only a very small or no critical thinking/creativity was observed in this passivity-laden lecture classroom.

Summary of Findings

1. Treatment students who studied geometry in the peer-tutoring classroom where students interacted with peers and with a variety of geometrical concept cards and models, under the guidance and supervision of a teacher, had higher mean and standard deviation scores than those of control students who learnt geometry in a whole-class setting by passively listening to lectures.
2. Male students in the experimental group achieved higher mean and standard deviation scores than female students in the same group (experimental).
3. Similarly, male students in the control classroom were superior in achievement to their female counterparts in the same classroom due to observed differences in mean and standard deviation scores.
4. Collaboration was observed among students in the treatment classroom as these students worked in small groups and as peers to accomplish assigned geometrical tasks.
5. Collaboration led to occurrence of such scientific behaviours as questioning, critically thinking about questions and responding to them, revision of initial position when there is new reason/evidence to do so, moderating decisions, observing, arguing, basing arguments on reasons and reporting.
6. Lots of critical thinking that had the potential to make students creative were observed in the peer-tutoring classroom.
7. Students productively learnt both academic and leadership skills

8. Free and friendly atmospheres for working and learning were observed.
9. Sessions of instructions here were observed to be rowdy though.
10. Passive listening with small or no contributions made by students to the teaching/learning process were observed in the lecture classroom.
11. Students in the control group hardly asked questions and when they did, the questions were of low-level thoughts.
12. Control students rarely had opportunities for answering questions and for the few available cases, many responses were incorrect.
13. Very small or no critical thinking was observed in the control classroom
14. The study confirmed a significant influence of peer-tutoring teaching strategy on students' achievement in geometry.
15. Also confirmed was a significant difference between male student's achievement in geometry and that of their female counterparts in the treatment group.
16. Male students' geometry achievement in the control group was similarly found to be significantly different from that of the females.

Discussion

From the outcome of this investigation, it is evidently clear that critical thinking which promotes creativity, teaching strategy and student achievement are variables of great importance in the teaching and learning of geometry and that one can influence the other. A discovery was made from this study for instance that, students who learnt geometry in the treatment classroom which adopted peer-tutoring as a strategy had an achievement that was superior to that of students who learnt geometry in the control group adopting lecture as a strategy. This report is clearly evident from the researcher's statement of discovery that, "Treatment students who studied geometry in the peer-tutoring classroom where students interacted with peers and with a variety of geometrical concept cards and models, under the guidance and supervision of a teacher had higher mean and standard deviation scores than those of control students who learnt geometry in a whole-class setting by passively listening to lectures". That the treatment students scored higher mean and standard deviation scores was due to the adoption of peer-tutoring as a teaching strategy which created and sustained better environment and atmosphere for learning than the conventional lecture. Balasa (2022) in a study titled the effect of misconceptions in learning school geometry on student achievements in geometry, had similar report to current. This researcher reported that achievement-wise, treatment students had superior achievement to that of control students as evidenced by differences between their mean and standard deviation scores. He further said that results in tables 6,8,10 and 12 indicated that differences in mean and standard deviation scores existed between the achievements of treatment and control students in favour of treatment. Treatment students had higher mean and standard deviation scores than control. Instructions in the treatment group were exemplary,

involving the use of various instructional materials by skillful and well experienced geometry teachers. Instructions in the control group on the other hand were delivered through the normal lecture with students mostly, passively listening. Impliedly, better opportunities for learning were created in the treatment classroom than they were in the control group. Achievement was therefore accordingly higher in the treatment class than it was in the control class.

Another discovery made by this investigation was that male students in the experimental group achieved higher mean and standard deviation scores than female students in the same group (experimental). Similarly, male students in the control classroom were superiors in achievement to their female counterparts in the same classroom due to observed differences in mean and standard deviation scores. This means that the sex of students in the study was a variable that helped in determining the measure of achievement made by these students in geometry. Again, similar situations were reported by Balasa (2021) in a study involving a sample of 180 SS2 students in the state of Taraba. The report indicated the existence of a significant difference between the achievement of male and female students within both the treatment and control groups. In both cases (treatment and control), male achievements were found to be superior to those of females. Tieng and Kwan Eu (2015) and Atebe and Schafer (2010) had similar findings.

A further discovery made by this investigation concerned the nature of collaborative work done by peer-tutoring students and its benefits to them. The discovery disclosed that treatment students' collaboration made them to ask questions, think critically about questions asked and respond to them, revised earlier position(s) with new reason(s)/evidence(s) emerging, moderate discussions, observe trends, argue (with reasons), challenge, report, and do other behavours likened to those of scientists. These beautiful activities have been found to be effective promoters of emotional intelligence, reasoning ability, memory capacity and intelligence. The promotion of these four independent variables (emotional intelligence, reasoning ability, memory capacity and intelligence), by the collaborative activities of peer-tutoring students in this study boosted their achievement on the geometry achievement test (GAT). This explained the superiority of their achievement to that of control students.

Musa, Dangana, Usman, A.I; Lawal, T.E and Mari, J.S (2021), similarly discovered and reported a moderately positive relationship between emotional intelligence and academic achievement, a highly positive relationship between reasoning ability and academic achievement, a highly positive relationship between memory-capacity and academic achievement and a highly positive relationship between intelligence and academic achievement. A number of other researchers reported similar situations. For instance, Rozell, *et.al.* (2002), David, *et. al.* (2005); and Singh, *et.al.*(2009) reported a significantly positive relationship between emotional intelligence and the GPA (grade point average) they made in the courses. In more explicit term, these researchers held

that students with high emotional intelligence had higher GPA's than students with low intelligence score. But Johnson's (2008) findings disagreed with that of current study. He found no significant correlation between emotional intelligence and students' GPA. Just like it is with current investigation, Ertepmar (1995); Cavllo (1996); Abisamra (2000); Oloyode (2012); and Mari (2012) reported that reasoning ability was a predictor of students' achievement in biology. Kuchon's (2012) report however differed from that of current researcher. Caren, *et. al*. (2016) too had a different report than current. Both researchers did not find reasoning ability to be a predictor of students' academic achievement. In reports that were in agreement with current, Alloway, *et.al.* (2005); Bull (2008); Hunda, *et. al*. (2009); and Swanson (2016) revealed that students having high memory-capacity had better performance than those having low memory-capacity. Ershova, *et. al.* (2016) however differed by reporting no significant correlation between memory-capacity and students' performance. In line with current researcher's report, Archana (2002); Martin (2004); Laidra, *et.al*. (2007); and Deshparde (2014), submitted that students' academic achievement relied strongly on their cognitive abilities. But Habibollah, *et. al.* (2010); and Riggo, *et. al.* (2013) had a contrary finding that no significant relationship exists between students' intelligence and academic achievement. A major finding by this study worthy of mention is that lots of critical thinking that had the potential to make students creative were observed in the peer-tutoring classroom. Such critical thinking episodes were not observed in the control classroom. For instance, participants were spotted to be behaving much in the same way as Goldstein *et. al.* (2015) reported as being the behaviours of creative persons. These researchers stated that creativity entails nothing other than an individual's ability to process new ideas or techniques through critical thinking and imagination. The participants also developed abilities for intensive explorations and openness to experience. This is similar discovery to that made by Frith, *et. al.* (2021) in which they reported that an individual's creativity depends on his/her ability to do extensive exploration and to have openness to experience.

A significant influence of the pee-tutoring teaching strategy on student's geometry achievement was confirmed by the investigation. This finding was in agreement with that of Balasa (2021) in which the existence of a statistically significant difference between the achievement of the treatment students and that of the control students was reported. Atebe and Schafer (2010), cited Uzikin as having had similar finding. It therefore looks advisable for geometry teachers to prefer peer-tutoring strategy of instructions to whole-class teaching or lecture.

Another major confirmation reported by this study was that of a statistically significant difference between male students' geometry achievement and that of their female counterparts in the treatment (peer-tutoring) classroom. The same situation was also reported in the control (lecture) classroom. Male students' geometry achievement in this classroom was similarly significantly different from that of females. This was similarly

significantly different from that of females. This clearly indicates that gender is a factor in determining students' achievement in geometry. Atebe and Scafer (2010) and Tieng and Kwan Eu (2015) had similar findings to that of current researcher.

Conclusion

The conclusion reached from this study was that:

1. Treatment students who studied geometry in the peer-tutoring classroom where students interacted with peers and with a variety of geometrical concept cards and models, under the guidance and supervision of a teacher, had higher mean and standard deviation scores than those of control students who learnt geometry in a whole-class setting by passively listening to lectures;
2. Male students in the experimental group achieved higher mean and standard deviation scores than female students in the same group (experimental);
3. Similarly, male students in the control classroom were superior in achievement to their female counterparts in the same classroom due to observed differences in mean and standard deviation scores;
4. Collaboration was observed among students in the treatment classroom as these students worked in small groups and as peers to accomplish assigned geometrical tasks;
5. Collaboration led to occurrence of such scientific behaviours as questioning, critical thinking about questions and responding to them, revising initial position when there is new reason/evidence to do so, moderating decisions, observing, arguing, basing arguments on reasons and reporting;
6. Lots of critical thinking that had the potential to make students creative were observed in the peer-tutoring classroom;
7. Students productivity learnt both academic and leadership skills;
8. Free and friendly atmospheres for working and learning were observed;
9. Sessions of instructions here were observed to be rowdy though;
10. Passive listening with small or no contribution made by students to the teaching/learning process were observed in the lecture classroom;
11. Students in the control group hardly asked questions and when they did, the questions were of low-level thoughts;
12. Control students rarely had opportunities for answering questions and for the few available cases, many responses were incorrect;
13. Very small or no critical thinking was observed in the control classroom;
14. The study confirmed a significant influence of peer-tutoring teaching strategy on students' achievement in geometry;
15. Also confirmed was a significant difference between male students' achievement in geometry and that of their female counterparts in the treatment group; and

16. Male students' geometry achievement in the control classroom was similarly confirmed to be significantly different from that of the females.

Implications of the Findings for Education

It has been found from this study that when students are made to learn in interactive situations, (such as in a peer-tutoring setting), they have opportunities to collaborate and to think critically about problem-solving and to solve problems together in a scientific setting. The critical thinking they do leads them to becoming creative. The subject of creativity is becoming increasingly important. As a matter of facts, we live in a world of creativity and as such we must make efforts at knowing the relevance of developing creativity (creative thinking) and searching for creative talents. This has far reaching implications for the classroom. Geometry teachers are advised to use instructional procedures, such as peer-tutoring to search for creative talents and to use same to develop these talents into creativity.

Also evident from the study was the fact that students' who learnt geometry content via peer-tutoring had better understanding of the geometry content learnt with greater achievement grades. Geometry teachers should therefore employ peer-tutoring to promote content understanding and boost achievement. Apart from promoting academic excellence, as discovered from the study, peer-tutoring helped to prepare participating students for leadership. Therefore, geometry teachers can use peer-tutoring instructional strategy to train students' for leadership skills.

Recommendations

The findings of this study led the researcher to recommend as follows:

1. In teaching, geometry teachers should patronize interactive teaching practice strategies, especially peer-tutoring since peers interact with other peers and with materials to learn more meaningfully and achieve higher.
2. In learning geometry, gender is a factor. So geometry teachers should take cognizance of this while preparing and delivering geometry lessons.
3. Instructions should be designed such that they do not only involve collaborative work but also promote it as children mostly enjoy accomplishing geometrical tasks by working cooperatively together. Also, collaboration helps students behave much in the same way as scientists do.
4. Geometry teachers are encouraged to not only prefer but also patronize peer-tutoring (p-t) as an instructional strategy for it creates environments and opportunities for students to develop their creative talents into creativity that is much needed for relevance in today's world.
5. Geometry teachers are encouraged to choose peer-tutoring because, though it can lead to rowdiness, it creates free and friendly atmosphere for students to work and learn.

6. As much as possible, geometry teachers are discouraged from patronizing the conventional lecture format of instruction because it reduces learners to passive listening with very small or no contribution made to the teaching/learning process.

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