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Effect of Peer-Tutoring Strategy on Senior Secondary School Students' Achievement in Mathematics

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ABSTRACT

This study examined the effect of peer-tutoring strategy on senior secondary school students' achievement in mathematics. The quantitative study was carried out with 210 students within the blueprint of a pretest-posttest quasi-experimental group research design. One instrument named the Mathematics Achievement Test (MAT) with a reliability coefficient of 0.84 was used to collect primary data relating to students' achievement in mathematics from six schools in education district II of Lagos State, Nigeria. Descriptive statistics of mean and standard deviation were used to answer the research questions while the inferential statistic of Analysis of Covariance (ANCOVA) was used to test the hypotheses at a 5% level of significance. The findings showed that peer tutoring has a significant main effect on secondary school students' achievement in mathematics. Gender has no significant influence on students' achievement in mathematics. Based on the findings of the study, the following recommendations were made: Education planners at the secondary school level should develop a policy of education whereby peer tutoring would be officially recognized as a teaching strategy for enhancing achievement in mathematics. Senior secondary school students should be encouraged to organize peer-tutoring classes for each other to gain maximally from its efficacy in mathematics.

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1. INTRODUCTION

Mathematics is central to all levels of education and its prime plan in coordinating all science subjects vis-à-vis numerical subjects cannot be disputed. Mathematics as one important subject for sustainable development has permeated all facets of human endeavor as it is required in learning sciences such as Biology, Chemistry, and Physics (Lawal & Awofala, 2019; Awofala & Lawani, 2020). The deployment of mathematical concepts, principles, and skills in the course of learning science education eases the understanding of sciences. Mathematics is not only compulsory at the secondary school level but also a prerequisite for admission into higher education 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 external examinations (Awofala & Lawani, 2020).

The weak performance of students in mathematics and very high failure rate in external examinations like the Secondary School Certificate Examination (SSCE) administered by the West African Examinations Council (WAEC), and the National Examinations Council (NECO) yearly has become a serious concern (Awofala & Lawani, 2020). For Nigeria, a developing country that needs science and technology for its development, the poor performance of students in science and mathematics and worse still, the very insignificant proportion of students who choose mathematics as a course of study after secondary education has turned the concern of the government and people of Nigeria into anxiety.

The significance of mathematics in producing versatile and resourceful graduates that are needed for economic development cannot be overemphasized for mathematics is regarded as the central intellectual discipline of technological societies Awofala *et al*. (2013) and the knowledge of science remains superficial without mathematics (Awofala *et al*., 2020; Awofala *et al*., 2022). It, therefore, means that the position of mathematics in the secondary school curriculum in Nigeria is important for scientific development. Mathematics as a science uses pattern and order with domain in numbers, chance, form, algorithms, and change. As a science of abstract objects, mathematics relies on logic rather than on observation as it is a standard of truth, yet employs observation, simulation, and even experimentation as means of discovering the truth.

Peer tutoring is a teaching and learning strategy where students learn from each other in an organized way and is a well-organized and beneficial learning experience in which one-student acts as the tutor or teacher and the other one serves as the tutee or learner. It creates an opportunity for the students to use their knowledge and experience and in the process, the tutors reinforce their learning by reviewing and reformulating their knowledge while the learner or tutee gets one on one attention.

Peer learning as a broad learning strategy adopts a range of activities ranging from a traditional proctor model in schools to the more innovative learning groups in colleges and universities. In the proctor model, the senior students act as tutors and junior students as tutees. On the other hand, in innovative learning groups, students of the same age group or same level help each other by forming partnerships (Adamu & Kusa, 2018; Al - Hebaishi, 2017; Alegre-Ansuategui *et al*., 2018). Other models include discussions, seminars, private study groups, counseling, peer-assessment schemes, collaborative project or laboratory work, workplace mentoring, and community activities (Antwi *et al*., 2016; Atasoy *et al*., 2014; Edwards *et al*., 2015).

Numerous advantages abound for teachers, students, and the students being tutored, by using the programs of peer tutorials. Research has shown that several students feel very comfortable, and therefore can focus well on the subject problem, with a peer tutor relatively

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more than a qualified teacher (Gok, 2012a; Gok, 2012b; Gok, 2014; Gok, 2015; Gok & Gok, 2016; Ibrahim & Wunba, 2018; Lasry *et al*., 2016; Michinov *et al*., 2015; Miller *et al*., 2014). Peer tutoring is a well-established practice in many universities whereas reciprocal learning is considered to be incidental (Miller *et al*., 2015; Morice *et al*., 2015).

Different models of peer tutoring have been explored and include a class-wide peer tutoring strategy (CWPT) which involves dividing the entire class into groups of two to five students with different ability levels Sayer *et al.,* (2016) and Vickrey *et al.,* (2015), peer-assisted learning strategies (PALS) which involve a teacher pairing students who need additional instruction to help with a peer who can assist (Vickrey *et al.,* 2015; Zingaro & Porter, 2014), reciprocal peer tutoring (RPT) which involves two or more students who alternate between acting as the tutor and tutee during the session, with equitable time in each role, Same-Age Peer Tutoring which is a strategy in which peers who are within one or two years or more advanced student can be paired with a less advanced student (Wang & Murota, 2016; Zhang *et al*., 2017). Some studies have centered on the effect of peer tutoring on students' achievement in mathematics in particular and other subjects generally, both locally and internationally.

Ullah *et al*. (2018) and Zhang *et al*., (2017) 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. Baleni *et al*. (2016) concluded that partaking in peer tutoring has a significant effect on students' performance. There were reports from many other researchers as well (Ochieng *et al*., 2018; Campit *et al*., 2015).

Learning mathematics has remained a relentless challenge for learners notwithstanding their level of education. Mathematical achievement is the competency shown by the student in the subject of mathematics and measures the score on an achievement test in mathematics. Mathematical achievement is highly correlated with an individual's life outcomes. These include academic achievements, career options, earning capacity, and overall life standards (Okunuga *et al*., 2020; Awofala & Lawal, 2022).

The traditional gender gap in educational outcomes advantaging boys have been completely filled-up in most countries and has reversed in favor of girls. Girls tend to do better than boys in reading test scores, grades at school, the propensity to choose academic programs in upper secondary school, tertiary education, attendance, and graduation rates (Ojaleye & Awofala, 2018). However, boys keep doing better than girls in mathematics tests; the average gender differential within mathematics at age 15 is a 0.11 standard deviation in favor of males.

Several explanations have been proposed for the gender gap in mathematics with some scholars referring to biological factors (Awofala, 2008a; Awofala, 2008b). However, as shown by international assessments the gender gap in mathematics differs substantially across the educational level. Hence "nurture" cannot be the only account for the female disadvantage in mathematics, there must be alternative explanations related to societal and cultural factors, supporting the existence of "nurture" effects. In this perspective, some scholars Awofala (2017) and Awofala (2011) provide evidence that there is a wide gender gap in the learning of mathematics. Studies on the factors that influence mathematics achievement highlighted teachers as critical resources (Awofala & Lawani, 2020a).

Schools, physical facilities, class size, curriculum, instructional strategies, and other resources influence students' learning indirectly through their effect on the behaviors of teachers and students (Awofala, 2012). Causes of low achievement in mathematics in senior secondary schools have been identified to include learners' abilities, school-related variables

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such as poor learning environment, learning cultures, and low expectations by principals and teachers (Lawal & Awofala, 2019; Lawal & Awofala, 2021).

Other factors that may affect the academic achievement of students may include social, economic, medical/health, familial, relationships between teachers and students, and school expectations. This study examined the effect of peer tutoring on senior secondary school students' achievement in mathematics.

The following research questions guided the study:

(i) What is the effect of peer-tutoring strategy on students' achievement in senior secondary school mathematics?

(ii) What is the influence of gender students' achievement in senior secondary school mathematics?

(iii) What is the interaction effect of peer-tutoring strategy and gender on students' achievement in mathematics?

Hypotheses are in the following:

(i) H01: There is no significant main effect of treatment (peer-tutoring vs. traditional method) on mathematics achievement of senior secondary school students.

(ii) H02: There is no significant main influence of gender on the mathematics achievement of senior secondary school students.

(iii) H03: There is no significant interaction effect of treatment and gender on mathematics achievement of senior secondary school students.

2. METHODS

2.1. Research Design

The design adopted for this study was a quasi-experimental pretest and posttest control group with a 2 x 2 factorial representation and used intact or pre-existing groups as random assignment of subjects to experimental and control groups is not possible (Ullah *et al*., 2018; Campit *et al*., 2015). The learning method was handled at two levels (peer tutored (experimental) group and traditional method (control) group) and gender at two levels (male and female). The study design is shown symbolically as:

O1 X1 O2 X1-gain = O2 – O1 O1 pre - test
O1 X2 O2 X2-gain = O2 – O1 O2 post - test

Where O1 = test before treatment for the two groups, X1 = experimental condition, X2 = the control group taught using the traditional method, and O2 = test after treatment (score for the two groups) and the mean difference between O2 and O1 for each group tested for statistical significance using Analysis of Covariance (ANCOVA).

2.2. Participants

The study was conducted in Education District II of Lagos State. There are three zones of Education under this district which are Kosofe, Shomolu, and Ikorodu and each of these zones was properly represented in the study. The participants for the study comprised 210 senior secondary II students. A stratified random sampling technique was used to select six schools (3 in each study group (experimental and control)) from all the senior secondary school students in Education District II, in Lagos State Nigeria that are Government – owned. One intact class was chosen from each of the six schools for the study.

The distribution of the participants showed that for the experimental group, there were 57 males and 48 females while for the control group, there were 65 males and 40 females. Also, their ages ranged from 13 to 18 years and the participants were predominantly Yoruba

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because the study was conducted in the Yoruba land of Lagos state. 52% of the participants were Christians while the remaining 48% were Muslims.

2.3. Instruments

One instrument named Mathematics Achievement Test (MAT) was used to collect primary data relating to the achievement of students in mathematics. The MAT was a collection of items from past WAEC questions covering number and numeration, algebraic processes, and geometry. This test consisted of 25 multiple choice questions only with options A – D. Each question attracts 1 mark for each correct option chosen to give a maximum of 25 marks. Although the items of the MAT were carefully selected from standard WAEC question papers, its face validity was ensured by two mathematics teachers, and the content validity was ensured using a table of specifications. The reliability of the instrument was tested using the Kuder-Richardson 21 and an internal consistency of 0.84 was computed and this showed that the MAT was a reliable instrument.

2.4. Procedure

The procedure undertaken for the administration of the instrument took 6 weeks.

(i) Week 1: permission was sought from schools through the presentation of an introductory letter to the schools, Interaction, and training of mathematics teachers in the participating schools who served as the research administrators, and the pre-test was conducted for the experimental and control groups.

(ii) Weeks 2 - 5: Groupings were arranged and tutees were identified, peer teaching process was conducted after the grouping by the research administrators for four weeks under the constant monitoring and supervision of the researcher and the research administrators.

(iii) Week 6: research administrators conducted the posttest for the treatment and the control group and collated the results while the researcher monitored the process.

2.5. Data analysis

Data collected were analyzed with quantitative procedures using mean and standard deviation to answer the research questions while the research hypotheses were tested at a 5% level of significance using Analysis of Covariance (ANCOVA) with the partial eta squared measuring the effect size. The analyses were done with the aid of Statistical Package for Social Sciences version 25.0.

3. RESULT AND DISCUSSION

Table 1 shows that for the pretest score, the treatment group peer tutored had a mean score of 45.41 (SD = 21.02) while the control group's traditional method had a mean score of 53.33 (SD = 19.12). The t-test of the difference in achievement between the experimental and control groups showed that there was a significant difference in the performance of these groups in the pretest ($t_{208} = -2.858$; $p < 0.05$).

The implication is that the control group performed significantly better than the experimental group in the pretest. Also, for the post-test score, the treatment group peer tutored had a mean score of 78.17 (SD = 15.11) while the control group had a mean score of 65.98 (SD = 19.31). The t-test of the difference in achievement between the experimental and control group showed that there was a significant difference in the performance of these groups in the post-test ($t_{208} = 5.094$; $p < 0.05$). Hence, the null hypothesis (H_0) is rejected. This

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implies that the experimental group performed significantly better that the control group in the post-test.

The overall difference in the mean score of the treatment group (peer tutored) was 32.76 (SD = 19.35) while for the control group (traditional method) it was 12.65 (SD = 20.83). The t-test of the difference in achievement between the experimental and control group showed that there was a significant difference in the performance of these groups from the pretest to the post-test ($t_{208} = 7.248$; $p < 0.05$). Hence, the null hypothesis (H_0) is rejected. This implies that the experimental group performed significantly better that the control group in the post-test.

Table 1. Descriptive statistics and the t-value on the effect of peer tutoring strategy on mathematics achievement of senior secondary school students.

Stage	Groups	N	Mean	Std. Deviation	difference	T	df	P
Pretest	Treatment	105	45.41	21.02	-7.92	-2.858	208	0.005
	Control	105	53.33	19.12				
Posttest	Treatment	105	78.17	15.11	12.19	5.094	208	<0.001
	Control	105	65.98	19.31				
Difference	Treatment		32.76	19.35	20.11	7.248	208	<0.001
	Control		12.65	20.83				

Table 2 shows that for the pretest score, male students had a mean score of 51.61 (SD = 20.92) while female students had a mean score of 46.27 (SD = 19.42). The t-test of the difference in achievement between males and female shows that there was no significant difference in the performance of these groups in the pretest ($t_{208} = 1.878$; $p>0.05$). The implication is that gender is not a significant factor in the performance in the pretest. Also, for the post-test score, male students had a mean score of 73.18 (SD = 16.79) while female students had a mean score of 70.55 (SD = 20.30). The t-test of the difference in achievement between male and female students showed that there was no significant difference in their performance in the post-test ($t_{208} = 1.027$; $p>0.05$). Hence, the null hypothesis (H_{02}) is not rejected. This implies that the male group did not perform significantly better than the female group in the post-test.

Table 2. Descriptive statistics and t-value on the influence of gender on mathematics achievement of senior secondary school students.

Groups	Gender	N	Mean	SD	t	Df	p-value
Pretest score	Male	122	51.61	20.92	1.878	208	0.062
	Female	88	46.27	19.42			
Posttest Score	Male	122	73.18	16.79	1.027	208	0.306
	Female	88	70.55	20.30			

Table 3 shows that there was a significant main effect of treatment on the mathematics achievement of senior secondary school students ($F_{(1,205)} = 56.785$; $p<0.05$). This implies that senior secondary school students who were exposed to the peer tutoring strategy performed significantly better than those not exposed to the strategy. The effect size of the treatment obtained is 0.217 which implies that the treatment contributed only 21.7% to the prediction of mathematics achievement of senior secondary school students.

Table 3 also shows that there was no significant main effect of gender on the mathematics achievement of senior secondary school students. ($F_{(1,205)}= 0.261$; $p>0.05$). The implication is

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that neither of the sexes performed better than the other in mathematics achievement. The effect size of the gender obtained was 0.006 which implies that gender has only a 0.60% effect on the mathematics achievement of senior secondary school students.

Table 3 shows also that there was a significant interaction effect of treatment and gender on students' achievement in mathematics ($F_{(1,205)}$ = 20.593, $p<0.05$). Hence, the null hypothesis is rejected and it is concluded that there was a significant interaction effect of treatment and gender on students' achievement in mathematics. It is also seen that achievement in the pretest is also a significant determinant of the variation in student's achievement in mathematics ($F_{(1,205)}$ = 31.595; $p<0.05$). The effect size of the treatment obtained is 0.217 which implies that the treatment has only a 21.7% effect on the mathematics achievement of senior secondary school students. While that of gender is 0.006 implying only a 0.6% effect on the mathematics achievement of senior secondary school students. It is seen that the effect of the treatment on mathematics achievement of senior secondary school students is over thirty-six times that of gender. However, the effect size of the interaction of treatment and gender obtained is 0.091 which implies that both variables have only a 9.1% effect on the mathematics achievement of senior secondary school students.

Table 3. Univariate analysis of covariance of the main effect of treatment and gender on students' achievement in mathematics.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Square
Intercept	5856.291	1	5856.291	402.562	0.000	0.663
Pre-test	459.625	1	459.625	31.595	0.000	0.134
Treatment	826.084	1	826.084	56.785	0.000	0.217
Gender	18.502	1	18.502	1.272	0.261	0.006
Treatment * Gender	299.579	1	299.579	20.593	0.000	0.091
Error	2982.246	205	14.548			
Corrected Total	4395.924	209				

The result of this study showed that there is a significant improvement in the posttest score over the pretest score both for the control group and the peer tutored group but was more pronounced in the peer tutored group (33%) as against the control group (13%). This result was in agreement with the findings of other researchers that peer tutoring influences secondary school students' achievement in mathematics because they tend to hold each other accountable and were able to increase their assignment completion rate (Mellado *et al.,* 2017; Campit *et al.,* 2015; Galia, 2015).

The improvement of the experimental group over the control group in the posttest is a testimony to the significant main effect of peer tutoring strategy as a teaching method amongst this study population. However, this study negated the conclusion of Baleni *et al.* (2016) that peer tutoring in the instance of tutorials in class has no significant influence on university students' performance. The significant effect of peer tutoring on students' achievement in mathematics could be a result of the fact that tutors help students develop and improve their study skills and learning strategies, as well as their self-confidence in mathematics learning. More so, peer tutoring allows for higher rates of student response and feedback, which results in better academic achievement in mathematics. Peer tutoring could have helped in supporting students' generalization of skills acquired in mathematics and increasing the opportunities for active learning and skill practice.

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Also, this study showed that there was no significant difference in mathematics achievement between senior secondary school male and female students. The results above agreed with other researchers that gender is not a significant factor in students' performance or achievement in Mathematics Awofala (2017) but negated the findings of Agu and Samuel (2018) who found a significant difference between male and female students' achievement in Basic Science and Technology and Okolocha and Okeke (2018) who found a significant difference in Keyboarding based on gender. Awofala (2011) found a significant influence of gender on students' achievement in mathematics. This implies that both male and female students performed equally in achievement in mathematics and this agreed with the conclusions of other researchers (Okolocha & Okeke, 2018; AbdulRaheem *et al*., 2017; Awofala & Anyikwa, 2014).

However, this study showed that there was a significant interaction effect of peer tutoring and gender on secondary school student's achievement in mathematics. This result agreed with the findings of Agu and Samuel (2018) but negated the findings of who reported an insignificant interaction effect of peer tutoring and gender on achievement in mathematics. The findings of AbdulRaheem *et al*. (2017) showed that there was no significant interaction effect of treatment and gender on students' achievement in economics. The results of the present study showed that treatment was gender sensitive.

4. CONCLUSION

The present study has shown that peer tutoring as a teaching strategy has a significant effect on the mathematics achievement of senior secondary school students. Also, gender was found to have no significant effect on the achievement in mathematics of senior secondary school students. This means that the mathematics achievement of male and female senior secondary school students did not differ significantly. Lastly, there was a significant interaction effect of peer-tutoring and gender on achievement in mathematics of senior secondary school students.

Based on the findings of this study, it is therefore recommended as follows: Firstly, mathematics teachers at the senior secondary school level should recognize the importance of peer-tutoring in enhancing the achievement of students in mathematics and so should allow students to peer tutor themselves by providing the enabling environment for it to happen. Secondly, curriculum planners in Nigeria should add peer tutoring as part of the strategy for improving students' achievement in mathematics.

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6. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. Authors confirmed that the paper was free of plagiarism.

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