ENHANCING ACHIEVEMENT AND RETENTION IN GEOMETRY OF SENIOR SECONDARY SCHOOL STUDENTS USING FOUR-MODE APPLICATION TECHNIQUES IN JOS METROPOLIS, PLATEAU STATE, NIGERIA

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Abstract:	`The study researched on "Enhancing Achievement and Retention in Geometry of Senior Secondary School Students Using Four-Mode Application Techniques in Jos Metropolis, Plateau State, Nigeria". Quasi-experimental, non-randomized pre-test post-test control group design was adopted for the study. The study population consisted of 3,631 with a sample size of 141 Senior Secondary one (SS1) students. Through a purposive sampling technique, two out of 42 co-educational public secondary schools were selected in the study area and randomly assigned as experimental and control groups. The experimental group was taught some selected topics in Geometry using 4MAT while the control group was taught the same Geometry topics using the conventional method. Four research questions and their corresponding hypotheses were asked and tested respectively. Instruments of study, Geometry Achievement Test (GAT) and Geometry Retention Test (GRT) were validated by experts and trial-tested using 30 SS1 students, and a Kudder-Richardson formula 20 reliability co-efficient of 8.0 was obtained. Research questions were answered using mean and standard deviation while inferential statistics, ANCOVA, was used to test the hypotheses at 0.05 level of significance. Results of the study indicated a significantly higher increase in both achievement and retention in Geometry of students in the experimental group more than their counter parts in the control group. The study also found that 4MAT was not gender bias in terms of students' achievement and retention in Geometry. The study recommended among others, that 4MAT instructional model should be used for teaching difficult concepts in Mathematics since its use has been found to enhance students' achievement and retention.
Key Words:	Geometry, Four-Mode Application Techniques, Achievement, Retention Senior Secondary.

Introduction

Throughout history Mathematics has played an intrinsic role in the of intellectual development of man as can be seen in the role it has played both in its practical application in many aspects of human activities and in the development of other areas of learning and academic subjects. There is hardly any area of human endeavor that is devoid of practical application of mathematics. The contribution of Mathematics to national development can be seen in many areas such as science and technology, business and industry, banking, building and constructions. Mathematic is of central importance to modern society. This is because the knowledge of Mathematics has been known to play a very important role in the development of society as it has been used to solve various problems that have socio economic and socio-scientific implications. It provides the vital underpinning of the knowledge economy. Mathematics have been the back bone of several human endeavors notably science and technology, which are the life wires of national development (Methkal & Algani, 2022). The knowledge and application of Mathematics have brought great improvement in many areas of human development including but not limited to communication, accommodation, production and recreational activity (Rohid and Rusmawati (2019). Mathematics is the science of logic of shape, quantity and arrangement. Mathematics seeks out patterns, formulates new conjectures and establishes truth by rigorous deductions from appropriately chosen axioms and definitions ("Mathematics - What Is Mathematics," 2024). Mathematics, which is not just the language of science but the foundation upon which science

is built, is a vast subject broadly divided into three main branches, namely Arithmetic, Algebra and Geometry.

The word 'Geometry' is derived from an ancient Greek word 'geometron'. 'geo' meaning 'Earth' and 'metron' meaning "measurement". Hence, geometry means earth measurement. Thus, Geometry is a vital branch of Mathematics that deals with the study of sizes, shapes, positions, angles and dimension of things (Jonah & Dogo, 2019). The word geometry was coined by early Mathematicians who synthesized Mathematics into a discipline to refer to the sciences of the properties and relations of lines, figures, angles, surfaces and solids (Iji, Ogbole & Uka, 2014). Furthermore, geometry is said to be a science of space involving describing and measuring figures, theory of ideas and methods by which one can construct and study idealized model of the physical world as well as other real-world phenomenon. Thus, we have Euclidean projectile, hyperbolic and elliptic geometry. Also included are topology (non-Euclidean) and combinational geometry. Furthermore, geometry as an aspect of Mathematics involves ideas for example graphs, bar charts and histogram. Geometry is a meeting point between Mathematics theory and Mathematics as model resources (Iji, *et al*. 2014).

Geometry occupies a unique position in the secondary school Mathematics curriculum, because it plays a major role in other mathematical fields such as topology, the study of various different spaces and trigonometry. Geometry provides many foundational skills and helps to

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build the thinking skills of logic, deductive reasoning, analytical reasoning and problem solving. Understanding geometry gives students a far better understanding of numerous branches of Mathematics as well as the skills required to solve geometrical mathematical problems in a variety of different settings ("Definition of Geometry – FutureSchool," 2017). However, it is has observed that the teaching and learning of geometry as a major branch of Mathematics is in dismal state which often results in poor achievement (Paula and Makondo, 2020). Researchers have attributed many reasons for students' poor achievement in mathematics. These include: inadequate instructional materials, lack of Mathematics laboratories, and lack of interest by the students or teachers' wrong instructional approaches or strategies, gender stereotypes, among many others (Sergei, Arcadii and David (2019).

Furthermore, researchers have found that the teaching and learning of geometry as a major branch of Mathematics are in dismal state which often results in poor achievement. They are of the view that students find it difficult to understand geometry and stressed that the teaching of geometrical contents as being practiced today using the conventional teaching strategy has been found to be infective, as it not been able to meet learners needs considering the recurring mass failure of students in Mathematics (Paula & Makondo, 2020). Sergei, Arcadii and David (2019), posits that some of the persistent poor achievement in geometry topics may be as a result of lack of interest by the students or teachers' wrong instructional approaches or strategies among many others. Therefore, it has become necessary to explore innovative and appropriate instructional approaches that will engage students with the cognitive task that could influence them to learn Mathematics successfully. The use of Four-Mode Application Techniques may help students to develop better understanding of Geometry which could lead to improved achievement and retention in Mathematics.

Literature Review

Four-Mode Application Techniques (4MAT)
4MAT was developed and published by Bernice McCarthy in 1980. It is an instructional model that provides a systematic approach to organizing and delivering instruction in a manner that addresses the learning styles and hemispheric preferences of students (McCarthy, 1987). Inherent in the 4MAT are two major premises: one is that people have major learning styles and hemispheric (right mode and left mode) processing preferences; secondly, teachers should design and use multiple instructional strategies in a systematic framework to teach to these preferences in order to improve teaching and learning. Furthermore, 4MAT is a conceptual brain dominance processing preferences framework of teaching and learning that is based directly on the works of David Kolb (experiential learning theory) (McCarthy, 1987). 4MAT identifies four interrelated learning styles based on how individuals perceive and process new information. Its premise is that individuals learn primarily in one of the four different, but complementary ways based on how they perceive and process information (McCarthy & McCarthy, 2006). McCarthy identified these four learning styles as Imaginative Learners (Type One Learners); Analytic

Learners (Type Two Learners); Common Sense Learners (Type Three Learners); and Dynamic Learners (Type Four Learners), based on Kolb's experiential learning theory that is, divergent, assimilative, convergent and accommodative learning styles respectively. These four types of learners will learn effectively if they are taught how to learn like each other at the same time in order to make learning successful. When using the model, teachers can implement a number of steps in their teaching. The eight steps involved in 4MAT include; connect, explain, image, inform, practice, extend, refine and perform. As the lesson goes on, instructions that can stimulate the function of the two hemispheres of the brain are introduced into the lesson. The learning activities are structured in a way that will address the eight steps as proposed by the model.

Additionally, in addressing the various learning styles, the 4MAT system also incorporates elements of Brain Based learning- specifically the different ways the right and left modes (right and left hemispheres) of the brain process information: The left mode is serial, analytic, rational, and verbal. It has a systematic mode of processing with analysis and planning as key strategies and solves problems sequentially by looking at the parts. The right mode, on the other hand is global, visual, and holistic, able to see patterns and connections. Its processing mode seeks patterns and solves problems by looking at the whole picture, with key processing strategies as Intuition, beliefs, and opinions. The unique quality of 4MAT that combines the accommodation of students divers learning styles and Brain research on how the students process information in a learning situation produce the double advantage of making instruction more meaningful to the learners and also stimulated active functioning of the learner's two brain hemispheres(Left and right modes). Therefore, the engagement of 4MAT model in teaching could lead to better retention and achievement. To this effect, this study sought to find out if 4MAT model could enhance the achievement and retention of students in Geometry owing to the nature of students' activities involved in it.

Achievement may be seen as something important that someone succeed in doing by his own effort. Similarly, academic achievement is described as the gain in knowledge of students as a result of participating in a learning schedule. It is referred to as an individual's performance after a specified course of instruction and a measure of achievement in a specific field of study (Abakpa, 2011). Academic achievement could therefore be a yardstick for ascertaining the capabilities of a student from which his overt, covert and inherent or unrevealed abilities could be inferred. Furthermore, academic achievement is generally used to determine how well an individual is able to assimilate, retain, recall and communicate his knowledge of what has been learnt (Munawaroh, 2017). In the researcher's view, efforts to tackle the problems of poor achievement in Mathematics may prove abortive if students' retention ability is not taken into consideration. Therefore, this study also aimed at finding out if Four-Mode Application Techniques teaching strategy could improve on students' retention in geometry. Retention is described as the learners' abilities to transfer knowledge earlier learned or learners' abilities to repeat achievement or behavior earlier acquired after some time

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(Denise and Jonathan (2016). Therefore, the Mathematics concept needs to be presented to the learner through a method that touches their sub consciousness which can trigger quick recalling of the concept being taught or learned. It is generally believed that the more the human senses are brought into interaction during the learning process, the greater the retention capacity of the learner. Gupta 2022), states that probably the none use of innovative strategies that involve active student participation could be the main cause of poor retention. In this regard, the use of Four- Mode Application Techniques may help students to develop better understanding of Geometry which may lead to improved retention and achievement in the subject. Adeosun (2019), emphasize that retention by students in mathematics may be influenced by gender.

Gender could be referred to as a range of characteristics used to distinguish between male and female, particularly in the cases of men and women .It is a construct that is used to differentiate male from female (boys from girls) and a biological difference between male and female creation (Gambari, Folade & Adegbenro, 2014). Iji, Omenka and Akpan (2017) reported that gender has a significant influence on students' achievement. Their study found a significant difference among male and female students in Mathematics achievement tests. However, Gmbari, *et al.* (2014), found no significant differences among male and female students in Mathematics achievement tests..

Aliustaoğlu and Tuna (2018), carried out a study on "Influence of 4MAT Model on Academic Achievement and Retention of Learning in Transformation Geometry". The purpose of the study was to determine the influence of 4MAT model on the teaching of "Transformation Geometry" – a subject included in secondary school seventh grade Mathematics curriculum – on students' academic achievement and retention of learning. The pretest-posttest control group quasi-experimental design was used in the study. The study took 3 weeks. This teaching period was determined by considering the time recommended in the textbook and the time allocated for activities in other studies on 4MAT model. In this period, experimental group students were taught by lesson plans and activities based on 4MAT model. Control group students were taught by the 7th grade textbook of the Ministry of National Education in the same period. The research sample consisted of 61 seventh grade students living in a northern province of Turkey. The Transformation Geometry Knowledge Test developed by the researcher was used as data collection tool. This test was used in this study as a pre-test at the beginning of the teaching process, as a posttest at the end of the teaching process and as retention test one month after the teaching process. The present study concluded that there was a significant difference in favor of the experimental group between the experimental group students and the control group students in terms of academic achievement and retention of learning in the learning of transformation geometry subject. It was seen that 4MAT model was more effective in the teaching of transformation geometry in comparison to textbook-based teaching. This study and the current study are similar in having 4MAT as the method of instruction, geometry as the subject area of study; research

design and achievement and retention in geometry as dependent variables of study. The two studies however, differ in terms of location, study population and method of data analysis. Therefore, this study aimed at finding out if the use of Four-Mode Application Techniques instructional model could enhance senior secondary one students' achievement and retention in Geometry.

The specific objectives of the study were to:

I. Determined whether SS1 students could improve on their achievement in Geometry due to the use of Four Mode-Application Techniques (4MAT).
II. Ascertained whether SS1 students could improve upon their retention in geometry due to the use of Four-Mode Application Techniques (4MAT).
III. Found out if there were differences in achievement of male and female SS1 students in Geometry due to the use of Four-Mode Application Techniques (4MAT).
IV. Found out if there were differences in retention of male and female SS1 students in Geometry due to the use of Four-Mode Application Techniques (4MAT).

Research Questions
The following research questions were asked as guide to the study:

I. What are the mean achievement scores of students taught Geometry using Four-Mode Application Techniques (4MAT) and those taught using conventional method?
II. What is the mean retention score of students taught Geometry using Four-Mode Application Techniques (4MAT) and those taught using the conventional method?
III. What are the mean achievement scores of male and female SS1 students taught Geometry using 4MAT?
IV. What are the mean retention scores of male and female SS1students taught Geometry using 4MAT?

Research Hypotheses
The following hypotheses were formulated and tested at 0.05 level of significance.

I. There is no significant difference in the mean achievement scores of SS1 students taught Geometry using 4MAT and those taught with conventional method.
II. There is no significant difference in the mean retention scores of SS1 students taught Geometry using 4MAT and those taught with conventional method.
III. There is no significant difference in the mean achievement scores of male and female SS1 students taught Geometry using 4MAT
IV. There is no significant difference in the mean retention scores of male and female SS1 students taught Geometry using 4MAT

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Research Methodology

The design deployed for the study was Quasi-experimental design, specifically the pre-test, posttest, non-randomized, non-equivalent control group design. The two schools sampled out of 42 and assigned as experimental and control groups schools were co-educational and were located in different schools in Jos North and Jos South LGAs that make up the Jos Metropolis.

The study involved one hundred and forty one (141) senior secondary one (SS1) students selected from a population of 3,631 through a multi-staged sampling technique. Instruments for data collection were the Geometry Achievement Test (GAT) and Geometry Retention Test (GRT). The GAT had 38 multiple-choice objective questions (with options, A.B.C.D.). 4MAT and Conventional methods of instruction were used in the experimental and control groups respectively to teach Geometry to SS1 students for three weeks. The GAT was administered to students in both groups as pre-test before treatment and as post-test after treatment. The GAT had a marking scheme of 1mark for each correct answer. The instruments were validated by five experts, two Mathematics educators, two experts in measurement and evaluation from Joseph Sarwuan Tarka University Makurdi, Benue State and one Mathematics teacher from BSU technical secondary school. Their useful recommendations on both face and content validity trimmed the GAT question items from 50 to 38. The instrument was tried-tested on 30 SS1 students of ECWA secondary school North Bank, Makurdi. Using Kudder-Richardson formula 20, the reliability coefficient obtained for the GAT was 0.80. The GRT was administered two weeks after the administration of the post-GAT. The GRT content was the same as that of the GAT. The only difference between the two was in the numbering of the question items. Research questions were answered using mean and standard deviation. The hypotheses were tested at 0.05 level of significance using Analysis of Covariance (ANCOVA). The choice of ANCOVA was because of the nature of the design of the study that is, Quasi experimental (specifically non-equivalent control-group design). This is because the design permits the use of pre-test, which acts as covariate, therefore, ANCOVA helps to establish the homogeneity or equivalence of the two groups before treatment. Besides this, since intact classes were used for the study, ANCOVA also helps to increase the power of the test because of error that may occur because of non-randomization of the subject of the study (i.e. Type1 error was reduced). The decision rule here was, reject Ho of the p-value is less than 0.05 and do not reject Ho if otherwise.

Results

The study results are presented according to research questions and their corresponding hypotheses.

Research question 1

What are the mean achievement scores of SS1 students taught Geometry using Four Mode-Application Techniques (4MAT) and those taught using conventional method?

TABLE 1: MEAN AND STANDARD DEVIATIONS OF GEOMETRY ACHIEVEMENT SCORES OF SS1 STUDENTS IN EXPERIMENTAL AND CONTROL GROUPS

Groups	N	Pre-GAT Mean	SD	Post-GAT Mean	SD	Mean Gain
Experimental	78	6.96	4.75	28.54	5.41	21.58
Control	63	5.56	4.07	10.25	6.44	4.69
Mean Difference		1.40		18.29		16.89
Total	141					

Results from Table 1 revealed that the pretests mean achievement scores of experimental group is 6.96 with standard deviation of 4.75 and that of control group is 5.56 with standard deviation of 4.07. The mean difference between the two groups at pretest is 1.40. The small difference noticed between the groups at pretest means that achievement in Geometry of both groups before commencements of treatment were similar. The posttest mean achievement scores for the experimental group is 28.54 with standard deviation of 5.41 while the posttest mean achievement scores for the control group is 10.25 with standard deviation of 6.44. The mean difference between the two groups at posttest is 18.29. The large difference noticed between the two groups at posttest could be an indication of the effect of 4MAT on achievement in Geometry of the experimental group. Also, the mean gain of experimental group is 21.58 while that of control group is 4.69 giving a mean gain difference of 16.89 in favor of the experimental group. The implication of this result is that SS1 students taught Geometry using 4MAT gain higher achievement in Geometry than SS1 students taught Geometry using conventional method. **Hypothesis 1**

There is no significant difference in the mean achievement scores of SS1 students taught Geometry using 4MAT and those taught using conventional method.

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TABLE 2: ANCOVA RESULTS OF ACHIEVEMENT SCORES OF SS1 STUDENTS IN EXPERIMENTAL AND CONTROL GROUPS

Dependent Variable: Post Geometry Achievement Test

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	11828.486[a]	2	5914.243	175.734	.000
Intercept	14874.756	1	14874.756	441.983	.000
Pre-GAT	176.985	1	176.985	5.259	.023
Group	**10930.478**	**1**	**10930.478**	**324.784**	**.000**
Error	4644.337	138	33.655		
Total	74972.000	141			
Corrected Total	16472.823	140			

a. R Squared = .718 (Adjusted R Squared = .714)

Results from Table 2 shows that the table values for groups is F(1, 138) =324.78, Sig =0.00 =p. Since p <0.05 level of significance, the null hypothesis is rejected. This means that there is significant difference between the mean achievement scores of SS1 students taught Geometry using 4MAT and those taught using conventional method. This result implies that SS1 students taught Geometry using 4MAT improved on their achievement in Geometry more than SS1 students taught Geometry using conventional method

Research questions 2

What is the mean retention score of SS1students taught Geometry using Four Mode Application Techniques (4MAT) and those taught using the conventional method?

TABLE 3: MEAN AND STANDARD DEVIATIONS OF SS1 STUDENTS RETENTION SCORE IN EXPERIMENTAL AND CONTROL GROUPS

Groups	N	Post-GAT Mean	SD	GRT Mean	SD	Mean Gain
Experimental	78	28.54	5.41	27.13	4.75	-1.41
Control	63	10.25	6.44	9.94	2.99	-0.31
Mean Difference		**18.29**		**17.19**		**1.1**
Total	141					

Results for Table 3 revealed that the posttests mean achievement scores of experimental group is 28.54 with standard deviation of 5.41 and that of control group is 10.25 with standard deviation of 6.44. The mean difference between the two groups at posttest is 18.29. The large difference noticed between the two groups at posttest is due to the effect of 4MAT on achievement in the experimental group. At retention level, the experimental group mean retention score is 27.13 with standard deviation of 4.75 while the control group mean retention score is 9.94 with standard deviation of 2.99. The mean difference between the two groups at retention level is 17.19 in favor of the experimental group. Also, the mean gain of the experimental group is -1.41 while that of the control group is -0.31, giving a mean gain difference of 1.1 in favor of the experimental group. The implication of this result is that SS1 students taught Geometry using 4MAT gain more retention in Geometry than SS1 students taught Geometry using conventional method.

Hypothesis 2
There is no significant difference in the mean retention scores of SS1 students taught Geometry using 4MAT and those taught with conventional method.

TABLE 4: ANCOVA RESULTS OF GEOMETRY RETENTION SCORES OF SS1 STUDENTS IN EXPERIMENTAL AND CONTROL GROUPS

Dependent Variable: Geometry Retention Test

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	10835.106[a]	2	5417.553	425.330	.000
Intercept	1710.645	1	1710.645	134.302	.000
Post-GAT	534.719	1	534.719	41.981	.000
Group	**1257.340**	**1**	**1257.340**	**98.713**	**.000**
Error	1757.745	138	12.737		
Total	65916.000	141			
Corrected Total	12592.851	140			

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a. R Squared = .860 (Adjusted R Squared = .858)

Results from Table 4 shows that the table values for groups is $F_{(1, 138)} = 98.71$, Sig $= 0.00 = p$. Since $p < 0.05$ level of significance, the null hypothesis is rejected. This means that there is significant difference between the mean retention scores of SS1 students taught Geometry using 4MAT and those taught Geometry using conventional method. The implication of this result is that learning Geometry using 4MAT improved SS1 students' retention in Geometry more than learning Geometry using the conventional method.

Research question 3

What are the mean achievement scores of male and female SS1 students taught Geometry using 4MAT?

TABLE 5: MEAN STANDARD DEVIATIONS OF ACHIEVEMENT SCORES MALE AND FEMALE SS1 STUDENTS TAUGHT GEOMETRY USING 4MAT.

Groups	N	Pre-GAT Mean	SD	Post-GAT Mean	SD	Mean Gain
Male	43	6.44	4.60	28.65	5.52	22.21
Female	35	7.60	4.95	28.54	5.41	20.94
Mean Difference		-1.16		0.11		1.27
Total	78					

Results from Table 5 reveal that the pretests mean achievement of 43 male SS1 students in experimental group is 6.44 with standard deviation of 6.09 and that of 35 female SS1 students is 7.60 with standard deviation of 4.95. The mean difference of male and female at pretest is -1,16. The small difference noticed between male and female at pretest means that achievement in Geometry of both genders before commencements of treatment was similar. The posttest mean achievement score for male students is 28.65 with standard deviation of 5.52 while the posttest mean achievement for female students is 28.54 with standard deviation of 5.41. The mean difference between the two groups at posttest is 0.11 in favor of the male students. Also, the mean gain of male students is 22.21 while that of female students is 20.94, giving mean gain difference of 1.27 in favor of the male students. The implication of this result is that male SS1 students achieved higher in Geometry than their female counterparts with the use of 4MAT instructional model. The small difference noticed between male and female at posttest could be an indication that 4MAT has no differential effect on achievement in Geometry of male and female SS1 students.

Hypothesis 3

There is no significant difference in the mean achievement scores of male and female SS1 students taught Geometry using 4MAT

TABLE 6: ANCOVA RESULTS OF ACHIEVEMENT SCORES OF MALE AND FEMALE SS1 STUDENTS TAUGHT GEOMETRY USING 4MAT

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	96.134[a]	2	48.067	1.671	.195
Intercept	17304.199	1	17304.199	601.606	.000
Pre-GAT	94.917	1	94.917	3.300	.073
Gender	**5.215**	**1**	**5.215**	**.181**	**.671**
Error	2157.251	75	28.763		
Total	65780.000	78			
Corrected Total	2253.385	77			

R Squared = .043 (Adjusted R Squared = .017)

Results from Table 6 show that the table values for groups is $F_{(1, 75)} = 0.181$, Sig $= .671 = p$. Since $p > 0.05$, the null hypothesis is not rejected. This means that there is no significant difference between the mean achievement scores of male and female SS1 students taught Geometry using 4MAT. This indicates that both male and female SS1 students taught Geometry using 4MAT equally improved on their achievement in Geometry. The result implies that 4MAT instructional model is not gender bias in terms of the achievement of SS1 students in geometry.

Research question 4

What are the mean retention scores of male and female SS1students taught Geometry using 4MAT?

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TABLE 7: MEAN AND STANDARD DEVIATIONS OF RETENTION SCORES OF MALE AND FEMALE SS1 STUDENTS TAUGHT GEOMETRY USING 4MAT

Groups	N	Post-GAT		Retention-GRT		Mean Gain
		Mean	SD	Mean	SD	
Male	43	28.65	5.38	27.40	4.60	-1.25
Female	35	28.41	5.52	26.80	4.98	-1.6
Mean Difference		0.24		0.60		0.35
Total	78					

Results for 7 revealed that the posttest mean achievement score for male students was 28.65 with standard deviation of 5.38 while that of the female students was 28.41 with standard deviation of 5.52. The mean difference between male and female at posttest was 0.24. Two weeks after the posttest, the mean retention scores of the male SS1 students in experimental group was 27.40 with a standard deviation of 4.60 while the mean retention scores of the female students was 26.80 with a standard deviation of 4.98. The mean difference between male and female SS1 students at a retention level was 0.60 in favor of the male students. Also, the mean retention gain of male students was -1.25 while that of female students was –was-1.6 giving a mean gain difference of 0.35 in favor of the male students. This result indicates that male SS1 students had had higher retention in Geometry than their female counter parts when they were taught the subject using 4MAT. The implication of this result could be that 4MAT instruction favors the male students more than their female counterparts in terms of the retention of the students in Geometry.

Hypothesis 4

There is no significant difference in the mean retention scores of male and female SS1 students taught Geometry using 4MAT.

TABLE 8: ANCOVA RESULTS OF RETENTION SCORES OF MALE AND FEMALE SS1 STUDENTS TAUGHT GEOMETRY USING 4MAT

Dependent Variable: Geometry Retention Test

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1380.241[a]	2	690.121	144.386	.000
Intercept	62.125	1	62.125	12.998	.001
PostGAT	1373.402	1	1373.402	287.341	.000
Gender	**3.073**	**1**	**3.073**	**.643**	**.425**
Error	358.477	75	4.780		
Total	59142.000	78			
Corrected Total	1738.718	77			

a. R Squared = .794 (Adjusted R Squared = .788)

Results from Table 8 shows that the table values for groups is $F(1, 75) = 4.522$, Sig = .643 = p. Since p > 0.05, the null hypothesis is retained.. This means that there is no significant difference between the mean retention scores of male and female SS1 students taught Geometry using 4MAT. This indicates that male and female SS1 students taught Geometry using 4MAT improved equally on their retention in Geometry. The result implies that 4MAT instructional model has no differential effect on male and female SS1 students in terms of their geometry retention.

Discussion of Findings
The findings of this study showed that SS1 students improved on their achievement and retention in Geometry due to the use of 4MAT instructional model during the period of this study in the course of their Geometry class lessons. Results for tables 2 and 4 revealed that there is significant difference between the mean achievement and mean retention of SS1 students in the experimental group taught Geometry using 4MAT and that of their counter-parts in the control group taught Geometry using conventional method. The results indicates that 4MAT instructional model is a better method in enhancing students' achievement and retention than the conventional method. This finding agrees with the study conducted by Age (2021) and Onah (2015), who found in their various studies that significant differences in mean achievement and mean retention existed between the experimental and control groups in favor of the experimental group, when senior secondary students were taught set theory using an innovative instructional methods like 4MAT. Furthermore, the findings in this study revealed that both male and female students' achievement and retention in Geometry were equally significantly enhanced in the experimental group. In other words, the use of 4MAT instructional model to teach Geometry favored both male and female SS1 students. Results in tables 6 and 8 confirm that these differences between the two groups are not statistically significant. This finding is consistent with Age (2021) and Onah (2015), who found in their respective studies that gender has no significant effect on students' achievement and retention.

Conclusion

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Based on the results of the study, it was concluded that the use of Four-Mode Application Techniques (4MAT) model in the teaching and learning of Geometry proved to be more effective than the conventional method in enhancing students' achievement and retention in Geometry.

Recommendations

Based on the findings of this study, it was recommended that

I. Mathematics teachers should be encouraged to use 4MAT instructional model in teaching difficult concepts like geometry since its use has been found to enhance students' achievement and retention.

II. School Administrators and Mathematics teachers should focus on more effective teaching strategies that promote students' achievement ant retention which results in their understanding, especially through their involvement in the learning activities.

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