International Journal of Research and Review
www.ijrrjournal.com E-ISSN: 2349-9788; P-ISSN: 2454-2237

Research Paper

Effect of 5Cs on Senior Secondary School Students' Achievement in Geometry in Makurdi Metropolis, Benue State, Nigeria

Iji Clement O[1], Age Terungwa James[2]

[1]Professor, [2]Doctoral Student,
Mathematics Education, Department of Mathematics Education, Federal University of Agriculture, Makurdi-Nigeria

Corresponding Author: Age Terungwa James

ABSTRACT

The purpose of this study was to determine the efficacy of the 5 Principles of the Modern Mathematics Classroom otherwise known as the 5Cs on the achievement of senior secondary school student in geometry in Makurdi Metropolis of Benue State. The design adopted for this study is Quasi-experimental. It specifically used a non-randomized pre-test posttest control design. The study was conducted in Makurdi metropolis of Benue state, Nigeria. The sample size of the study was 181 students. It consisted of 84 males and 97 females from four schools. The control group has 102 students while the experimental group has 79 students. The instrument of this study was Geometry Achievement Test (GAT). It comprised of 25 –item multiple choice objectives questions constructed by the researcher. Its reliability coefficient was calculated to be 0.84 using Kuder-Richardson Coefficient, K-R21. Descriptive statistics of mean and standard deviations were used to answer the research questions. Inferential statistics of Analysis of Covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance. The findings indicate that the use of 5Cs enhances students' achievement in geometry and both male and female students equally improved on their achievement in geometry.
Key words: Achievement, Geometry, Strategy.

1. INTRODUCTION

Geometry as a concept in mathematics has a lot of benefits to both the learners and the society at large. Its definition varies from author to author. Geometry is a branch of mathematics that deals with the measure and properties of points, lines, curves and surfaces (Achor, Imoko & Ajai, 2010). According to Iji, Ogbole and Uka (2014) geometry is an aspect of school mathematics that has every day application in the life of the child. It helps the child in the development of aesthetism around his/her environment as well as inductive reasoning skills. To Russell (2014) studying geometry provides many foundational skills and helps to build the thinking skills of logic, deductive reasoning, analytical reasoning and problem solving to name but just a few. Umoru and Ubom (2013) state that geometry is a vibrant and exciting part of mathematics and a key to understanding the world through concrete experiences with geometric figures and relationship.

The Royal Society/JMC report in Age (2017) suggests that the aims of teaching geometry can be summarised as follows:

- Develop spatial awareness, geometrical intuition and the ability to visualise;
- Provide a breadth of geometrical experiences in 2 and 3 dimensions;
- Develop knowledge and understanding of and the ability to use geometrical properties and theorems;

• Encourage the development and use of conjecture, deductive reasoning and proof;
• Develop skills of applying geometry through modeling and problem solving in real world contexts;
• Develop useful ICT skills in specifically geometrical contexts;
• Engender a positive attitude to mathematics; and
• Develop an awareness of the historical and cultural heritage of geometry in society, and of the contemporary applications of geometry.

The questions that researchers often asked is that, are these aims beautifully outlined met? The answer perhaps is no, and several factors are been attributed for the inability to meet the aims of teaching geometry.

There is an incessant poor achievement among the senior secondary school student in mathematics in general and geometry in particular, and this is worrisome to mathematics researchers. Achievement in mathematics is basically concern with the students' performance in either teac her- made test or standardized achievement test given by examination bodies. Harbor-Peters in Ozofor (2015) reported that students' poor performance in mathematics has been more prominent in some aspects of mathematics curriculum content than in others. Such content areas have also been shown to be very difficult to tackle by students for example geometry. According to Olunloye (2010), this ugly trend of high failure rate in mathematics is a national disaster. Therefore, feasible ways of improving the achievement has remained an area of great concern for researchers.

Gender is also identified as a sub-variable responsible for poor achievement among senior secondary students in geometry. Njoku in Gambari, Folade and Adegbenro (2014) state that gender issues have been linked with performance of students in academic tasks in several studies but without any definite conclusion. Some studies revealed that male students performed better than females in science. Osemmwinyen (2009) and Iwendi (2012) found no gender differences in the performance of male and female students in mathematics. Contrary to the above results, Kurume (2004) and Gimba (2006) found that female students perform better than male students in geometry. This study is posed to finding out if the use of The 5 Principles of the Modern Mathematics Classroom otherwise known as the 5Cs could solve this problem.

The deplorable state of mathematics achievement is attributed to a number of factors such as lack of instructional resources (Yara, and Otieno, 2010); Instructional techniques Olunloye (2010). Anyagh, Agbo-Egwu and Kalu (2017) revealed that the issue of how best to help the learners acquire knowledge, skills and values has been a problem to educationists over the years. Anyagh, Igba and Age (2018) opined that in attempting to provide answers to this problem, educational scholars put forward different strategies, practices, methods or approaches of teaching. Iji, Abakpa and Age (2018) stated that teachers of Mathematics are continually challenged to find the most effective method of teaching students. Studies have reported that students often view mathematics as a set of isolated procedures, failing to see real-life applications of their learning outside of the classroom. However, researchers have found that mathematics classrooms and the individualistic nature of mathematics, whereby students work independently, actually discourages learning (Celik, 2018). Therefore improving student enjoyment of mathematics is a key strategy to address subject disengagement. Innovative teaching methods that provide positive mathematical learning experiences could help to enhance students' achievement in mathematics (Rilley, et al, 2017).

As pointed by Mullis et al. (2012), the current approaches and teaching methods in the classrooms were still confined to the traditional teacher-centered approach.

Similar findings were also reported by Noraini (2006) found that teachers' geometry learning activities were uncreative and boring due to merely using blackboard to explain definitions, concepts, and specific theorems. Some strategies are capable of improving the achievement of students in mathematics and other subjects (Iji, 2005; Ihendinihu, 2008).

Mathematics instruction is frequently conducted under a false assumption: that mathematics is a fixed, linear sequence of skills. This leaves out what makes mathematicians pursue their subject with passion and drive: the mystery and magic of mathematics. Anyagh, Age and Abari (2019) state that Mathematics teachers today are finding ways to work with various forms of visual media to help gain and keep students' interest. In quest of finding a lasting solution to this ugly trend, this study made use of the 5 Principles of the Modern Mathematics Classroom otherwise known as the 5Cs. By learning and applying these five simple principles, you can inspire students, teach them how to think like innovators, and make them believe they are all "math people." The 5 Cs let you build a classroom culture that emphasizes the most important part of any mathematics curriculum: the processes, practices, and habits of mind. In order to embrace the magic, the classroom must be a place where problem solving happens daily and is deeply embedded in its culture (https://geraldaungst.com/5cmath/) .

The 5 Principles of the Modern Mathematics Classroom otherwise known as the 5Cs developed by Gerald Aungst are as shown below:

Conjecture

In a traditional mathematics classroom, the primary goal is for students to get the right answers to questions and exercises. In a classroom where conjecture is encouraged, students ask most of the questions, and the answer to a question is very often another question. For example in teaching geometrical constructions, students ask questions such as why use centre of convenience as radius? Students are allowed to asked many relevant questions as they can.

Communication

In a traditional classroom, communication is primarily one way: the teacher explaining a procedure or algorithm to students. In a problem-oriented classroom, students must learn to communicate frequently about problems and how they solve them. In the process of communicating on how problems are being solved, more clarifications and light is been thrown to some areas considered to be abstract or confusing to the learners.

Collaboration

In a traditional classroom, students work alone, and the emphasis is on an individual's skill fluency. Problem solving classrooms are all about the "we". Concepts like geometry are best learned together. Some steps that may be seen as a challenge to other students might be the simpliest steps to other students, thus, solving problem in groups may brighten up the chances of a learner in learning some geometrical concepts such as construction.

Chaos

Though this sounds sketchy, it is simply encapsulating the idea that real mathematics work is messy. In a traditional classroom, neatness and order rule the day. Real problems, on the other hand, require experimentation, false starts, mistakes, and corrections, sometimes over and over again. Most of the geometrical problems need to be sketch before finally solving the problem.

Celebration

In a traditional classroom, recognition is given for right answers and high grades. In a problem- solving culture, anything that leads towards a solution is celebrated: finding one small step of a complicated problem, thinking of an innovative approach even if it doesn't pan out, or even making a spectacular mistake and asking for help. Marks are allocated on steps leading to the final answer, rather concentrating on the final answer only.

Therefore the study seeks to determine whether the application of these principles in geometrical classroom will be a panacea for students' low achievement in geometry.

1.1 Statement of the Problem

There are many challenges facing the educational system in Nigeria which among them is the poor achievement in mathematics in external examinations such as the West African examination council (WAEC) and the national examination council (NECO). The key factors responsible for this poor achievement in mathematics in general and geometry in particular are the ways and the means (strategies) the mathematics teachers implore on the students and their gender. Several researches have agreed that there is high demand for a paradigm shift in the curricular content and the ways of teaching and learning of mathematics (Kolawole, 2008; Adeyemi, 2008). Gender factor is very strong in the learning and teaching of geometry and if not taken into cognizance during the teaching process, it affects the students' achievement. Could the use of the 5 Principles of the Modern Mathematics Classroom otherwise known as the 5Cs arrest the situation of poor geometrical achievement and closes the gap that do exist among the gender(male and female)?

1.2 Purpose of the Study

The purpose of this study is to determine the efficacy of the 5 Principles of the Modern Mathematics Classroom otherwise known as the 5Cs on the achievement of senior secondary school student in geometry in Makurdi Metropolis of Benue State. Specially the study sought to:

i. Determine the effect of 5Cs on senior secondary school students' achievement in geometry.
ii. Determine the effect of 5Cs on the mean achievement scores of male and female senior secondary students in geometry.

1.3 Research Questions

The following research questions were asked in this study:

i. What is the effect of 5Cs on senior secondary school students' mean achievement scores in geometry?
ii. What is the effect of 5Cs on the mean achievement scores of male and female senior secondary students in geometry?

1.4 Research Hypotheses

The following null hypotheses were formulated to guide the study:

i. There is no significant difference in the mean achievement scores of senior secondary students taught geometry with 5Cs and those taught without 5Cs.
ii. There is no significant difference in the mean achievement scores of male and female senior secondary school students taught geometry with 5cs.

2. METHOD AND PROCEDURE

The design adopted for this study is Quasi-experimental. It specifically used a non-randomized pre-test posttest control design. The subjects of the study were not randomized into experimental and control groups but left as intact classes. This was to avoid the disruption of the school programmes. Though, classes were assigned into experimental and control groups. The study was conducted in Makurdi metropolis of Benue state, Nigeria. Makurdi serve as both the state capital and Local Government Area Headquarter. The population of this study was made up of all the Senior Secondary One (SS1) students from all the 143 Government approved secondary schools in Makurdi metropolis. Simple random sampling was used to select four schools from the total number of schools in Makurdi.

The sample size of the study was 181 students. It consisted of 84 males and 97 females from four schools. The control group has 102 students while the experimental group has 79 students. The choice of SS1 was purposive because it is at this level that foundation is been laid for a successful senior secondary education. The choice of which schools and classes to be used as experimental and control was done through simple random sampling with the use of a flip of a coin.

The instrument of this study was Geometry Achievement Test (GAT). It comprised of 25 –item multiple choice objectives questions constructed by the researcher. Its reliability coefficient was calculated to be 0.84 using Kuder-Richardson Coefficient,K-R21. Descriptive statistics of mean and standard deviations were used in answering the research questions. Inferential statistics of analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

3. RESULT

The results from the analysis of data for this study are presented according to the research questions asked and hypotheses formulated.

3.1 Research Question one

What is the effect of 5Cs on senior secondary school students' mean achievement scores in geometry?

Table 1: Mean Achievement Scores and Standard Deviation of Students in Experiment and Control Groups

Groups	N	Pre-5CsG		Post-5CsG	
		Mean	SD	Mean	SD
Experimental	79	30.21	10.20	40.11	11.31
Control	102	24.30	9.10	30.91	10.20
Mean Difference		5. 91		9.20	
Total	181				

Table 1 shows that the experimental group (5CsG) gained more in achievement by 11.31 than the control group with the mean gain of 10.20.

3.2 Hypothesis 1

There is no significant difference in the mean achievement scores of senior secondary students taught geometry with 5Cs and those taught without 5Cs

Table 2: Analysis of Covariance of Experimental and Control Groups Achievement Scores in Geometry Achievement Test

Source of Variance	Sum of Squares	df	Means Square	F_{cal}	Sig.
Corrected	17282.04	2	8641.02	345.41	.000
Intercept	5122.90	1	5122.90	197.85	.000
Pre-5CsG	15727.59	1	15727.59	664.81	.000
Group	1638.38	1	1638.38	70.05	.000
Error	7458.74	81	92.08		
Total	374869.10	100			
Corrected Total	34287.87	181			

Table 2 shows ANCOVA value F(1, 180) = 70.05, P = .000, P< 0.05. Thus, the null hypothesis is rejected. This implies that the students taught geometry using 5Cs achieved higher than those taught without 5Cs.

3.3 Research Question 2: what is the effect of 5Cs on the senior secondary school students' mean achievement scores in geometry?

Table 3: Mean Achievement Scores and Standard Deviation of Male and Female Students in the Experimental Group

Groups	N	Pre-5CsG		Post-5CsG	
		Mean	SD	Mean	SD
Male	36	30.21	9.20	40.11	10.31
Female	43	29.30	10.10	39.91	12.20
Mean Difference		0.91		0.20	
Total	79				

Table 3 shows that, the mean pretest geometry achievement scores of the male students in the experimental group was 30.21 while that of the female was 29.30. After undergoing geometry lesson using 5Cs, the post test geometry achievement scores of the male students in the experimental group was 40.11 while that of the female was 39.91. The mean geometry achievement scores of male students in the experimental group is slightly higher than that of the female students by geometry achievement mean scores of 5.28.

3.4 Hypothesis 2:

There is no significant difference in the mean achievement scores of male and female students taught geometry 5Cs and those taught without 5Cs. The result of this hypothesis is shown in Table 4.

Table 4: Analysis of Covariance of Achievement Scores of Male and Female Students in Experimental Groups in Geometry Achievement Test

Source of Variance	Sum of Squares	df	Means Square	F_{cal}	Sig.
Corrected	7271.51	2	3635.76	93.04	.000
Intercept	4707.63	1	4707.63	120.46	.000
Pre-5CsG	7271.11	1	7271.11	186.46	.000
Gender	5.74	1	5.73	15	.700
Error	5822.96	36	161.75		
Total	374869.10	43			
Corrected Total	34287.87	79			

In Table 4, the ANCOVA value $F(1, 78) = 15$, $p = .700$, $p > 0.005$. Hence, we do not reject the null hypothesis. The result shows that there is no significance difference in the mean achievement scores in geometry between male and female students using 5Cs. This implies that the difference in the mean achievement scores in geometry between male and female using 5Cs is not statistically significant.

3.5 Summary of findings

The following major findings were based on the data presented for this study

Senior secondary one student taught geometry during this study improved upon their mean achievement scores due to the use of 5Cs.

Both male and female students in experimental group improved their achievement in geometry during the period of study.

4. DISCUSSION OF FINDINGS

This section describes the highlights and details of the major findings of this study as shown above.

The results of the findings indicates that the students who were taught geometry using the 5Cs improved on their achievement, thus in agreement with Iji (2010) who asserted that the issue of poor achievement in examinations was due to problem of methods .he contended that that there had been an increasing awareness by those concern with mathematics education that the present methods of teaching have not been very successful in the pursuit of the objectives set for it. The study also agreed with Pulat (2009) who studied impact of 5e learning cycle on sixth grade students' mathematics achievement on and attitudes toward mathematics. The results of the study found that there was a statistically significant change in mathematics achievement of sixth grade students who participated in the instruction based on 5E learning cycle. Innovative teaching methods that provide positive mathematical learning experiences could help to enhance students' achievement in mathematics (Riley et al., 2017).

Furthermore, the study shows that there is no significant difference in the achievement of both the male and female students in geometry. The implication here is that utilizing 5Cs in geometry classroom is gender friendly. This finding is in agreement with Osemmwinyen (2009) and Iwendi (2012) who found that there is no statistically significant difference between male and female students taught mathematics. Relatively, Emaikwu, Iji and Abari (2015) and Gambari, Folade and Adegbenro (2014) in their various studies show that both male and female students in experimental group achieved the same in their post tests.

5. CONCLUSION AND RECOMMENDATIONS

The use of an appropriate strategy in the teaching of mathematics in general and geometry in particular enable students to improve in their achievement. This was clearly shown since the use of 5Cs in this study enhances students' achievement in geometry. Also based on this study both male and female students equally improved on their achievement in geometry.

Based on the findings of this study, the following recommendations are made:

Mathematics teachers should make deliberate efforts to embrace the use of the 5Cs in their mathematics classroom.

Workshops and seminars should be organized by stakeholders in mathematics education for in-service mathematics teachers on the need of using modern mathematics classroom model (5Cs).

REFERENCES

1. Achor, E.E., Imoko, B.I. &Ajai, J.T. (2010). Sex differentials in students' achievement and interest in Geometry using games and simulations techniques. Necatibey Faculty of education Electronic. Journal of Science and Mathematics Education,4 (1) .
2. Age, T.J. (2017). Effect of geometer's sketchpad on senior secpndary school students' interest and achievement in geometry in G boko metropolis. Unpublished M.Ed. thesis, University of Agriculture, Makurdi .
3. Anyagh P.I, Abgo-Egwu A.O & Kalu L.E (2017). Demystifying the teaching of Mathematics as an indispensable tool for Technological Development in Nigeria. Benue Journal of Mathematics and Mathematics Education. 2.(3),17. [3].
4. Anyagh, P.I., Igba, T. & Age, T.J.(2018). Effective Mathematics Study Techniques: A Panacea for Examination Malpractice. International Journal of Research & Review, 5(9), 75-80
5. Anyagh, P.I., Age, T.J. & Abari, M.T. (2019). Investigating Mathematics Teachers' Awareness in the Use of Mathematical Softwares in Teaching Secondary School Students' in Benue State, Nigeria. *International Journal of Research and Innovation in Applied Science*,4(5), 1-5.
6. Aungst, G. (2018). 5 Principles of the Modern Mathematics Classroom. Retrieved from https://geraldaungst.com/5cmath/ on 17/04/2018.
7. BA Adeyemi, B.A. (2008). Effects of cooperative learning and problem solving strategies on junior secondary school students' achievement in social studies. Electronic Journal of Research in Educational Psychology, 6, 691-708.
8. Celik, H.C. (2018). The Effects of Activity Based Learning on Sixth Grade Students' Achievement and Attitudes towards Mathematics Activities. EURASIA Journal of Mathematics, Science and Technology Education, 14(5), 1963-1977.
9. Emaikwu, S. O., Iji, C.O. & Abari, M.T. (2015). Effect of Geogebra on Senior Secondary School Students' Interest and Achievement in Statistics in Makurdi Local Government Area of Benue State, Nigeria. IOSR Journal of Mathematics, 11(3), 14-21
10. Gambari, A. I., Falode, C. O. & Adegbenro, D. A. (2014). Effectiveness of computer animation and geometrical instructional model on mathematics achievement and retention among junior secondary school students. European Journal of Science and Mathematics Education, 2(2),127-146 .
11. Gimba, R. W. (2006). Effects of 3-dimensio nal instructional materials on the teaching a nd
learning of mathematics among senior secon dary schools in Minna metropolis. 2nd SSS E Annual National Conference, Federal Uni versity of Technology, Minna. Held betwen 19th – 2nd November, 2006.
12. Ihendinihu, U.E. (2008). Effects of Guided Scoring Instructional Strategy on the performance of secondary school students in mathematics in Abia state. Unpublished M.ED Dissertation submitted to the faculty of education, Abia- state University Uturu.
13. Iji, C.O., Abakpa, B.O. & Age, T.J. (2018). Effect of Geometer's Sketchpad on Senior Secondary School Students' Interest and Achievement in Geometry in Gboko Metropolis, Benue State. International Journal of Research & Review. 5(4), 33-39.
14. Iji, C .O., Ogbole, P.O. & Uka, N. K. (2014). Effects of improvised instructional materials on students achievement in Geometry at the upper Basic education level in Makurdi metropolis, Benue State, Nigeria. *America Journal of educational research*. 2 (7): 538-542.
15. Iji, C. O. (2005).Effect of logo and basic Programming on the Achievement and Retention in Geometry of Junior Secondary School Students. Journal of Mathematical Association of Nigeria.
16. Iji, C.O. (2010). Mathematics the language of the new millennium: implication for mathematics teaching in Nigerian primary schools. *Benue journal of Research in Science and Education*, 69, 23-30
17. Iwendi, B. C. (2012). Effects of gender and age on the mathematics achievement of seco ndary
school students in Minna metropolis, Nigeri

a. JOSTMED, 9(1), 215-223. Available onli ne: http://www.jostmed.com .

18. Kolawole, E.B. (2008). Effects of competitive and cooperative learning strategies on academic performance of Nigerian students in mathematics. Journal of Education Research and Review, 3, 33-41.
19. Kurumeh M.S.(204). Effect of ethno-mathematics approach on students' achievement in geometry and mensuration. The journal of mathematical association of Nigeria;31(1):35-44.
20. Mullis, M. O. M., Foy, P. & Arora, A. (2012) International Results in Mathematics. TIMSS & PIRLS International Study Center, Lynch School of Education, Boston College Chestnut Hill, MA, USA and International Association for the Evaluation of Educational Achievement (IEA) IEA Secretariat Amsterdam, the Netherlands.
21. Noraini, I. (2006). Teaching and learning of mathematics: Making sense and developing cognitive abilities. Perak; Utusan publication Sdn.Bhd
22. Olunloye, O. (2010). Mass Failure in Mathematics: a National Disaster. Tribune of 07/02/2010.retrieved from http/www.tribune.com.ng on 08/05/2011.
23. Osemwinyen, A. C. (2009). Effects of e-lear ning on retention and achievement in second ary school mathematics in Abuja, Nigeria. Unpublished Ph.D thesis, University of Nig eria, Nsukka.
24. Ozofor, N. M.(2015). Effect of two modes of computer aided instruction on students' achievement and interest in statistics and probability. International journal of education and research,3(1), 89-102.
25. Pulat, S. (2009). Impact of 5e learning cycle on sixth grade students' mathematics achievement on and attitudes toward mathematics. M.Sc. thesis, Department of Elementary Science and Mathematics Education, Middle East Technical University.
26. Riley, N., Luban, D., Holmes, K., Gore, J., & Morgan, P. (2017). Movement-based mathematics: enjoyment and engagement without compromising learning through the easy minds program. EURASIA Journal of Mathematics Science and Technology Education, 13(6):1653-1673. https://doi.org/10.12973/eurasia.2017.00690a.
27. Russel, D.(2014).Whatis geometry Retrieved from math.about.com/od/geometry/a/why geo.htm on the 18th October 2014.
28. Telima, A. (2011). Problems of Teaching and Learning of Geometry in Secondary Schools in Rivers State, Nigeria. International Journal of Emerging Sciences, 1(2), 143-152.
29. Umoru, T.S.&Ubom, A.E.B. (2013). The effects of mathematical games and simulations on senior secondary school students' interest in geometry. www.ajol.info/journal/jorind .
30. Yara, P.O.& Otieno, K.O. (2010). Teaching/ learning Resources and Academic Performance in Mathematics in Secondary schools in Bondo District of Kenya. Asian Social Science, 6(12).126-132.

How to cite this article: Clement OI, James AT. Effect of 5Cs on senior secondary school students' achievement in geometry in Makurdi metropolis, Benue state, Nigeria. International Journal of Research and Review. 2019; 6(12):61-68.

******