The International Journal of Engineering and Science (IJES)
|| Volume || 8 || Issue || 9 Series I || Pages || PP 70-80 || 2019 ||
ISSN (e): 2319 – 1813 ISSN (p): 23-19 – 1805

Effect of 5e-Learning Cycle Model on Senior Secondary School Students' Achievement and Retention in Geometry

Dr. Chinyere F. Okafor
Department Of Science Education Chukwuemeka Odumegwu Ojukwu, University Uli Campus, Anambra State, Nigeria.

----------ABSTRACT----------
The study was designed to determine the effect of 5E-Learning Cycle Model (L.C.M.) on SS1 students' achievement and retention in geometry in Onitsha Education Zone of Anambra State. Six research questions were raised and six null hypotheses were tested. The study adopted a quasi-experimental, non-equivalent, control group design. Two co-educational secondary schools were drawn for the study using purposive sampling technique., oneout of the two sampled schools was through balloting assigned to experimental group while the other one to control group. The sample for the study consisted of 180 SS1 students (87 males and 93 females). The 5E-L.C. M. was used as treatment for experimental group while the control was exposed to conventional teaching method. The instrument for data collection was Geometry Achievement Test (GAT) which was a 50 item multiple choice objective type achievement test covering two topics in geometry. This was validated by two experts, from Mathematics Education Department and Measurement and Evaluation, all in Science Education Department, Faculty of Education, Chukwuemeka Odumegwu Ojukwu University. A reliability coefficient of .84 was obtained using Pearson's Product Moment correlation Coefficient (r). The internal consistency of the test items also yielded .84 using Kinder-Richardson Formula 20. Data collected were analyzed using means and standard deviation to answer the research questions. The hypotheses were tested at .05 level of significance using analysis of covariance (ANCOVA). The result of the study revealed that 5E-L.C.M. had significant effect on students' achievement and retention in geometry. Gender was a significant factor in determining students'retention in geometry, though not a significant factor in students' achievement in geometry. The study also revealed that the interaction effect of method and gender on students' achievement and retention of concepts taught during the study was not significant. The findings enable the researcher to conclude that 5E-L.C.M. is effective in improving students' achievement and retention in geometry. Thus, it was recommended among others that 5E-L.C.M. be adopted for effective teaching of mathematics in secondary schools and that state government or their ministries of Education and Professional associations should organize workshops, Seminars and Conferences to train the Serving teachers on the steps involved in the application of 5E-Learnig Cycle Model, incorporating it too in the training of pre-service teachers so as to popularize its use.

***Keywords**:Achievement, Effect, 5E-Learning cycle model, Geometry, Retention, Senior Secondary School.*

Date of Submission: 11-09-2019 Date of acceptance: 29-09-2019

I. INTRODUCTION

Mathematics is a living discipline, vital to the health and prosperity of a nation. The place of mathematics in the life of any nation cannot be overemphasized as it is inextricably linked with the place of development of that nation (Esangbedo, 2014). Mathematics, as a school subject, holds a leading position in the foundation of science and technology without which a nation can never become prosperous and economically independent. As a matter of fact, no nation can develop scientifically and technologically beyond the mathematics component of the school curriculum, Esangbedo concluded. This is because, mathematics plays a crucial role in realizing a nation's vision of swift scientific and technological development. Mathematics is equally a subject of great value because it touches everyday life of every individual. In corroboration to this assertion Kolawole, Oladosu and Ajehinmobi (2013) opined that mathematics is an instrument that facilitates the learning of other formal school subjects and also a very important tool for resolving problem situation in all disciplines. In recognition of the importance of mathematics to national development, the Federal Government of Nigeria made mathematics a compulsory subject for both primary and secondary school students (Federal Republic of Nigeria (FRN), 2004).

Despite the relative importance of mathematics, students' achievement in the subject in both internal and external examinations has remained consistently poor. This abysmal achievement in mathematics in public (Government owned) secondary schools has been a source of worry to concerned public, Stake holders,

Mathematics educators and Government as it is no doubt threatening the foundation of Nigeria's values and vision as a nation. Abakpa (2014) reported that students who obtained credit pass in mathematics in the last ten years in West African Secondary School Certificate Examination were less than 50% of registered candidates each year.Furthermore, reports from West African Examination Council(WAEC) on students' percentage in mathematics in May/June (2007-2015) revealed a steady trend of mass failure of students in mathematics except in 2008, when 57% of students obtained credit passes. Evidence equally abound in empirical researches that students exhibit weakness in so many topics of Mathematics (Anaduaka, 2008, Okafor, 2016). This weakness has, however been found to be more in the area of mathematics referred to as geometry (WAEC Chief Examiners Report,2007- 2015).

Geometry is the branch of mathematics concerned with the properties, relationships and measurement of points, lines, curves and surfaces (Encyclopedia, 2005).Geometry is an important branch of mathematics as it deals with shapes and patterns which are found in the environment. It is linked to many other topics in mathematics involving measurement; which are used daily by many professionals like Land surveyors, Engineers,Architects etc.Geometry has consistently been identified as an area in which candidates avoid and skip attempting questions (WAEC Chief Examiner's Reports, 2007-2015). This calls for the need to concentrate effort to finding teaching methods that promote teaching and learning of mathematics especially geometry so as to increase students' achievement and retention. This search for a better teaching method could be achieved by firstly identifying the causes of this abysmal achievement.

Several researches have been conducted to identify the causes of poor students' achievement in mathematics and to proffer solutions. Idah and Isobaye (2014) noted that the consistent poor achievement stem from unavailability of teaching materials, inadequacy of qualified teachers, lack of proper teaching methodology and lack of students' interest in mathematics. Likewise, Sunday, Akanmu and Fajemidagha (2014) observed that many of the professional mathematics teachers do not use appropriate method in teaching mathematics. Hence, Okafor (2016) proposed interactive mode of teaching as a solution to improve students' achievement; as students would be actively engaged in the learning process. Okafor equally asserted that the conventional method employed by teachers has negative effect, as students develop hatred for the subject, giving rise to persistent failure.This conventional method of teaching according to Okafor has the teacher as the information giver, with the teaching lacking inspiring methods that involve hands-on, minds-on, laboratory activities etc. that reduces students' mass failure in public mathematics examinations and do not empower students to become deep thinkers, who are capable of making new discoveries and solving complex problems. It is a teacher-centered method, which limits students' participation to listening, answering and asking questions and copying notes as the lesson progresses. The method is also one directional and thus discourages teacher-learners and learner-learner interaction. Eze (2011) noted that this method of teaching mathematics is not only ineffective, but also seriously retard the growth of students' mathematical reasoning and problem solving skills, thereby retarding retentive and permanent learning.

Retention in the context of this study refers to the act of absorbing, holding or continuing to hold or have facts or things learned. Retention of learning, therefore is the repeat performance by a learner of the behavior earlier acquired after an interval of time. According to Kundu and Tutoo (2002), retention implies that the knowledge and skills acquired are useful only when it can be stored in the mind and reproduced for application in new situations; implying that for achievement to occur, retention must have taken place. Similarly, Iji (2010) contended that for improvement of retention of learned materials in mathematics, activity-based learning is indispensable as it encourages participation by the learners and acquisition of skills. Retention thus, depends on teaching method adopted by the teacher. Hence, there is need to find better methods of improving students' achievement and retention in mathematics. This work seeks to explore one of such methods like the 5E-(Engage, Explore, Explain, Elaborate and Evaluate) Learning Cycle Model (L.C.M.)

5E-L.C.M. is an integration of various teaching methods as it presents a concept through five pathways that facilitate learning. 5E-Learning cycle model has its foundations in Jean Piaget's theory of knowledge. It is also born from learning constructivism paradigm which is part of Vygotsky's social constructivism and Ausbel's meaningful learning theory (Akar, 2005). 5E-learning cycle model's name comes from the number of its phrases and initials of each phrase. These phrases are Engage/ Enter, Explore, Explain, Elaborate and Evaluate (Hokkanen, 2011).

The 5E-Learning cycle model emphasizes the following:

- Engage / Enter: This is where the teacher engages students in a new concept using short activities or questions that promote curiosity and draw out prior knowledge in order to unveil students' pre-existing knowledge.
- Exploration: In exploration , students not only conduct activities i.e. Laboratory-activities, group discussion , hands on activities , role playing and logic by means of their own pre-existing knowledge but also explore questions and implement preliminary investigations.

- Explanation:Here, the teacher has the opportunity to directly introduce a concept, process or skill so that students can imply their understanding of the concept or track their correct and incorrect knowledge based on the teachers' clarifications.
- Elaborate: In Elaboration, students try to advance their newly structured knowledge into deeper and broader understanding in order to elaborate on their conceptual understanding and skills.
- Evaluation: Students' comprehension and ability are assessed in evaluation and that helps the teacher to monitor how the students' have progressed in accomplishing the educational objectives (Volkmann&Abell, 2003).

The above phases seem not to be followed when conventional method is applied in teaching as usually the exploration phase which involves laboratory activities, hands- on- activities etc. is always ignored, as well as engagement and elaboration phases. Tuna and Kacar (2013) opined that 5E-L.C.M. has the potential in improving students' achievement and motivation in science subjects, while also helping the students retain content information. They found that students taught sciences with 5E-L.C.M. performed better academically than their counterparts taught with conventional method irrespective of gender.

Gender according to Adeney (2011) is a socially ascribed attribute, which differentiates feminine from masculine. A number of studies have verified the influence of gender on mathematics achievement and retention of students. Okafor (2016) found teaching method as a factor that hinder access and retention of girls in Science, technology and mathematics.Reichmann, and Peckham (2002) revealed that girls are less confident about future mathematics achievement and show less confidence in their ability to learn than boys and less willing to approach new materials, implying that male students' achievement was superior to female. Musa (2012), Uloko and Usman (2008) and Vale (2009) likewise reported that males achieve higher than their female counterparts when exposed to some mathematics activities. Although gender related achievement reports above showed disparity, there are still some reports which do not agree with any of them. Abubakar and Eze (2009); Suleiman and Ademola (2010) reported that both male and female achievement are at par, after exposing them to some mathematics activities. This is in line with some studies that divulge that gender plays no significant role in achievement in Science and technology (Anaduaka, 2008; Anaduaka & Okafor, 2013a; Salau, 2000). Salau believes that there is no innate biological and psychological reasons why girls should not do well as boys in mathematics if provided with adequate motivation and good learning environment, and if the right method is adopted.In respect to the above reports on gender parity and disparity in mathematics achievement and retention, there is need for further investigation on gender issue as it relates to mathematics achievement; especially when students are exposed to certain methods like 5E-learning cycle model with emphasis in the teaching and learning of geometry. This work has proposed to explore the effectiveness of 5E-learning cycle model which has been found effective in the accomplishment of educational objective, though in some related science subjects and in other Countries (Balci, 2005; Johnson & Marx, 2009). With the emphasis of 5E-L.C.M. on the learner, it is obvious that learning is an active process occurring within and influenced by the learner as much as by the instructor and school.

However, despite the several research evidences in favor of the learning cycle, there is yet not much awareness of its impact on students' achievement and retention in mathematics in Nigeria. This may well be what Nigerian mathematics Educators need to redeem the prevailing situation of poor academic achievement of students in the subject. It is therefore necessary to verify the effect of the model on the achievement and retention in geometry of Nigerian students.

II. STATEMENT OF PROBLEM

The indispensability of mathematics in the development of our society has been universally acknowledged, although the output of its teaching and learning is still not encouraging. Literature is replete with evidence that teacher's use of ineffective method in mathematics teaching has contributed to students' poor achievement and retention in mathematics, especially in the geometrical components in SSCE. Conventional method, which was revealed to militate against students'participation and engagement in the learning process and results in their poor achievement is still commonly used by mathematics teachers in Nigeria.

There is need therefore; to search for a better method that will demystify mathematics. This is to ensure that students achieve and retain what they are expected to learn in a given lesson for resultant achievement in SSCE. This prompted the quest for an innovative method like the 5E-Learning Cycle Model. The 5E-L.C.M. has evolved and been embraced widely in other countries like Turkey, United States and Internationally. Educators in those countries believe it works so well in improving achievement and retention of all categories of students in science subjects.

However, there is little or no evidence in literature to show the application of 5E-L.C.M. in the learning of geometry, as regards ascertaining its impacts on students' achievement and retention irrespective of gender. Hence, the present study is therefore designed to determine the effect of 5E-L.C.M. on senior secondary school students'achievement and retention in geometry.

Purpose of the Study

The main purpose of this study is to determine the effect of 5E-Learning cycle model on senior secondary school students'achievement and retention in geometry. Specifically, this study sought to determine the:

1. Effect of 5E-learning cycle model on students' mean achievement in geometry.
2. Effect of 5E- learning cycle model on students' mean retention in geometry
3. Influence of gender on students' mean achievement in geometry.
4. Influence of gender on students'mean retention in geometry.
5. Interaction effect of method and gender on mean achievement score of students in geometry
6. Interaction effect of method and gender on mean retention score of students in geometry.

Research Questions

The following research questions guided the study:

1. What is the effect of 5E-learning cycle model on students' mean achievement score in geometry?
2. What is the effect of 5E- learning cycle model on students'mean retention score in geometry?
3. What is the influence of gender on students' mean achievement score in geometry?
4. What is the influence of gender on students' mean retention score in geometry?
5. What is the interaction effect of method and gender on mean achievement score of students in geometry?
6. What is the interaction effect of method and gender on mean retention score of students in geometry?

Research Hypotheses

The following null hypotheses were tested at .05 level of Significance:

Ho_1: There is no significant difference in the mean achievement score of students taught geometry using 5E-learning cycle model and those taught using conventional method.

Ho_2: There is no significant difference in the mean retention score of students taught geometry using 5E-learning cycle model and those taught using conventional method.

Ho_3: Gender has no significant influence on students'mean achievement score in geometry

Ho_4: Gender has no significant influence on students' mean retention score in geometry.

Ho_5: There is no significant interaction effect of method and gender on mean achievement score of students in geometry.

Ho_6: There is no significant interaction effect of method and gender on mean retention score of students in geometry.

III. RESEARCH METHOD

The research design adopted was quasi-experimental design. The study specifically employed non-equivalent control group design. There was no randomization of subjects as intact classes were randomly assigned to experimental and control groups by balloting. The experimental and control groups were pre-tested before treatment and post tested after the treatment was administered. Retention test was administered equally, two weeks after the post test (with the items reshuffled to avoid students'recognition of the test items thus influencing retention). The study was conducted in Onitsha Education Zone of Anambra State with a population of 6975 SSS1 mathematics students of all the 31 public secondary schools in the zone in 2018/2019 Session (Post Primary School Service Commission, Onitsha Zone, 2019). Purposive sampling technique was applied to select two co-educational schools from the six existing in the zone due to their uniformity of streams. The two intact classes of SS1, existing in the sampled schools with 45 students each formed the sample size of 180 students (87 males and 93 females). The instrument was made up of 50 multiple choice items with four options and any correct response attracts two marks, giving a total of 100 marks. It was validated by two experts in mathematics Education and Measurement and Evaluation, all in Science Education Department, Faculty of Education, Chukwuemeka Odumegwu University, Uli- Anambra State.

The pilot testing was conducted in a school located in the study area but not within the sampled schools with 40 students and the reliability coefficient of the instrument was established as .84 using Pearson's product moment correlation coefficient (r) and internal consistency of the test items yielded .84 too using Kinder-Richardson Formula 20.The intact classes in the experimental group was exposed to the treatment using 5E-L.C.M. while the intact classes of SS1 students in the control group was exposed to the treatment using conventional method. The topics covered during the two different treatments were length of arcs, perimeter of sectors and volume of simple solids. The topics were selected from SS1 mathematics scheme of work and that informed the choice of SS1 students for this study, 20 items were of lower order abilities and 30 of the items were of higher order cognitive abilities giving a percentage ration of 40:60 in line with Bloom'sCognitive domain. The treatment lasted for eight weeks and the lessons were presented in the sampled schools with the help of the research assistants, guided by the lesson plans prepared by the researcher (Experimental group have

their lesson plans with the application of 5E-L.C.M. whereas the control group have theirs in line with conventional method).

Analysis of data collected was done using mean and standard deviation to answer the research questions while hypothesis were analyzed using Analysis of Covariance (ANCOVA) at .05 level of significance.

IV. RESULTS

Research Question 1:
What is the effect of 5E-learning cycle model on students'mean achievement score in geometry?

Table 1: Mean and Standard deviation of pre- achievement test and post- achievement test scores of students in geometry

Variable		**Pre test**		**Post test**		
Methods of Teaching	**N**	**x̄**	**SD**	**x̄**	**SD**	**Mean gain**
5E-learning cycle model	90	21.11	6.10	63.51	9.43	42.40
Conventional method	90	23.40	8.17	46.84	9.53	23.44

Table 1 shows that the mean achievement score of students taught geometry using 5E-learning cycle model was 63.51 with a gain score of 42.40, while that of their counterparts taught without the application of 5E-learning cycle model was 46.84 with a gain score of 23.44. This is an indication that 5E- learning cycle model had more effect on students' achievement in geometry than the conventional method.

Hypothesis 1:
There is no significant difference in the mean achievement score of students taught geometry using 5E-learning cycle model and those taught using conventional method.

Table 2: Analysis of Covariance (ANCOVA) of the significant difference in the mean achievement score of students taught geometry using 5E-learning cycle model and those taught using conventional method.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	12955.775[a]	4	3238.944	36.516	.000
Intercept	42656.250	1	42656.250	480.904	.000
Pretest score	421.495	1	421.495	4.752	.031
Groups	12855.088	1	12855.088	144.927	.000
Gender	3.448	1	3.448	.039	.844
Groups * Gender	12.300	1	12.300	.139	.710
Error	15522.536	175	88.700		
Total	576504.000	180			
Corrected Total	28478.311	179			

The result in Table 2 showed that the mean achievement score of students taught geometry using 5E-learning cycle model differed significantly. This was indicated by the calculated F-value of 144.927 which is significant at .000 and is less than .05 set as level of significance. The null hypothesis of no significant difference in the mean achievement score of students taught geometry using 5E-learning cycle model and those taught with conventional method stands rejected. Implying that there is a significant difference in the mean achievement scores of both groups in favor of the experimental group as 5E-learning cycle model increased students'achivement in geometry than the conventional method.

Research Question 2
What is the effect of 5E-learning cycle model on students'mean retention score in geometry?

Table 3: Mean and Standard deviation of post-achievement test and retention test scores of students in geometry

Variable		**Post test**		**Retention**		
Methods of Teaching	**N**	**x̄**	**SD**	**x̄**	**SD**	**Mean gain**
5E-Learning Cycle Model	90	63.51	9.43	65.23	8.71	1.72
Conventional Method	90	46.84	9.53	47.11	9.87	0.27

Table 3, shows the effect of 5E-learning cycle model on students' retention in geometry. Result shows that the group taught geometry using 5E-learning cycle model had a posttest mean achievement score of 63.51 with a standard deviation of 9.43 and retention mean score of 65.23 with a standard deviation of 8.71. The difference between the post test and retention mean score was 1.72. The group taught geometry using

conventional method had a posttest mean achievement score of 46.84 with a standard deviation of 9.53 and retention mean of 47.11 with a standard deviation of 9.87. The difference between the post test and retention mean score was 0.27. However, for each of the groups, the retention mean scores were greater than the posttest mean achievement scores with the group taught using 5E-learning cycle model having a higher retention mean gain. This is an indication that 5E-learning cycle model had more effect on students' retention in geometry than the conventional method.

Hypothesis 2
There is no significant difference in the mean retention scores of students taught geometry using 5E-learning cycle model and those taught using conventional method.

Table 4: Analysis of Covariance (ANCOVA) of the significant difference in the mean retention scores of students taught geometry using 5E-learning cycle model and those taught using conventional method

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	25653.050[a]	4	6413.263	246.848	.000
Intercept	620.423	1	620.423	23.880	.000
Posttest score	10678.253	1	10678.253	411.008	.000
Groups	500.512	1	500.512	19.265	.000
Gender	104.457	1	104.457	4.021	.046
Groups * Gender	7.142	1	7.142	.275	.601
Error	4546.611	175	25.981		
Total	598157.000	180			
Corrected Total	30199.661	179			

The result in Table 4 shows that with respect to students' retention, an F-ratio of 19.27 was obtained with associated probability value of 0.00. Since the associated probability value of 0.00 was less than 0.05 set as level of significance, the null hypothesis (Ho_2), which stated that there is no significant difference in the mean retention scores of students taught geometry using 5E-learning cycle model and those taught using conventional method, was rejected. Thus, inference drawn therefore is that there was a significant difference in the mean retention scores of students taught geometry using 5E-learning cycle model and those taught using conventional method with those taught using 5E-learning cycle model having a higher mean retention gain. This shows that 5E-learning cycle model increased students' retention in geometry than the conventional method.

Research Question 3:
What is the influence of gender on students' mean achievement score in geometry?

Table 5: Mean and Standard deviation of pre-achievement test and post-achievement test scores of male and female students in geometry

Gender	**N**	**$\bar{x}$**	**SD**	**$\bar{x}$**	**SD**	**Mean gain**
Male	87	22.39	7.43	55.45	12.31	33.06
Female	.93	22.13	7.18	54.92	12.90	32.79

Results in Table 5 showed that male students had a pretest mean achievement score of 22.39 with a standard deviation of 7.43 and a posttest mean achievement score of 55.45 with a standard deviation of 12.31. The difference between the pretest and posttest mean achievement score for male students was 33.06. The female students taught geometry had a pretest mean achievement score of 22.13 with a standard deviation of 7.18 and a posttest mean achievement score of 54.92 with a standard deviation of 12.90. The difference between the pretest and posttest mean achievement score for female students was 32.79. However, for each of the groups, the posttest means achievement score was greater than the pretest mean achievement score with the male students having slightly higher mean gain. This is an indication that both male and female students appear to have similar achievement in geometry.

Hypothesis 3

Gender has no significant influence on students' mean achievement score in geometry

The result in Table 2 shows that with respect to students' achievement, an F-ratio of 0.039 was obtained with associated probability value of 0.84. Since the associated probability value of 0.84 was greater than 0.05 set as level of significance, the null hypothesis (Ho_3), which stated that gender has no significant influence on students' mean achievement score in Geometry was not rejected. Thus, inference drawn was that gender has no significant influence on students' mean achievement score in geometry.

Research Question 4:

What is the influence of gender on students' mean retention score in geometry?

Table 6: Mean and Standard deviation of post-achievement test and retention test scores of male and female students in geometry

Variable		Post test		Retention		
Gender	**N**	**$\bar{x}$**	**SD**	**$\bar{x}$**	**SD**	**Mean gain**
Male	87	55.45	12.37	57.21	12.01	1.76
Female	93	54.92	12.90	55.20	13.84	0.28

Results in Table 6 showed that male students had a posttest mean achievement score of 55.45 with a standard deviation of 12.37 and retention mean's score of 57.21 with a standard deviation of 12.01. The difference between the posttest achievement score and retention score of male students was 1.75. The female students taught geometry had a posttest mean achievement score of 54.92 with a standard deviation of 12.90 and retention mean score of 55.20 with a standard deviation of 13.84. The difference between the posttest achievement score and retention score of female students was 0.28. However, for each of the groups, the retention means were greater than the posttest means with the male students having a higher mean retention score.

Hypothesis 4

Gender has no significant influence on students' mean retention score in geometry.

The result in Table 4 also shows that, an F-ratio of 4.02 with associated probability value of 0.046 was obtained with respect to gender and students' retention. Since the associated probability value of 0.046 was less than 0.05 set as level of significance, the null hypothesis (Ho_4), which stated that gender has no significant influence on students' mean retention score in geometry was rejected. Thus, inference drawn therefore is that there was significant difference in the mean retention scores of male and female students taught Geometry. This result shows that gender was a significant factor in determining students' retention in geometry.

Research Question 5:

What is the interaction effect of method and Gender on mean achievement score of students in geometry?

Table 7: Mean and Standard deviation of students overall pre-achievement test and post-achievement test scores in geometry by teaching method and gender

Variable			Pre test		Post test		
Methods	**Gender**	**N**	**$\bar{x}$**	**SD**	**$\bar{x}$**	**SD**	**Mean gain**
5E-Learning Cycle Model	Male	44	20.59	6.87	63.27	8.93	42.68
	Female	46	21.61	5.29	63.74	9.97	42.13
Conventional Method	Male	43	24.23	7.61	47.44	10.08	23.21
	Female	47	22.64	8.67	46.30	9.06	23.66

Results in Table 7 showed that the male students under 5E-learning cycle model had a pretest mean of 20.59 with a standard deviation of 6.87 and a posttest mean of 63.27 with a standard deviation of 8.93. The difference between the pretest and posttest mean was 42.68. The female students under 5E-learning cycle model had a pretest mean of 21.61 with a standard deviation of 5.29 and a posttest mean of 63.74 with a standard deviation of 9.97. The difference between the pretest and posttest mean for the female group was 42.13. Result in Table 7 also shows that the male students taught geometry using conventional method had a pretest mean of 24.23 with a standard deviation of 7.61 and a posttest mean of 47.44 with a standard deviation of 10.08. The difference between the pretest and posttest mean was 23.21. The female students under conventional method had a pretest mean of 22.64 with a standard deviation of 8.67 and a posttest mean of 46.30 with a standard deviation of 9.06. The difference between the pretest and posttest mean was 23.66. However, for each of the groups, the posttest means were greater than the pretest means. Male and female students in 5E-learning cycle model outperformed their counterparts in conventional method.

Hypothesis 5

There is no significant interaction effect of method and gender on mean achievement score of students in geometry.

The result in Table 2 shows that with respect to the interaction between method and gender on achievement, an F-ratio of 0.14 was obtained with associated probability value of 0.71. Since the associated probability value of 0.71 is greater than 0.05 set as level of significance, the null hypothesis (Ho_5), which stated that there is no significant interaction effect of method and gender on mean achievement score of students in geometry, was not rejected. Thus, inference drawn was that, there was no significant interaction effect of method and gender on mean achievement score of students in geometry.

Research Question 6:

What is the interaction effect of method and gender on mean retention score of students in geometry?

Table 8: Mean and Standard deviation of students overall post-achievement test and retention test scores in geometry by teaching method and gender

Variable			Post test		Retention		
Methods	**Gender**	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean gain**
5E-Learning Cycle Model	Male	44	63.27	8.93	65.61	8.39	1.72
	Female	46	63.74	9.97	64.87	9.08	0.27
Conventional Method	Male	43	47.44	10.08	48.60	8.57	1.16
	Female	47	46.30	9.06	45.74	10.84	-1.56

Results in Table 8 showed that the male students under 5E-learning cycle model had a posttest mean of 63.27 with a standard deviation of 8.93 and retention score of 65.61 with a standard deviation of 8.39. The difference between the post test and retention mean score was 1.72. The female students under 5E-learning cycle model had a posttest mean of 63.74 with a standard deviation of 9.97 and mean retention score of 64.87 with a standard deviation of 9.08. The difference between the posttest mean and retention mean for the female group was 0.27. Result in Table 8 also shows that the male students taught geometry using conventional method had a posttest mean of 47.44 with a standard deviation of 10.08 and retention mean score of 48.60 with a standard deviation of 8.57. The difference between the post test and retention mean was 1.16. The female students under conventional method had a posttest mean of 46.30 with a standard deviation of 9.06 and retention mean score of 45.74 with a standard deviation of 10.84. The difference between the posttest mean and retention mean was -1.56. However, for each of the groups, the retention means were greater than the posttest means except for the female group in the conventional method where the retention mean was less than posttest mean. This indicates that male and female students in 5E-learning cycle model retained what was learnt in geometry more than their counterparts in lecture method. The negative sign in front of mean gain value for female under lecture method indicates that they lost some of the knowledge they have acquired in geometry after sometime.

Hypothesis 6

There is no significant interaction effect of method and gender on mean retention score of students in geometry.

The result in Table 4 shows that with respect to the interaction between method and gender on retention, an F-ratio 0.275with associated probability value of 0.60 was obtained. Since the associated probability value of 0.60 was greater than 0.05 set as level of significance, the null hypothesis (Ho_6), which stated that there is no significant interaction effect of method and gender on mean retention of students in geometry, was not rejected. Thus, inference drawn was that there was no significant interaction effect of method and gender on mean retention score of students in geometry.

V. DISCUSSION OF FINDINGS

The findingsof the study indicates that 5E-learning cycle model has more effect on students' achievement in geometry than the conventional method. With the test of hypothesis one, as shown in Table 2, it was found that the observed difference in the mean achievement scores of both groups was significant. This implies that 5E-learning cycle model significantly enhanced students' achievement in the units of geometry studied than the conventional method. This result is in line with the finding of Adeney (2011) and Okafor (2016), that teaching method effect the quality of output of instruction in Science, Technology and Mathematics. 5E-learning cycle model by its structure provided opportunities for active participation of students in the experimental group. It was therefore noticed that the model apart from its superiority over the conventional method proved to be an effective teaching method on its own, for an improvement in the teaching and learning of mathematics; considering the relatively high mean score of 63.51 made by the experimental group students.

This goes to support the position of Anaduaka (2008) that combination of methods (which 5E-learning cycle model portrays) will be effective in realizing the goal of learning.

The result of the analysis on the effect of 5E-learning cycle model on students' retention in geometry reveals that 5E-learning model has more effect on students' retention in geometry than the conventional method. Furthermore, the difference between the mean retention score of the experimental and control group was 18.12. When this observed difference was tested for significance as shown in Table 4, the difference was found to be significant. This clearly indicates that 5E-learning cycle model was useful in helping students retain what they were taught in geometry than the conventional method which is deficient in meeting learners' need. This result supported Iji(2010), who discovered that the ability to remember takes place more effectively when experiences are passed across to the learner via an appropriate instructional method. This finding also agrees with Okafor (2009) who asserted that increase in knowledge depends on the ability to remember, Since 5E-learning cycle model helps students to retain learned concepts, it equally increases their knowledge.This becomes obvious with this finding that 5E-learninc cycle model enable students to have deeper understanding of what they are taught and this have the potential to dramatically change the way students view mathematics. It is therefore evident from these results that 5E-learning cycle model enhanced greatly students' achievement and retention in geometry.

This study also revealed that gender has no significant influence on students' achievement in geometry as shown in Table 2, though male students have slightly higher mean gain than their female counterparts. The finding is in consonance with that of Anaduaka and Okafor (2013), Suleiman and Ademola (2010) and Salau(2000), in which they reported that students' achievement towards mathematics was significantly independent of sex. However, it would appear to contradict the findings of Musa (2012) and Vale (2009) who reported statistical significant effect of gender on students' achievement in mathematics. They noted that male students' achieve higher than their female counterparts when exposed to some mathematics activities. Some studies on gender influence on students' achievement in science were of the opinion that boys are more exposed to scientific activities very early in life than girls. Hence they are encouraged to enter for science related professions like Engineering and Technology while the girls go for biology, home economics and other allied subjects. Collaborating Ogunleye (2002) noted that during the science Education reforms in 1980's, it became evident that both the pedagogical practices and the presentation of science in many classrooms reflected social and cultural stereotypes which were masculine and curriculum better suited to boys only. Though, the result of this study has shown that giving equal science experience and unlimited access to education for females, girls would as well achieve in physical sciences like Chemistry, Physics and Mathematics.

Evidence of this study on the influence of gender on students' retention in geometry shows that there was significant difference in the mean retention score of male and female students taught geometry in favor of males as revealed in Table 4. This implies that gender was a significant factor in determining students' retention in geometry. This is contrary to Anyor and Iji (2014) and Nneji (2013) who noted that gender was an insignificant factor in students' retention of algebra and quadratic graphs taught to them as they recorded healthy competition between genders. However, it is in line with the finding of Asante (2010), Fennema (2000) and Ogunkunle (2007) which show significant gender differences in retention. They noted that male students showed greater retention of learned concepts than their female counterparts. This calls for urgent attention as Okafor (2009) noted that there is no tool for development more effective than the education of girls. Collaborating Ogunkunle (2007) noted that for any nation to achieve sustainable and rapid economic development, it is imperative the females participate actively in science and technology activities. This implies that women's educational status in any nation correlates to its level of development. Therefore, there is need for bridging the gender gap in students' retention of learned concepts.

The interaction effect of method and gender on mean achievement score of students in geometry was not significant as shown in Table 2, as both male and female students achieved equally on application of 5E-learning cycle model. The male and female students taught geometry with 5E- learning cycle model performed better than their counterparts taught with conventional method. This is an indication that 5E-learning cycle model minimizes gender differences in achievement. However the result contradict the findings of Abiam and Odok (2006) and Akinsola (2007); who reported that female are weaker in geometry area of mathematics activities. This finding also corroborates with the findings of Vale (2009) and Okafor (2016) who found no significant interaction between instructional method and gender on students' achievement. Therefore one would rightly say that 5E-learning cycle model is not gender biased.

The interaction effect of method and gender on students' retention in geometry was also not significant as exposed in Table 4 as both male and female students retained learned concepts equally. This is in line with the findings of Iji (2010) that reveal no significant difference between retention mean scores of male and female students in experimental-control groups confirming that the interaction effect of method and gender on students' retention is not significant. This study is also in alliance with the assertion that gender difference may exist but a good teaching method should be capable of neutralizing the difference (Okafor, 2016). Likewise changing how

we teach is hard to do, but when it is done, knowledgeable, confident students will be the end products. Though the cost of change is high but the investment is essential and definitely our students deserve nothing less.

VI. CONCLUSION

The following conclusions were drawn from the findings;

1. There was a significant difference in the mean achievement scores of students taught geometry using 5E-learning cycle model and those taught using conventional method with those taught using 5E-learning cycle model having higher mean achievement gain.
2. There was a significant difference in the mean retention score of students taught geometry using 5E-learning cycle model and those taught using conventional method, with those taught using 5E-learning cycle model having a higher mean retention gain.
3. Gender has no significant influence on students' mean achievement score in geometry.
4. There was a significant difference in the mean retention scores of male and female students taught geometry using 5E-L. C. M. in favor of the males.
5. There was no significant interaction effect of method and gender on mean achievement score of students in geometry.
6. There was no significant interaction effect of method and gender on mean retention score of students in geometry.

RECOMMENDATIONS:

Sequel to the results of the study, the following recommendations were made:

1. The government should advocate that 5E-learning cycle model should be adopted by all mathematics teachers for effective teaching and learning of mathematics in secondary schools.
2. Curriculum planners should ensure that the curriculum of teacher education in the country should include 5E-learning cycle model, so as to popularize its use.
3. School administrators should organize workshops and seminars internally to enable teachers interact and learn from each other the art of teaching through 5E-learning cycle model and keep abreast with different ideas that evolve.
4. Teachers should be encouraged to belong to professional associations like the Science Teachers Association of Nigeria (STAN), Mathematical Association of Nigeria (MAN) etc. whereby they will have opportunity of interacting with experts in the field and thus update and enrich their knowledge base.

REFERENCES

[1]. Abakpa,B.O. (2014). Mathematics teachers' perception of instructional strategies for developing mathematics creativity among secondary school students. Journal of Issues on Mathematics 16(2), 180-192.

[2]. Abiam, P.O. & Odok,J.K. (2006). Factors affecting students' achievement in different branches of secondary school mathematics. Journal of Educational and Technology, (1), 161-168.

[3]. Abubakar, R.B. & Eze, F.B. (2009). Female students' academic performance in mathematics at federal college of education technical Omoku. International Journal of Social and Policy Issues,6(1& 2),48-53.

[4]. Adeney, O. A.A. (2011). Is gender a factor in mathematics performance among Nigerian senior secondary students with varying school organization and location? International Journal of Mathematics ,French and Technology, 3, 17-21.

[5]. Akar, E. (2005). Effectiveness of 5E-learning cycle model on students' understanding of acid-base concepts. Dissertation Abstract International. www.encyclopedia.com/doc/la/- 1723767.html.

[6]. Akinsola, M.K. (2007). Mastery learning , co-operative mastery learning strategies and students'achievement in integrated science. Department of teacher education , University ofIbadan, Nigeria. Retrieved from http//www.ipn.uni-kiel.del/ projket/ esera/book/1132.

[7]. Anaduaka, U.S. (2008). Effect of multiple intelligence teaching approach on students' achievement andinterest in geometry; PhD Dissertation, Nsukka: University of Nigeria.

[8]. Anaduaka, U.S. and Okafor, C.F. (2013a). Poor performance of Nigerian students in mathematics insenior secondary certificate examination (SSCE). What is not working? Journal of Research in National Development, 11(2),1-5.

[9]. Anyor, J.W. and Iji, C.O. (2014). Effect of integrated curriculum delivery strategy on secondary school students' achievement and retention in algebra in Benue State, Nigeria. ABACUS 29(1), 83-96.

[10]. Asante, K.O. (2010). Sex differences in mathematics performance among senior high students in Ghana. Retrieved fromhttp://www.faqs.org/periodicals/201012/2187713381.htm#xzz//5vDOTS

[11]. Balci, S. (2005). Improving the 8th grade students' understanding of photosynthesis and respiration in plants by using 5E-learning cycle and conceptual change text. Unpublished Master's Thesis. Ankara: Middle East Technical University.

[12]. Encarts Dictionary Tools (2005). Encarts reference library DVD. Multimedia Encyclopedia, Atlas and Research Tools.

[13]. Esangbedo, P.O. (2014). Mathematics education as a fundamental requirement for national development and transformation. ABACUS, 39(1), 297-306.

[14]. Eze,,J.E.(2011). A practical approach to effective teaching and learning of mathematics in normadic schools. Abacus, the Journal of Mathematics Association of Nigeria, 36(1), 129-138.

[15]. Fennema, E. (2000). Gender and mathematics , what is known and what I wish was known. Retrieved, http://www.wcer.wisc.edu/archieve/nise/News.

[16]. Federal Republic of Nigeria (2004). National Policy on education (4th Edition). Lagos: NERDC Press.

[17]. Hokkanen, S.L. (2011). Improving students' achievement , interest and confidence in science through the implementation of 5E-Learning Cycle in the middle grades of an urban school. Ms Thesis Bozema: Montana State University.

[18]. Idah, H. & Isobaye, G. (2014). A review of studies in mathematics education in Efik speaking communities of Niger Delta, Nigeria. Journal of Issues on Mathematics, 16(2), 52-63.
[19]. Iji, C.O. (2010). Actualizing mathematics achievement and retention among primary school pupils using interactive logo programming package. Abacus, Journal of the Mathematical Association of Nigeria, 35(1), 80-90.
[20]. Johnson, C & Marx,.S. (2009). Transformative professional development: A model for urban science education reform. Journal of Science Teacher Education. 20,113-134.
[21]. Kolawole, E.B., Oladosu, C.I. & Ajehinmobi, O. (2013). Comparability of effectiveness of problemsolving methods on learners performance. Mathematics Unique Journal of Educational Research , 1(2), 012-019.http://www.uniqueresearchjournal.org/IJER
[22]. Kundu, C.L. & Tutoo,D.N. (2002). Educatioanl Psychology. New Delhi: Sterling Publishers Ltd.Musa, M. B. (2012). Developing Students' geometric thinking through playful activities. Journal of Issues on Mathematics, 15, 43-48.
[23]. Nneji, S.O. (2013). Effect of pola george's problem solving model on students' achievement and retention in Algebra. Journal of Educational and Social Research. MCSER Publishing, Rome- Italy 3(6), 41-48.
[24]. Ogunleye, A.O. (2002). Science education reforms and its implications for the professional development of science teachers in Nigeria. In Matt,A.G.Akale (Ed). Proceedings of the 43rd Annual Conference of STAN.169-177.
[25]. Ogunkunle,R.(2007) . Effect of gender on mathematics achievement of students in constructivist and non-constructivist group in secondary schools. ABACUS; 32(1), 41-50.
[26]. Okafor, C.F. (2009). The effect of students' participation in test construction on their achievement and retention in some geometrical concepts. Unpublished Ms Thesis, Nsukka: University of Nigeria.
[27]. Okafor, C.F. (2016). Effect of improvised geometric manipulative on senior secondary school Students' achievement in geometry. COOU Research Journal of Scientific Educational and Allied Disciplines, 1(1), 39-46.
[28]. Reichmann D.B & Peckham, P. (2002). Gender differences in attributions for success and failure situations across subject areas. Journal of Educational Research, 81,120-125.
[29]. Post Primary School Service Commission (2019). Statistics of public secondary school students performance in WAEC/NECO Examinations. Awka Planning, Research and Statistics Department.
[30]. Salau, M.O. (2000). Options in sustaining mathematics as the language of science and technology in the 21st century. In G.C. Obodo (Ed). 37th Annual Conference of Mathematics Association of Nigeria, 41-60.
[31]. Suleiman, R. Gamagiwa , K.B, Ademola Q.M. (2010). Effect of E-learning method of teaching mathematics : Implication on attainment ofbasic science goals and objectives. The Journal of the Mathematics Association of Nigeria, 35 (1) 91-96.
[32]. Sunday, A. Alkanmu, M.A. Fajemidagha, M.O. (2014). Effect of target task mode of teaching on Students' performance in geometrical construction.ABACUS, Journal of the MathematicalAssociation of Nigeria, 39(1), 33-42.
[33]. Tuna, A. Kacar, A. (2013). The effect of 5E-learning cycle model in teaching trigonometry on Students, academic achievement and the permanence of their knowledge. International Journal on New Trends in Education and their Implications, 4(1), 73-86.
[34]. Uloko, E.S. Usman, K.O. (2008) Effect of ethno mathematics teaching approach and interest on Students' achievement in locus. Benue Journal of Research in Science and Science Education, 1(1), 81-91.
[35]. Volkmann, M.J. Abell, S.K. (2003). Seam less assessment. Sciences and children. Retrieved from http: / learning center, nshta org/my-learing –centre/my-library. Aspx. Type-ja
[36]. Vale,C.(2009). Trend and factor concerning gender and mathematics in Australia.Retrieved from http/www.faqs. org/periodical.
[37]. West Africa Examination Council (2007 -2015). Chief Examiners, Report (Nigeria) SSCEMay/June Examinations.

Dr. Chinyere F. Okafor" Effect of 5e-Learning Cycle Model on Senior Secondary School Students' Achievement and Retention in Geometry" The International Journal of Engineering and Science (IJES), 8.9 (2019): 70-80