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Effect of Two Meta-Cognitive Strategies on Students' Achievement in Mathematics

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Abstract

The study investigated the effect of two meta-cognitive strategies on students' achievement in mathematics. Influence of gender as well as the interaction effects of the teaching strategies and gender was also investigated in the study. Three research questions were posed and three null hypotheses were formulated to guide the conduct of the study. The study employed factorial research design. The population of this study consists of 3,606 senior secondary one (SS1) mathematics students in Nsukka Education Zone of Enugu State. This population is made up of 1493 males and 2113 female students. The sample size of 256 SS 1 mathematics students was used for the study. The sample was obtained using multistage sampling technique. Geometry Achievement Test (GAT) developed by the researchers was used to collect the pertinent data for the study. The data collected from the study were analyzed using means and standard deviations to answer the research questions and analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance. The study revealed that (1) Collaborative learning strategy significantly enhanced students' academic achievement in geometry when compared with problem solving strategy; (2) Gender did not significantly influence students' achievement in geometry; (3) The interaction effect of teaching strategies and gender on students' achievement in geometry was not significant.

Keywords: Mathematics, Meta-Cognitive Strategy, Achievement, Gender.

Introduction

Mathematics is a compulsory subject at primary and secondary levels of education in Nigeria. Mathematics is used as a basic entry requirement into courses like medicine engineering among others. Usman (2002) observed that in order to secure admission into higher level of education, a credit pass in mathematics is a prerequisite for most programmes. Valt and Maree (2007) opined that mathematics can be described as an important subject in secondary education, and as an adequate learning facility that is very important in any country. Mathematics is an indispensable tool for development of science and technology. This implies that no nation can develop scientifically and technologically without proper foundations in school mathematics (Okafor, 2005). Therefore, mathematics serves as a means of sharpening man's reasoning ability and developing man's personality. Mathematics is therefore indispensable in nation building.

There are some aspects of mathematics that have posed lots of problems to students' academic achievements. These are: negative indices, application of rule of BODMAS in solving problems, trigonometric relations/values of angles, longitude and latitude, scale drawings and geometry (WAEC Chief Examiners Report, 2018). Reports from other examination bodies indicate students' poor achievement in mathematics. WAEC Chief Examiners' Reports of 2014-2018 shows that in 2014, 2015, 2016, 2017 and 2018 May/June WAEC results, 31.28%, 36.68%, 52.97%, 50.22% and 49.98% of the students in the respective years had credits in mathematics. However, it was noted that students' weakness manifested mostly in

geometry in almost all the years under review. The reports show that students are very weak in geometry and also exhibited poor knowledge of circle theorems and geometrical construction. In addition, many candidates were unable to draw the tangent at a given point to determine the gradient at that point (West African Examination Council 2014, 2015, 2016, 2017, 2018).

Student's poor achievement in mathematics has been attributed to a number of factors. These factors include; poor primary school background (Obioma, 2006), lack of interest (Olaria, 2006), poor teaching and learning environment (Abakpa & Iji, 2011) and ineffective method of instruction (Kalijah, 2002, Agomuo & Nzewi, 2003). Consequently, the WAEC Chief Examiner Report (2017-2018) emphasized on the need to improve teaching methods to enhance academic achievement of students in mathematics. Studies by Udousoro (2002) and Udeji (2007) showed that effective teaching method enhances students' achievement in biology. Ahuja and Jahangiri (2003) suggested that student-centered teaching strategy would be more effective in learning mathematics than the teacher-centered strategy would. There is therefore need to adopt and use student-centered strategies in teaching geometry. One of such student-centered strategies which could be applied to the teaching of geometry to enhance students' achievement is the Meta-cognitive strategy.

Onovughe, Adedipe and Temidayo (2011) defined meta-cognition as a level of thinking that involves active control over the process of thinking that is used in learning situations. Meta-cognitive strategy refers to one's knowledge concerning one's own cognitive processes. Cognitive processes or activities mean elaboration of the methods used in teaching. The function of cognition is to solve problems, to bring cognitive enterprises to a good end (Okoza & Aluede, 2014). Onovughe et al (2011) further stated that planning the way of strategizing a learning task, monitoring comprehension, and evaluating the progress towards the completion of a task are skills that are meta-cognition in nature. Meta-cognitive activities involve necessary components for successful problem solving. Such components include mathematical knowledge and experience, separating relevant from irrelevant information, and the ability to use a variety of strategies (Schneider & Artelt, 2010). According to Martinez (2006), meta-cognition is the monitoring and control of thought. Thus, Kuhn and Dean (2004) regard meta-cognition as awareness and management of one's own thought. Based on Kuhn and Dean's work, meta-cognition is what enables a learner who has been taught a particular strategy in a particular problem context to retrieve and use that same strategy in a similar context. Hence, learning strategy is what a teacher or learner arranged to establish interaction between the teacher, the students, and the subject matter, of any combination of these three dimensions (Vijaya & Jinto, 2014). Cognitive strategies are used to help an individual achieve a particular goal (eg, understanding a text) while meta-cognitive strategies are used to ensure that the goal has been reached (eg. quizzing oneself to evaluate one's understanding of that test). Therefore, meta-cognitive strategies are actions which go beyond purely cognitive devices and which provide learners to coordinate their own learning process (Begam, 2007). The author further stated that, meta-cognitive strategies are sequential processes that one uses to control cognitive activities, and to ensure that a cognitive goal is achieved. These processes help to regulate and oversee learning, and consist of planning and monitoring cognitive activities, as well as checking the outcomes of those activities.

Research findings of some studies that employed meta-cognitive instructional strategies show that meta-cognitive strategy enhances students' achievement in various subjects. For instance, Xiying and Gang (2010) found out that students achieved higher in English when taught using meta-cognitive strategies. Similarly, students' achievement in Biology was enhanced and effective correlates of success in college anatomy and physiology when meta-cognitive approach was used (Okoza, Aluede & Owens-Sogolo, 2013).

The above evidence suggests that meta-cognitive strategy enhances students' academic achievement. However, there are some strategies that make up the meta-cognitive strategies, these are; Collaborative, Simulation, Modeling, Self-Regulation, Concept Mapping and Problem Solving (Alan 1987; Kayashima & Inaba 2003; Valt & Maree 2007; Toit & Kotze 2009; Ofodu & Adedipe 2011; Onu, Eskay, Igbo, Obiyo & Agbo 2012; Okoza, Aluede and Owens-Sogolo 2013; Okoza & Aluede 2014). There is need, therefore, to investigate which meta-cognitive strategies can best improve students' achievement in geometry. In this study, the Problem solving and Collaborative strategies will be investigated. The rationale for choosing the two strategies was based on the fact that from literature, very little work has been done on the two strategies compared to other meta-cognitive strategies in other subjects than mathematics.

Problem solving is a way of analyzing situations and of using skills to reason out what cannot be learnt by memorizing specific facts, but by absorbing oneself in the problem-solving process (Valt & Maree, 2007). According to Ochonogor (2001), problem solving is a technique of seeking answer or solution to a given problem. It is also applying existing experiences and existing knowledge to the problem that has to be solved. Learning facilitation in mathematics is regarded as 'problem solving' in which meta-cognition plays a well-defined role since problem solvers become involved in cognitive and meta-cognitive behaviour when they attempt to solve problems (Schoenfeld, 1992). In problem solving, existing knowledge of problem-solving activities are ideal opportunities to enhance generally self-aware thinkers. Oriaifo (2002) explained that teaching the science subjects through the application of problem solving techniques strengthens science education. Problem solving strategy contributes to the development of reflective thinking, creative expression, critical analysis and logical reasoning (Obodo, 2004). In problem solving strategy, Nekang (2011) suggested that teachers should make sure that learners have the following: 'Understanding – determine what information is given in a problem and what you need to find; Make a plan - after you understand the problem, select a strategy for solving it; Carry out the plan – solve the problem by carrying out the plan; Evaluate solutions – examine your answers carefully to see if it fits the facts given in the problem; Posing related problems – pose a related mathematical problem by simply changing the unknown in the solved problem i.e. change the conditions of the current problem.'

On the other hand, Collaborative learning is an educational strategy in teaching and learning that involves groups of learners working together to solve a problem, complete tasks, or create a product. In collaborative learning environment, the learners are challenged both socially and emotionally as they listen to different perspectives, and are required to articulate and defend their ideas (Laal and Laal, 2012). In so doing, the learners begin to create their own unique conceptual frameworks and not rely solely on an expert's or a text's framework. In a collaborative learning setting, learners have the opportunity to converse with peers, present and defend ideas, exchange diverse beliefs, question other conceptual frameworks, and are actively engaged (Srinivas, 2011). Collaborative learning represents a significant shift from the typical teacher-centered milieu in secondary school classrooms. In collaborative classrooms, the lecturing, listening, and note-taking process may not disappear entirely, but it lives alongside other processes that are based in students' discussion and active work with the course material. From the literature, there is evidence that collaborative learners exposed to collaborative strategies in other subjects achieve a higher level of thought and retain information longer than learners who work quietly as individuals (Johnson & Johnson, 1986). Furthermore, Tottan (1991) opined that "the shared" learning gives learners an opportunity to engage in discussion, take responsibility for their own learning, and thus become critical thinkers. The proponents of collaborative learning strategy according to Gokhals (1995) claim that the active exchange of ideas within small groups in

collaborative strategy promote critical thinking and increase students' achievement.

Achievement is the outcome of education to which a student, teacher or institution has been able to realize their educational goals (Ezeudu, 2006). Achievement implies something that somebody has done successfully especially using his/her own efforts and skills (Okeke, 2016). Achievement is the act of obtaining a result through efforts in the quality and quantity of students' work. On the other hand, Bitrus (2014) stated that academic achievement is a measure of knowledge gained through education process usually indicated by test scores, grade point average and degree. This is why some schools define this as a certain grade point average (GPA), or ranking in class. According to Nwagbo (2013), academic achievement can be defined as performance of students in schools. It could be getting high grades and a high GPA level. This high GPA level may be achieved through the use of innovative teaching strategies such as two meta-cognitive teaching strategies (problem solving and collaborative). In this regard, Jonassen, Peck and Wilson (1999) stated that the use of innovative teaching strategies may help students to develop better understanding of a subject such a mathematics which may lead to improved performance in achievement.

Gender is a range of characteristics used to distinguish between male and female, particularly in the cases of men and women, masculine and feminine attributes assigned to them. Gender is a social construct, it is not biologically determined but a concept equivalent to race or class (Offorma,2004). This definition suggests that gender is socially or culturally constructed characteristics and role, which are associated with males and females in society. According to Okeke (2000), gender is referred to as a socially constructed role and socially learned behaviors and expectations associated with males and females. Opre and Opre (2005) defines gender as broad categories that reflect our impressions and beliefs about females and males. It refers to a set of categorical beliefs regarding the characteristic attributes of a person (men and women) based on his or her belonging to one of the two genders. Afonja (2002) defines gender as a socially constructed concept based on the assumed position that a group of humans should possess. The difference in academic achievement due to gender differences in mathematics in general and geometry in particular has been a source of worry to mathematics educators and researchers (Ezeugo & Agwagah, 2000; Umeh, 2011). Eraikhuemen (2003) in a study from secondary schools in Edo south senatorial zone reported a significant difference in the academic achievement of male and female students in mathematics while Ukwungwu, (2001) reported that boys performed better in physics. Mbaba (2010) found out no significant difference in the performance of boys and girls in introductory technology. This study would also investigate gender differences of students in geometry. This is because studies in gender differences in relation to academic achievement have been carried out in other subjects. Hence, there is need to investigate the effectiveness of two meta-cognitive strategies on senior secondary school students' academic achievement in geometry in Nsukka Education Zone of Enugu State.

Statement of the Problem

Students' achievement in mathematics especially in geometry at senior secondary school level has been observed to be consistently poor. This poor achievement has been linked to the poor teaching strategies employed by the teachers in teaching mathematics. These poor teaching strategies have been attributed to the constant use of traditional teaching methods (talk and chalk method) in teaching and learning mathematics. Mathematics as a science subject is practically oriented; hence there is the need to use learner-centered innovative strategies such as the Problem Solving and Collaborative strategies which are parts of meta-cognitive instructional strategy that ensures students' active participation in the teaching and learning

processes. Previous studies showed that Problem Solving and Collaborative meta-cognitive strategies could enhance students' achievement in subjects like English, Biology Physics, Psychology and even Mathematics. However, the extent to which Problem Solving and Collaborative meta-cognitive instructional strategies could help students to improve their achievement in geometry is not known, since very little work has been done on them. Hence, the major problem of the study put in question form is: would the use of the two meta-cognitive strategies in teaching mathematics enhance achievement among senior secondary school students in geometry?

Purpose of the Study

The general purpose of the study is to determine the effect of two meta-cognitive strategies on students' achievement in geometry. Specifically, the study seeks to determine the:

1. mean achievement scores of students taught geometry using problem solving and collaborative strategies;
2. influence of gender on students mean achievement score in geometry;
3. interaction effect of teaching strategies and gender on students' mean achievement score in geometry.

Scope of the Study

The study was limited to senior secondary one (SS1) students in Nsukka Education Zone of Enugu State. The Nsukka Education Zone is made up of Nsukka, Igbo Etiti, and Uzo Uwani Local Government Areas. The choice of SS1 students is because the students by age can understand, control and manipulate their cognitive processes during teaching and learning processes. The content scope of this study was geometry which includes the following sub-topics: perimeter, arcs, sectors of circles and surface areas of common solids. The choice of the concept is because students see it as an abstract and difficult mathematics concept.

Research Questions

The following research questions were posed to guide the study.

1. What are the mean achievement scores of students taught geometry using problem solving strategy and those taught using collaborative strategy?
2. What is the influence of gender on students' mean achievement scores in geometry?
3. What is the interaction effect of teaching strategy and gender on students' mean achievement scores in geometry?

Hypotheses

The following null hypotheses (H_o) were formulated to guide the study and will be tested at 0.05 level of significance:

H_{O1}: There is no significant difference in the mean achievement scores of students' taught geometry using problem solving and those taught using collaborative strategies.

H_{O2}: There is no significant difference in the mean achievement scores of male and female students in geometry.

H_{O3}: There is no significant interaction effect of teaching strategy and gender on students' mean achievement scores in geometry.

Methodology

Design of the Study

This study employed the factorial research design. Factorial research design according to Trochim (2016) is an experimental design that allows the researcher to study the effect of each factor on the response variable, as well as the effects of interactions between factors on the response variable. The design was considered appropriate in this study because the research involved two innovative teaching strategies and also investigated the interaction effect of the teaching strategies and gender.

Area of the Study

This study was carried out in the Nsukka Education Zone of Enugu State. The Nsukka Education Zone is made up of three Local Government Areas namely: Nsukka, Uzo-Uwani and Igbo Etiti Local Government Areas. The area of the study is bounded to the North by Igbo Eze South Local Government Area of Enugu State, to the West by Isi-Uzo Local Government Area of Enugu State, to the south by Udi Local Government Area of Enugu State and to the east by Ayamelum Local Government Area of Anambra State.

Population of the Study

The population of this study consists of 3,606 senior secondary one (SS1) mathematics students in Nsukka Education Zone of Enugu State. This is made up of 1493 males and 2113 female students (Post Primary School Board, Nsukka Zonal Office, 2016).

Sample and Sampling Technique

The sample size of the study was 156 SS1 mathematics students. Multistage sampling technique was employed. At the first stage, simple random sampling technique was used to sample two local government areas out of the three local government areas that make up of the zone. The two local government areas are Nsukka and Igbo Etiti Local Government Areas. At the level of LGA, stratified random sampling technique was used to sample two schools each from the two local government area, (that is; Nsukka and Igbo Etiti) based on gender. The number of SS1 mathematics students in the sampled schools constituted the sample size.

Instruments for Data Collection

Geometric Achievement Test (GAT) developed by the researcher was used for data collection in this study. This instrument was developed with the use of Table of Specification (Test blue print). The test items were constructed based on the following SS1 contents of Geometry. They include: perimeter, arcs, sector of circles and surface areas of common solids. The instrument consists of forty (40) multiple choice questions with options lettered from A- E. The scoring of the instrument was the mark allocated to each question based on the guideline from the table specification for one correct response and zero (0) for wrong response.

Validation of Instrument

The instrument (GAT) was subjected to both face and content validations. The validation of GAT was done by three experts in Department of Science Education (Mathematics Education and Measurement and Evaluation Units), University of Nigeria, Nsukka. The specialists were requested to validate the instrument with respect to clarity of language, appropriateness and adequacy of the items in measuring what it is

supposed to measure. The advice, comments, corrections and suggestions of the experts helped in the modification of the instrument.

Reliability of the Instrument

To determine the reliability of the instrument, the researcher administered 25 copies of the instrument to SS 1 Mathematics students of a School in Udenu Local Government Area of Enugu State who were not part of the study. The scores obtained from the students were used to determine the internal consistency and reliability co-efficient of 0.92 was obtained using Kuder-Richardson (KR-20) formula. The choice of Kuder-Richardson (KR-20) was because the instrument was dichotomously scored and was not of the same difficulty.

Training of Mathematics Teachers

The lesson plans developed by the researcher for the two meta-cognitive strategies was used in training the teachers who participated in the study. The training session was conducted in Nsukka LGA Headquarters and lasted for one week. The training sessions were in the evening in order not to interfere with the teachers' working hours. The programme of activities for the one week covered the introduction, familiarization of the teaching methods, their techniques, principles and objectives expected to be achieved by the students at the end of the lesson. At the end of the training, the researcher allowed the teachers to do a micro-teaching using the lesson plan assigned to them.

Experimental Procedures

Before the commencement of the experiment, the pre-test was administered to the students in the different experimental groups. This enabled the researcher to determine the achievement status of the subjects before treatment. The students in their different groups were taught by their regular mathematics teachers under the supervision of the researcher. However, the researcher made sure that the mathematics teachers used the lesson note prepared by the researcher for each group. For students in experimental group one (i.e Collaborative method), their regular classroom mathematics teachers taught them using the lesson plan specifically prepared by the researcher which incorporated the aspects of Collaborative Strategy, while the students in the experimental group two (i.e Problem-Solving method) were taught using Problem-solving Strategy. At the end of the experiments, GAT was administered to all the students in the different groups. The scores obtained at this stage served as a post-test score.

Method of Data Analysis

Research questions were answered using mean and standard deviation, while analysis of covariance (ANCOVA) was used in testing the formulated hypotheses at 0.05 level of significance.

Results

The results of this study are presented in this chapter according to the research questions and hypotheses.

Research Question One

What is the mean achievement score of students taught geometry using problem solving strategy and those taught using collaborative strategy?

Table 1: Mean and standard deviation of students' achievement in geometry

Groups		Pre-test		Post-test		Gain Scores	Gain Scores Difference
	N	Mean	SD	Mean	SD		
Collaborative Strategy	**134**	**22.53**	**7.68**	**30.10**	**7.04**	**7.57**	**1.51**
Problem Solving	**122**	**21.89**	**7.46**	**27.95**	**5.41**	**6.06**	

Table 1 shows the mean achievement scores of mathematics students exposed to collaborative learning strategy and problem solving strategy. Result from the Table revealed that mean achievement score of 22.53 and 21.89 with standard deviation of 7.68 and 7.46 were obtained for collaborative learning strategy and problem solving respectively at the pre-test. However, at the post-test, the mean achievement score of 30.10 and 27.95 with standard deviation of 7.04 and 5.41 were recorded for collaborative and problem solving strategies respectively. The mean score difference of 1.51 was recorded for the two groups in favour of collaborative teaching strategy. The result of the finding indicates that collaborative teaching strategy proved superior over problem solving strategy in enhancing students' achievement in geometry.

Research Question Two

What is the influence of gender on students' mean achievement scores in geometry?

Table 2: Mean and standard deviation of male and female students' achievement in geometry

Gender		Pre-test		Post-test		Gain Scores	Gain Scores Difference
	N	Mean	SD	Mean	SD		
Male	**119**	**22.50**	**8.14**	**29.82**	**6.74**	**7.32**	**.32**
Female	**137**	**21.99**	**7.06**	**28.99**	**6.42**	**7**	

Result in Table 2 revealed that at the pre-test, male students had mean achievement score of 22.50 with standard deviation of 8.14 while their female counterpart had mean achievement score of 21.99 and standard deviation of 7.06. At the post-test, male students had mean achievement score of 29.82 and standard deviation of 6.74 while female students had mean achievement score of 28.99 with standard deviation of 6.42. The results therefore, show that male students slightly had a higher mean achievement score than their female counterpart. This can be seen from a very slight mean gain score difference of .32. Therefore, gender influences students' achievement in geometry.

Research Question Three

What is the interaction effect of teaching strategy and gender on students' mean achievement scores in geometry?

Table 3: Mean and standard deviation of interaction effect of teaching strategy and gender on students' achievement in geometry

Teaching Strategy	Gender	N	Mean	Std. Dev.
Collaborative Strategy	**Male**	**61**	**31.38**	**7.51**
	Female	**73**	**30.10**	**7.04**
Problem Solving Strategy	**Male**	**58**	**28.19**	**5.42**
	Female	**64**	**27.73**	**5.43**

Result in Table 3 reveals the mean achievement scores of male and female students exposed to collaborative teaching strategy as 31.38 and 30.10 with standard deviation of 7.51 and 7.04 respectively. Meanwhile, male and female students exposed to problem solving strategy had mean scores of 28.19 and 27.73 with standard deviations of 5.42 and 5.43 respectively. This shows that both the male and female students exposed to collaborative teaching strategy achieved better than their counterparts exposed to problem solving strategy. However, within the collaborative and problem-solving strategies, male students achieved better than their female counterparts. The result implies that irrespective of the teaching method used, male students seemed to achieve better than their female counterparts in geometry.

Hypothesis One

There is no significant difference in the mean achievement score of students' taught geometry using problem solving and those taught using collaborative strategies.

Table 4: Analysis of covariance (ANCOVA) of students' mean achievement scores in geometry exposed to both collaborative and problem-solving strategies

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	600.560[a]	4	150.140	3.616	.007
Intercept	20512.583	1	20512.583	494.033	.000
Pretest	64.369	1	64.369	1.550	.214
Method	473.029	1	473.029	11.393	.001
Gender	44.057	1	44.057	1.061	.304
Method * Gender	11.024	1	11.024	.265	.607
Error	10421.686	251	41.521		
Total	231981.000	256			
Corrected Total	11022.246	255			

Result in Table 4 shows that teaching strategy is a significant factor on students' achievement in geometry; F (1, 251) = 11.393, P = .001. Thus, the null hypothesis of no significant difference is rejected. This is because the exact probability value of .001 is less than level of significance set at 0.05. Therefore, the researchers conclude that there is a significant difference in the mean achievement score of students' taught geometry using problem solving and those taught using collaborative strategies.

Hypothesis Two

There is no significant difference in the mean achievement scores of male and female students in geometry.

Result of the analysis in Table 4 was also used to test hypothesis two. The Table shows that gender is not a significant factor on students' achievement in geometry; F (1, 251) = 1.061, P=.304. Therefore, the null hypothesis of no significant difference was accepted since the exact probability value of .304 is greater than level of significance set at 0.05. The researchers therefore, concludes that there is no significant difference in the mean achievement scores of male and female students in geometry.

Hypothesis Three

There is no significant interaction effect of teaching strategy and gender on students' achievement mean scores in geometry.

The result of the analysis in Table 4 was also used to test hypothesis three. The Table shows that the exact probability value of .607 associated with method and gender is greater than 0.05 level of significance; (F (1, 251) = .265, P=.607). Thus, the null hypothesis of no significant interaction effect of method and gender on students' mean achievement scores in geometry is upheld. The researchers therefore, concludes that the interaction effect of gender and method on students' achievement mean scores in geometry.

Discussion

The findings of the study in Table 1 revealed that students exposed to collaborative teaching strategy had higher mean achievement scores compared to students exposed to problem solving strategy. The achievement difference was further strengthened by analysis of covariance (ANCOVA) in Table 4 which shows that there is a significant difference in the mean achievement scores of students taught geometry using collaborative teaching strategy and those taught using problem solving teaching strategy. The result implies that collaborative teaching strategy significantly enhanced students' academic achievement in geometry when compared to problem solving strategy. The implication is that, collaborative teaching strategy when used in teaching geometry is capable of producing positive effects on students' academic achievement.

The result was not surprising because, peer tutoring learning strategy allows the students to take active part in constructing their own knowledge. In support of this assertion, MacGregor (1990) opined that collaborative teaching strategy involves groups of students working together to solve a problem, complete a task or create a product. The teacher in this learning strategy only serves as a facilitator in using collaborative teaching strategy. The findings of the study are in agreement with the findings of Obeta (2008) who reported that primary school pupils taught mathematics using peer collaborative teaching strategy achieved higher than those taught using conventional method. Also in agreement was the finding of Igbo (2004) whose study reported that the achievement of mathematics disabled children increased after five weeks of peer collaboration in mathematical leaning. Also, the findings of the study are also in line with the findings of

Adoye (2002) that reported significant differences in the mean achievement scores of students taught using peer collaborative teaching strategy. The findings of Uroko (2010) on effects of training in reciprocal peer tutoring strategy on achievement, interest and perceived self-efficacy in reading comprehension of senior secondary school students was also in agreement with the findings of the study reciprocal peer tutoring strategy significantly improved the achievement in reading comprehension among senior secondary school students.

The result of the findings in Table 2 revealed that gender influences students' achievement in geometry. Male students had a higher achievement mean score than their female counterparts. However, further analysis using analysis of covariance (ANCOVA) in Table 4 revealed no significant difference in the achievement mean score of male and female students in geometry. This shows that the higher mean achievement score accrued to male students as earlier seen in Table 2 was due to chance factor. The result indicated that collaborative teaching strategy as an instructional strategy is gender-friendly in enhancing students' achievement in geometry. This implies that that male and female students benefited equally from the teaching strategy. This result of the study is in agreement with the early findings of Uroko (2010) who reported that gender grouping was not a significant factor in the achievement of students exposed to training in reciprocal peer tutoring strategy in reading comprehension. The result of the study supports the study of Nwagbo (2013) that found no gender differences in students' achievement in quadratic equation. This result is also in accordance with Etukudo (2002) whose result indicated that there was no significant difference between male and female students' achievement in mathematics. This result is in line with the findings of some earlier research studies conducted by Ezeugwu (2007), Gilbert (2009) and Ekwe (2013) that reported no significance difference in the achievement mean scores of male and female students in various subjected investigated.

The findings of this study with respect to the interaction effect of learning strategies and gender on students' achievement in geometry revealed no significant interaction effect of teaching method and gender; although male students performed better than female students in both collaborative teaching strategy and problem-solving strategy. The result implies that the achievement of students across gender was consistent. The study is in agreement with findings of Uroko (2015) who reported that the interaction effect of reciprocal peer tutoring strategy and gender on students' achievement in reading comprehension was not significant. The finding however implies that male and female students benefitted in the achievement of the Basic General Mathematics content taught during the study. The findings of Omebe and Omiko (2015) who investigated the effect of instructional resources on students' achievement in physics in secondary schools in Ebonyi State of Nigeria found no significant effect of interaction between treatment and gender on students' achievement in physics. The result however disagrees with the findings of Eraikhuemen (2003) that reported significant interaction effect of gender and school location on the academic achievement of students.

Conclusion

The result of this study established the following;

1. Collaborative learning strategy significantly enhanced students' academic achievement in geometry when compared with problem solving strategy.
2. Gender did not significantly influence students' achievement in geometry.
3. The interaction effect of teaching strategies and gender on students' achievement in geometry was not significant.

Recommendations

Based on the findings of this study, the following recommendations were made by the researcher:

1. Mathematics teachers should adopt the use of collaborative teaching strategy in their lessons in order to enhance students' academic achievement and in the geometry.
2. Government agencies and professional associations whose responsibility is to design and revise the curriculum for secondary schools should incorporate and emphasize the use of collaborative teaching strategy in teaching mathematics in senior secondary schools.
3. Government in conjunction with other professional associations should organize workshops, seminars; conferences and in-service training on a regular basis to train teachers on the use of collaborative teaching strategy since the strategy have been found to be effective in enhancing students' academic achievement in geometry.
4. Mathematics teachers should endeavour to note that gender does not account for students' academic achievement rather the method used by teachers in teaching a particular subject. Therefore, mathematics teachers should often change their method of teaching in order to promote students' academic achievement in geometry in senior secondary schools.

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