Abacus (Mathematics Education Series) Vol. 44, No 1, Aug. 2019

THE EFFICACY OF 4-STAGE PROFICIENCY APPROACH IN ERADICATING GENDER RELATED MATHEMATICAL PROFICIENCY DIFFERENCES AMONG SENIOR SECONDARY STUDENTS IN LAGOS STATE

by

Dada, F. H.; Johnson, F. O.& Lawal, R. F.

Department of Mathematics and Statistics, Federal College of Education (Technical),Akoka, Lagos & Department of Science and Mathematics, Aguda Community Senior Secondary School, Surulere, Lagos. femifolawal256@gmail.com

Abstract

Mathematical performance in relation to gender is a long standing issue with the male gender often times regarded as the mathematically superior specie. Also, teachers' continual adoption of the conventional strategy has been criticized. This study therefore examined the role of a proficiency based instructional approach (Tutorial-Terms-operations-Problem solving Proficiency Approach (TTOPPA)) in improving students' mathematics achievement and specificallyboosting female students' achievement to males' equivalent. The study adopted a quasi-experimental design of the pretest-posttestcontrol group type. The sample consisted of 283 SS II students of which 135 students were females and 148 students were males. The treatment (TTOPPA) lasted for a period of five weeks. Mathematics Achievement Test (MAT)with reliability coefficient of 0.966 was used to obtain relevant data on students' achievement. Research questions were answered using descriptive statistics while raised hypotheses were tested using inferential statistics. Results showed that male students were significantly better than the femalestudents; TTOPPA was more effective than the conventional method in improving students' achievement in mathematics, the approach also eradicated gender differences in achievement that existed in the experimental group prior to the administration of treatment. It was recommended that mathematics teachers should adopt gender unbiased approaches such as TTOPPA in mathematics instructions so as to eliminate gender performance gaps which are inherent in conventional classes. In that way, male and female studentscan be made to achieve equally and females' participation in mathematics and related disciplines can be improved.

Key Words: *4-stage proficiency approach, gender performance, achievement, eradication.*

Introduction

Mathematics is a subject whose usage cuts across many spheres of human endeavor.The basic knowledge of mathematics is necessary for anyone who intends to be a functional member of the society to which he belongs.Kilpatrick, Swafford and Findell (2001) maintain that mathematics is one of humanity's great achievements which has enhanced the capabilities of the human mind and facilitated the development of science, technology, engineering, business, and government through its great sophistication and beauty that epitomize the power of deductive reasoning.The application of mathematics is far reaching. For instance, mathematics is applied at a basic level in buying and selling of goods and rendering of services and at a proficient level in real problem situations like planning the financial choices to make in order to cut down expenses for a party or deciding the route to take to an event in order to get there earlier and save time and resources.

Despite the great importance of mathematics, students' performance and achievement in the subject have been dismal over the years especially at the senior secondary level(Binda, 2005).Worst still, male students often achieve more than their female counterparts. Again, this gap in gender performance appears to be more pronounced at the

senior secondary school level (Odogwu, 2002).Odogwu (2002) asserted that in the primary school, boys' and girls' achievements in mathematics are at par but a decline in the performance of girls begins to be apparent during the senior years of secondary school. About two decades ago, females' participation in mathematics related courses was relatively low (Ogunleye, 1999). According to Ogunleye (1999), available data in the educational system indicated that fewer girls than boys were enrolled in school and girls appeared to perform less well than boys in sciences and mathematics. Also, many of the female students dropped science subjects such as mathematics and physics at early ages particularly because these subjects were regarded as unfeminine.

The subject of gender disparity in mathematics performance has been a long standing issue with inconclusive and inconsistent research findings. Females' participation in Science, Technology, Engineering and Mathematics (STEM) fields could be said to have improved in recent times. These gender performance gaps might have reduced substantially in recent years because female students are beginning to record improved achievementsin mathematics. In some cases, the achievements of girlsare better than males' (Anagbogu&Ezeliora, 2007). For instance, Ijadunola and Lawal (2016) found girls to have better suited study habits than boys in mathematics.In other cases, equivalent to males' achievementwere found (Koroka&Ezenwa, 2011; Yaki, 2011; Onyishi&Agwagah, 2011). In fact, Timayi, Ibrahim &Sirajo (2016) and Essien and Setati (2007) found no significant difference in the interest and academic achievement (in geometry) and mathematical proficiency of boys and girls taught mathematics using jigsaw IV cooperative learning strategy and ASTRALAB packagerespectively. However, Agwagah (2013) points out that gender disparity in mathematics education still exists in favour of the male students. Studies such as Adaramola&Obomanu (2013), Imoko&Anyagh (2012),Popoola& Ajani (2011) and Etukudo (2002)confirm male students' mathematical superiority over the females.

Researchers,Etukudo(2002) and Fajemidagbaand Suleiman (2012)have argued based on research findings that the gender differences still exist because many mathematics teachers adopt weak instructional methods, biased strategiesand/or ineffective approaches in mathematics instructions.The bulk of the blame is passed on to teachers who adopt the conventional method of instruction without regard to criticisms on it for its numerous inadequacies. One of the notable disadvantages of the conventional method is this gender bias in students' achievement or performance. With many teachers stuck to the use of the conventional method (Awofala, 2002 in Okoli&Agu, 2006) and the lop-sided performance outcome, a pertinent concern is whether or not mathematics teachers' pedagogical practice such as adopted methodology of instruction is indeed gender biased. The question is if mathematics performance truly depends on gender?

Advocacies are constantly made for teachers to adopt strategies deemed as gender unbiased, effective, better than the conventional method and documented to have improved students' achievement in mathematics. Computer Assisted Instruction (Ezenweani, 2010a); Mastery Learning Approach(Zakariyya, Ndagara&Yahaya, 2016; Abakpa&Igwue, 2013) and 4-stage proficiency approach –TTOPPA (Douglas, 2013) are some of such strategies. However, some of these approaches still retained significant traces of gender performance gaps.

A strategy documented to improve students' achievement or performance in mathematics well over the conventional method is cooperative learning strategy. Eniayeju (2010) examined the effects of cooperative learning strategy on students' achievement in mathematics using primary six boys and girls. The study adopted a quasi-experimental design

of the pretest-posttest-equivalent control group type with random assignment of clusters to treatments. The groupings were heterogeneous cooperative (different sexes in the same cooperative group); homogeneous cooperative (all members of the cooperative group of same sex) and conventional strategies. A sample size of three hundred and eighty nine (389) students participated in the study. The findings of the study revealed that the use of cooperative grouping and learning whether heterogeneous or homogeneous was effective in improving students' achievement significantly well over the use of conventional strategy. Also, girls in cooperative groups achieved significantly better than the boys in the cooperative groups. Hence, though improvements were recorded in students' achievement, gender performance gaps existed in favour of females.

Another strategy documented for its effectiveness in improving students' achievement and also eradicating gender differences is the Computer Assisted Instruction (CAI). A study by Etukudo (2002) examined the effect of computer assisted instruction on gender and performance of junior secondary school students in mathematics. The study adopted a pretest-posttest experimental design with equal number of subjects in both control and experimental groups. Both treatment units were taught the same topics but the experimental group received a computer assisted instruction (two students to a computer) while the control group received the conventional chalk board instruction. Each treatment group contained twenty boys and twenty girls. Analysis of the pretest scores revealed that significant gender difference in the performance of male and female students in junior secondary schools in mathematics existed in favour of the males. For the posttest, results showed that the experimental (CAI) group had no significant gender difference in the performance of the students. However, for the control group, there was still a significant gender difference in the performance of subjects.

CAI is evidently effective in improving students' performances and eradicating gender performance difference and should therefore be adopted by mathematics teachers in mathematics instructions but the unavailability or insufficient number of computers in most government schools and erratic power supply do not encourage the use of CAI in most schools. Consequently, though CAI is effective in improving students' performances and eradicating gender performance differences in mathematics classrooms, it cannot easily be implemented in Nigerian public schools where the majority of students are enrolled.

Another approach documented to have improved the mathematics proficiency of students is the Tutorial-Terms-Operations-Problem solving Proficiency Approach (TTOPPA). A study by Douglas (2013) which involved students struggling with mathematics in grades 2-4 found that students who were at risk of academic failure achieved significant mathematical gains through exposure to the TTOPPA. The design of the study was a randomized control trial (RCT) in which standardized and proprietary tests of mathematical ability were used. The experimental groupand the control groupswere taught using TTOPPA ant the conventional approach respectively.Results showed that students in the experimental group achieved significantly greater gains ($p < .05$) than their peers in the control group in all tests considered. This proved that students at risk of academic failure can be helped to achieve significantly greater mathematical gains by adopting the TTOPPA. However, the effectiveness of TTOPPA in relation to gender performance and its efficacy on secondary school studentsare still untapped. The inclusion of gender and the use of secondary school students in the present study are therefore justified.

Statement of the Problem

The major concern is that both males and females need mathematics outside the classroom and all students who wish topursue professionalism in mathematically related disciplines must be mathematical proficient.Female participation is highly encouraged in many mathematics related career areas in recent times to achieve justifiable equity yet female students' achievement in mathematics in comparison to their male counterpart is often very low.Also,teachers' attempts to cover the syllabus while catering for large classes is most favoured by the adoption of the conventional method which has been criticized for producing lopsided results.There is the need to present teachers with effective methods capable of retaining the advantages of the conventional method while overcoming its numerous inadequacies. This study therefore examined the efficacy of the TTOPPA in improving students' mathematical proficiency and in helping female students gain significant mathematical proficiency (Douglas, 2013).

Objectives/purposes of the study

The main objective of the study was to investigatethe efficacy of TTOPPA in eradicating gender performance differences inherent in conventional classes while improving students' achievement across gender. Specifically, the delineated purposes of the study were to:

1. examinethe influence of gender on the mathematics achievement of conventionally taughtsenior secondary school students from Nigerian public schools.
2. investigate the efficacy of TTOPPA in improving students' achievement across gender.
3. determine the efficacy of TTOPPA in eradicating gender performance differences if any.

Research Questions

The following research questions guided the study:

1. How does gender influence the mathematics achievement of senior secondary school students from public schools?
2. What is the difference in achievement gain within the two treatment groups?
3. Can differences in gender performance (if any) be eradicated through teachers' adoption of TTOPPA in mathematics instructions?

Research Hypotheses

The following null hypotheses were raised in the study and tested using the study data.

1. There is no significant influence of gender on the mathematicsachievement of students.
2. There is no significant difference in the achievement gains of students taught using the conventional method and those taught using TTOPPA.
3. There is no significant difference between the achievements of male and female students within same instructional approach.

Significance of the Study

The study is significant to all stakeholders of mathematics education: mathematics teachers, mathematics curriculum developers, mathematics supervisors, students, parents, the government and the society at large. It equips teachers with the basic knowledge of the need to let go of the usual conventional method. It has provided research based evidence to support that gender performance difference can be eliminated or reduced to non-significant levels.It

forms a basis for further research on TTOPPA as there is paucity of researches in that line in Nigeria.

Methodology

The study adopted a quasi-experimental design of the pretest-posttest control group type. The study was conducted in Education Districts I and IV of Lagos State. The population of the study consisted of all the senior secondary school students in Lagos State. The target population are the 286, 544 SS II students in the State. The sample consisted of a total of 283 SS II students from a total of four intact classes fromthe Education Districts. The Education Districts and schools were selected using purposive sampling technique based on earliest approvals of the Tutor-Generals and consent of the teachers for the study to be conducted in their schools.Selection of intact classes and assignment to treatments were done using simple random sampling technique. The scope of the study was delimited to senior secondary school year 2 mathematics students in Lagos State because the population, nature and mix of students in Lagos State public secondary schools are believed to be very good representations of the Nigerian senior secondary students' niche. Senior secondary schoolstudents were used because research findings have shown that differences in gender performance are more pronounced at this level. SS II students were chosen because students at this level are free from any form of external examination that may interfere with the research process. Gender was the only moderating variable because of inconsistencies of research results and the fact that the efficacy of TTOPPA is to be evaluated in the light of its ability to eradicate gender performance differences. Thus the study determined the efficacy of TTOPPA in improving students' achievement generally and specifically in helping female students attain considerably equivalent achievements in mathematics instructions.

Research Instrument

An essay type instrument, Mathematics Achievement Test (MAT) developed by one of the researchers was used to obtain data for the study. The MAT is in three sections (A, B and C). Section A requires students to fill their personal data such as gender and age. Section B is for Basic Conceptual Knowledgeand contained three questions while section C is the Problem solving and processes section. Section C contained five questions, two of which are routine problems while the other three (the quadratic formula dilemma, the birthday cakes decoration and the girls' measures problems) are non-routine problems. Students were required to show their complete solution processes (all workings) in this section. The MAT was scored over one hundred (100). Questions were scored according to complexity. Consequently, question one (Q1) bore four (4) marks, question two (Q2) bore 15 marks (10 marks for problem solving and 5 marks for explanation of solution procedures). Question three (Q3) bore six (6) marks while questions four (Q4) and five (Q5) were allotted thirty (30) marks each. Solution procedures as well as the final answers were scored.

Validity and Reliability of Instruments

The research instrument was face and content validated by three professional mathematics education lecturers and necessary corrections were made. MAT was tested and retested after a period of two weeks. The reliability coefficients of the two administrations obtained using Pearson Moment correlation was 0.966.

Procedure for Data Collection

The sampled intact classes were first observed during lesson classes to ascertain the instructional method adopted by the teacher. After confirming teacher's adoption of the conventional method, the MAT was administered to students as a pretest and students' responses (workings) were marked using a comprehensive marking scheme to MAT as guide. A student's total score in this first test was regarded as the pretest score. After the treatments which lasted for a period of five weeks, the MAT was re-administered to the students as a posttest and marked using the same marking guide.The score in this second test was regarded as the posttest achievement score.

Data Analysis

Both descriptive and inferential statistics were used in analyzing data, answering research questions and testing research hypotheses. All research questions were answered quantitatively using frequency counts, means and standard deviations while all hypotheses were tested using independent samples t-test and ANCOVA.

RESULTS AND DISCUSSION

Research question 1: How does gender influence the mathematics achievement of senior secondary school students from Nigerian public schools?

Table 1 contains the result of the descriptive statistics on students' pretest scores in the MAT.**Table 1: Descriptive statistics of students' pretest achievement scores in the MAT**

	N	Sum	Mean	Mean std. error	Std. D.
General achievement	283	5267	18.611	0.747	13.638
males' achievement	148	3041	20.547	1.088	14.792
Females' achievement	135	2226	16.486	0.966	11.747

Table 1 above shows that the mean score of all the students in the MAT was 18.611 with a standard deviation of 13.6375. Male students had a mean of 20.547 with a standard deviation of 14.7922 while the females had a mean of 16.486 with a standard deviation of 11.7468. The male students had a mean score that was greater than the mean score of the females.

Hypothesis 1: There is no significant influence of gender on the mathematics achievement of senior secondary school students.

The difference in the mean scores of the male and female groups was tested for statistical significance using the independent samples t-test. The result is presented in table 2 below.

Table 2: Result of independent t-test for influence of gender on students' achievement

		Levene's Test for Equality of Variances		t-test for Equality of Means						
				T	Df	Sig. (2-tailed)	Mean Diff.	Std. Error Diff.	95% Confidence Interval of the Diff.	
		F	Sig.						Lower	Upper
MA	EVA	10.351	0.001	-2.628	281	0.009	-4.061	1.454	-6.683	-0.961

EVA- Equal variances assumed, MA- Mathematics achievement

Table 2 shows that the mean difference of 4.061 (in favour of the males) was significant with $p = 0.009 < 0.05$. Hence, there was significant influence of gender on the mathematics achievement of male and female students taught using the conventional method.

Research question 2:What is the difference in improvement in achievement by the two treatment groups?

Table 3 below contains the results of the descriptive analyses on the pretest and posttest MAT scores of students based on treatment group.

Table 3: Descriptive statistics of students' MAT scores based on treatment groups

	Pretest mean	Std. D.	Posttest mean	Std. D.	Within group's mean difference
Conventional group N = 136	19.037	12.593	21.537	11.932	2.494
TTOPPA group N = 147	18.218	12.075	27.667	9.2468	9.446
Between group's mean difference	0.819		6.133		

Table 3 above shows that the control group had a mean of 19.037 in the pretest and a mean of 21.531 in the posttest. The resulting mean difference was 2.494 for the conventional group. For the TTOPPA taught group, the pretest mean score was 18.218 while the mean score in the posttest was 27.0751. The resulting pretest to posttest mean difference was 9.446. The pretest mean score of the conventionally taught group was marginally greater than that of the TTOPPA taught group.However, the posttest mean score of the TTOPPA taught group was greater than that of the conventionally taught group. The between groups' mean differences were 0.819 and 6.133 for the pretest and the posttest. The positive mean differences for the pretest and posttest were in favour of the control and TTOPPA groups respectively.

Hypothesis 2: There is no significant difference in the achievement of students taught using the conventional approach and those taught using TTOPPA.

Independent samples t-tests were first used to ascertain the significances of mean differences between groups in the pretest based on treatment groups. Table 4 below contains the result.

Table 4: Independent samples t-test of significance of between groups' pretest differences

		Levene's Test for Equality of Variances		t-test for Equality of Means						
				T	Df	Sig. (2-tailed)	Mean Diff.	Std. Error Diff.	95% Confidence Interval of the Diff.	
		F	Sig.						Lower	Upper
MA	EVA	0.007	0.932	1.002	281	0.317	0.819	0.832	-0.804	2.470

EVA-Equal variances assumed, MA- Mathematics achievement.

The results contained in table 4 showed that the two treatment groups were not significantly different in the pretest as $p = 0.317 > 0.05$. ANCOVA was then used to determine the significance of between groups' posttest differences using the pretest scores as covariate to partial out any form of initial insignificant difference existing between the treatment groups. Table 5 contains the result.

Table 5: summary of ANCOVA analysis of posttest scores for significance of effect of treatment received.

Source	Sum of squares	df	Mean square	F	Sig	Partial eta^2
Corrected model	10856.487	2	5428.244	38.275	0.000	0.632
Intercept	6268.865	1	6268.865	265.212	0.000	0.487

Pretest	132.297	1	132.297	5.593	0.019	0.031
Treatment	2649.241	1	2649.241	112.081	0.000	0.395
Error	6382.864	281	22.714			
Total	26289.754	283				
Corrected Total	17238.425	282				

Wilk's Lambda statistic reported.

Result obtained from ANCOVA analysis shows that there was a significant difference (F1, 281 = 112.081, p = 0.00 < 0.05 and partial eta2 = 0.395) between groups based on treatment received in favour of the TTOPPA group. Hence, the difference in improvements between the two treatment groups was statistically significant. This means that TTOPPA was more effective than the conventional approach in bringing about improvement in students' achievement.

Research Question 3: Can gender performance differences (if any) be eradicated through teachers' adoption of TTOPPA in mathematics instructions?

This question was answered by comparing students' scores based on gender differently for the two groups. Table 6 contains the result of the descriptive analysis.

Table 6: Descriptive statistics of students' posttest scores based on gender for the two treatment groups

	CMG		TTOPPA	
	mean	Std. D.	Mean	Std. D.
Male	22.599 (N = 74)	11.011	28.119 (N = 74)	9.256
female	20.270 (N = 62)	12.133	27.208 (N = 73)	10.143

The males in each group had mean scores that were greater than the mean scores of the counterpart females.

Hypothesis 3: There is no significant difference between the achievements of male and female students within same instructional approach.

Independent samples t-tests conducted to ascertain the existence or otherwise of genderinfluence in each of the two treatment groups in the pretest showed that there was significant influence of gender in favour of the males in each group. The same test was repeated on the posttest. Table 7 contains the results.

Table 7: Independent samples t-tests for significance of posttest mean differences based on gender for the two treatment groups

		Levene's test for equality of variances		t-test for equality of means						
									95% confidence interval of the difference	
						Sig. (2	Mean	Std. Error		
		F	Sig.	T	Df	-tailed)	diff.	diff.	lower	upper
TTOPPA	EVA	3.404	0.066	-1.678	145	0.094	-0.911	0.603	-2.1964	0.174
CMG	EVA	5.058	0.025	-2.412	134	0.016	-2.329	0.5510	-2.412	-0.246

CMG- Conventional method group; EVA – Equal variances assumed

Table 7 shows that there was no significant gender difference in the TTOPPA group in the posttest. However, for the CMG, there was a significant gender difference in the posttest. Hence, the gender gap that existed during the pretest for TTOPPA group was eradicated through the use of the approach while the gender gap in the pretest for CMG was not eradicated.

Discussion

The mathematics achievement of students has remained abysmal for several years. Furthermore, male students have often times been regarded as more mathematically able students in comparison to the females. In fact as Ogunleye (1999) affirmed, because of the deemed higher mathematical power of the male gender, many disciplines requiring more of mathematical abilities have been tagged masculine domains. Gender performance difference is relatively inherent in many conventional classes. This study found that there was significant influence of gender on the achievement of students when taught conventionally. This finding agrees with the findings of some previous studies which found that male students perform better than female students in mathematics and science (Popoola& Ajani, 2011; Imoko&Anyagh, 2012). However, the finding did not agree with some previous research finding that females achieve better than males (Agwagah, 1993, Anagbogu&Ezeliora, 2007). The findings did not also agree with findings that showed no significant difference in the achievement of boys and girls (Essien&Setati 2007; Ijadunola& Lawal, 2016; Fajemidagba& Suleiman, 2012).

With respect to the relative effectiveness of the two treatment structures, results showed that there were marginal differences between the mean scores of the pretest and posttest (in favour of the posttest) for both CM and TTOPPA groups. The TTOPPA was effective well over the CM in improving students' achievement. The results agrees with other previous studies like Etukudo, 2002; Adaramola&Obomanu, 2013; Douglas, 2013; Timayi, Ibrahim &Sirajo (2016) who found that methods other than the CM can improve students' achievement greatly. Also, TTOPPA was found effective for the eradication of gender performance gaps. The result aligns with Etukudo (2002) who found that CIA eradicated gender performance gaps in mathematics classes. The major limitation of CIA which TTOPPA has overcome is effective implementation in Nigerian schools due to insufficient computer systems and erratic power supply.

Conclusion

This study established that students' achievement can be improved generally and gender performance gaps can be bridged. In effect, all students can be made to achieve satisfactory level of mathematical success irrespective of gender.

Recommendation

It was recommended based on the findings of the study that teachers of mathematics should adopt TTOPPA in teaching as the approach has empirical proofs supporting its effectiveness in improving students' achievement and in bridging gender performance gaps.

References

Abakpa, B. O. &Igwue, D. O. (2013).Effect of Mastery Learning Approach (MLA) on senior secondary school students' achievement and interest in geometry in Makurdi, Benue State, Nigeria.*Abacus: Journal of the Mathematical Association of Nigeria, 38* (1), 163 – 176.

Adaramola, M. O. &Obomanu, B. J. (2013). Correlates of certain ability in mathematics achievement measured using bloom's taxonomy amongst secondary school students in Nigeria. *Journal of the Mathematical Association of Nigeria, 38*(1), 93-102.

Agwagah, U. N. V. (1993).Instruction in mathematics reading as a factor in students' achievement and interest in word problem solving.*Journal of the Mathematical Association of Nigeria, 18*(1).6-15.

Anagbogu, M. A. &Ezeliora, B. (2007).Sex differences and scientific performance.*Women Journal of Science and Technology, 4*(1), 10-20.

Binda, S. I. (2005). *The effects of understanding the language of mathematics on performance in mathematics among secondary school students in Plateau State.*Unpublished Ph.D. Thesis, University of Jos. Nigeria.

Douglas, M. (2013).Developing mathematical proficiency. EPS Literacy and Intervention: Academy of Mathematics. Retrieved on 14/03/2016 from https://eps.schoolspecialty.com/EPS/media/Site-Resources/Downloads/research

Eniayeju, A. A. (2010). Effects of Cooperative Learning Strategy on the achievement of Primary six boys and girls in Mathematics.*Abacus, 35* (1), 1-9.

Etukudo, U. E. (2002).The effect of Computer Assisted Instruction (CAI) on gender and performance of junior secondary school students in mathematics.*Abacus: Journal of the Mathematical Association of Nigeria, 27*(1), 1-8.

Ezenweani, U. L. (2010). Esthetic images linking school and societal mathematics. *Journal of the Mathematical Association of Nigeria, 35*(1), 32-45.

Fajemidagba, M. O. & Suleiman, B. (2012).Effects of Polya and Bransford and Stein problem solving Models on students' performance in mathematics.*Abacus, 37* (1), 124-133.

Ijadunola, K. T. and Lawal, R.F. (2016). Age, gender, study habits and students' performance in mathematics. *Akoka Journal of Pure and Applied Science Education, 14*(1), 25-35.

Imoko, B. I. &Anyagh, P. I. (2012).Effect of formular strategy on students' retention in algebra.*African Journal of Science, Technology and Mathematics Education, 2*(1), 15-27.

Kilpatrick, J., Swafford, J. &Findell, B. (2001).*Adding it up: Helping Children Learn mathematics.* Mathematics Learning Study Committee, Center for Education, *Division of Behavioral and Social Sciences and Education*. Washington, DC: National Academy Press. Retrieved from www.sjsd.k12.mo.us/cms/lib3/MO01001773/

Koroka, M. U. S. &Ezenwa, V. I. (2011).The influence of gender on the use of analogy in biology students' understanding of the concept of osmosis among secondary school students in Minna, Niger State.*Journal of Science, Technology, Mathematics and Education (JOSTMED), 8*(2), 290-301.

Odogwu, H. N. (2002). Female students' perception and attitude to mathematics: A bane to their SMT education. *ABACUS: The Journal of the Mathematical Association of Nigeria, 27*(1), 19-29.

Ogunleye, A. O. (1999). *ScienceEducation in Nigeria: Historical Development Curriculum Reforms and Research.* Nigeria: Sunshine International Publications Limited.

Okoli, B. &Agu, N. N. (2006).Evaluation of pupils' problem solving abilities in mathematics using target task approach (TTA).*International Journal of Educational Research and Development, 5* (1), 23-33.

Onyishi, E. U. &Agwagah, U. N. V. (2011). Improving the teaching and learning of mathematics through the use of mind maps for the attainment of millennium development. *ABACUS: the Journal of the Mathematical Association of Nigeria, 36* (1), 27-34.

Popoola, B. A. & Ajani, T. O. (2011). Influence of pupils' gender, environment and school ownership status on mathematics performance of secondary school students in Yewa North, Ogun State. *Journal of the Mathematical Association of Nigeria, 36* (1), 56-65.

Timayi, J. M., Ibrahim, M. O. and Sirajo, A. M. (2016).Gender differentials in students' interest and academic achievement in Geometry using jigsaw IV cooperative Learning strategy.*ABACUS: the Journal of the Mathematical Association of Nigeria, 41* (1), 147-155.

Yaki, A. A. (2011). Effects of guided inquiry instructional strategy in cooperative and individualized learning settings on secondary school students' achievement in biology in Abuja Municipal Area Council.*JOSTMED: Journal of Science, Technology, Mathematics and Education, 7*(3), 204-213.

Zakariyya, A. A., Ndagara, A. S. &Yahaya, A. A. (2016).Effects of Mastery Learning Approach (MLA) on senior secondary school students' performance in Geometry in Bidaa, Niger State, Nigeria. *ABACUS: the Journal of the Mathematical Association of Nigeria, 41* (1), 17-25.