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Effect of 4MAT Instructional Model on the Interest and Academic Achievement of Upper Basic III Secondary School Students in Algebra

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ABSTRACT

This study investigated the effect of the 4MAT Instructional Model on the Interest and Academic achievement of upper basic 3 secondary school students in Algebra. A quasi-experimental design of pretest, post-test non-randomized and non-equivalent control groups were used for the study. The study was guided by four research questions and two null hypotheses. The population for the study was all the 34 upper basic secondary schools in the Bauchi metropolis during the 2020-2021 academic sessions with a total of 10271 upper basic 3 students. A purposive sampling technique was used to select two co-educational upper-basic schools. A sample of 150 (80 control, 70 experimental) students were used for the study. Two groups were used, one experimental group and the other the control group. The experimental group was taught algebra with the 4MAT instructional model, while the control group was taught using the lecture method. The instruments used for data collection were Algebra Achievement Test (AAT) and the Algebra Interest Inventory questionnaire (AIIQ). The validity of the instruments was obtained by giving to experts from mathematics education and measurements and evaluation and their observations were affected accordingly. The reliability of the instrument was determined by pilot testing the instrument on a selected sample of schools that were not located within the area of the study on two different occasions, 0.78 and 0.87 reliability coefficients were obtained. Data collected were analyzed using mean and standard deviation to answer the research questions. Analysis of covariance (ANCOVA) was used to test the hypotheses at a 0.05 level of significance. The results showed that teaching using the 4MAT instructional model improved students' achievement and interest in algebra. It was recommended that teachers should shift from the Lecture method of teaching and also use the 4MAT instructional model to enhance teaching and learning in schools.

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INTRODUCTION

The goals of Science education is to provide learning experiences through which students acquire scientific literacy and develop scientific knowledge and understanding, processing skills, values and attitudes to help them Contribute to a scientific world and technology (Sani & Ikpe 2019). According to Badmus & Omosewo (2018) the goals of science education is to increase people's understanding of science and the construction of knowledge as well as to promote scientific literacy and responsible citizenship. Science is the bedrock on which modern day technological breakthrough is hinged. Njoku, (2017) viewed science as a systematic study of the universe and environment through observation and experimentation leading to production of an organized body of knowledge. It embraces every attempt of humans to explore, interpret and

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manage the natural world (Garuba, et al., 2016). Science plays important roles in the society because it relates to our daily life and career. Due to importance of science in our society, the Federal Government of Nigeria, through the Federal Ministry of Education introduced science subjects in the nation's secondary school curriculum and mathematics is one of such subjects introduced.

Mathematics is a body of knowledge centered on concepts such as quantity, structure, space, change and also the academic discipline that studies them (Yadav, 2017). Mathematics is further defined by Yadav as the science that draws necessary conclusions. Akinoso, (2016), maintains that Mathematics is a science of pattern and highly needed in everyday life. Mathematics has a number of useful benefits to our mind if we go into its study. It develops our reasoning, help us to have analytical thinking, quickens our mind, generates practicality and also its use can be applied in the day to day activities (Odili 2006). Today, mathematics has become a veritable and indispensable tool in national development (Owora & Chika, 2019). Despite the high positions and place given to mathematics, students do not like the subject. The West African Examination Council (WAEC) Chief Examiner's Report indicates that the general achievement of the candidates in mathematics from 2016 to 2021 differ significantly as illustrated in Table 1.

Table 1-: Total number of students and percentage of candidates that sat for May/June WASSCE from 2016-2021 and have Five Credits including Mathematics and English

YEAR	TOTAL NUMBER OF REGISTERED CANDIDATES	TOTAL NUMBER WHO SAT FOR EXAMINATION	NUMBER THAT OBTAINED FIVE CREDIT	PERCENTAGE THAT HAVE FIVE CREDIT
2016	1,552,758	1,544,234	878,040	52.97
2017	1,567,016	1,559,162	923,486	59.22
2018	1,578,846	1,471,151	786,016	49.98
2019	1,596,161	1,590,173	1,020,519	64.18
2020	1,549,740	1,538,445	1,003,668	65.24
2021	1,573,849	1,560,261	1,274,784	81.7

Source-: Test Development Division, West African Examination Council (WAEC)

However, the chief Examiners also reported that candidate's achievement in mathematics is improving every year, but there is still low percentage of students passing mathematics excellently. The chief examiners also reported that majority of the students perceive mathematics as difficult, abstract, unattractive, boring, not captivating, un-motivating and not related to their daily living. Aliyu, (2019) also lamented that in Nigeria, mathematics is in a sorry state at all levels of education as a result of many factors and this has led to poor achievement in the WAEC examinations. Lack of students' interest in mathematics is one among the factors that contribute to the poor achievement of students in mathematics (Gurat & Sagun, 2018; Anibueze, 2018).

Interests are the sum total likes and dislikes for a wide range of stimulus activities. It also refers to the desire to achieve, or perform, or the feeling that one wants to know more about something or someone. (Hidi S & Renninger 2006) noted that interest is a strong factor in the teaching and learning of mathematics. It has been discovered that it is natural with learners all over the world to want to know about things around them that is, being curious; their interest to know about these things change as they grow. Nwoye, et al, (2019) on the other hand stated that interest develops from situational to individual interest and it is important for students' learning and strongly connected to mathematics achievement. It is a very important factor in the teaching and learning of mathematics. It is essential to point out that any type of teaching which takes into consideration the interest of children or learners will likely succeed because they will likely be interested in the learning process.

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However, these factors as identified in the literature (students' lack of interest, and poor achievement in mathematics) can be corrected if mathematics teachers will effectively use 4MAT instructional model that can have a lasting effect on students' learning of algebra and mathematics in general (Ovez,2012; Uyganor & Dikkartın, 2009; NCTM 2007).

4MAT Teaching Model is a conceptual framework for teaching and learning. It is an integrated curriculum approach, enabling different strategies and teaching methods based on structural theory (Temel, & Ardic, 2018). The 4MAT Teaching Method is a learning style that identifies four interrelated learning methods that depend on how we perceived and process new information: type one imaginative learners (that is perceive information through tangible experience and internalize it through reflective observation), type two analytical learners (student learn by perceive information in abstract form and process by reflecting, and integrate their observations with previous knowledge and experience), type three common sense learners (student perceive information through abstract conceptualization and internalize it through active experience) and type four dynamic learners (student learn with the trial-and-error method) (McCarthy, 2000).

Review of the relevant literature studies shows that the 4MAT teaching method has positive effects on the academic achievement of students. For example, Uyangor, (2012), investigated the effectiveness of the 4MAT teaching model on student achievement and attitude levels. The study employed quasi - experimental design with a pre-test, post-test control group. The sample of the study comprised 81 students from the 7th grade at Public School in Balıkesir during the 2009-2010 education periods. The findings indicated that 4MAT method of instruction was effective in improving student achievement and attitude.

In another similar study conducted, by Ovez, (2012) on the effect of 4MAT Model on Student's algebra achievements and level of reaching attainments. The study utilized quasi experimental design with a pre-test, post-test control group. The result of the analysis indicated that the difference in achievement score averages between the experimental group and control group were significantly in favor of the experimental group and the level of reaching attainments in the experimental group, which was applied the 4MAT teaching model, were higher compared to the control group.

Furthermore, in the study carried out by Temel, & Ardic, (2018), on the title effect of 4MAT instructional model on teaching of Geometric subjects. The study used a quasi-experimental design with control group and was carried out with 86 students (41 students in the experimental group and 45 students in the control group) at a lower secondary school located in Trabzon. The results of the study showed that the courses conducted according to the 4MAT teaching model were more effective on students' achievement and more permanent. It also showed that the common effect of teaching method and learning style on students' academic achievement was not significant. In this context, it was suggested that teachers who used different methods, techniques and strategies in their lessons should primarily determine their students' learning styles.

Feyza & Tuna (2018) also conducted research on the influence of 4MAT model on academic achievement and retention in learning of transformation Geometry. The pretest – post test control group quasi- experimental design was used in the study. The 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.

However, many studies have been done on the effect of 4MAT instructional model on students' academic performance (Uyangor, 2012; Uyangor & Dikkartın 2009; Ovez, 2012), but no study is done on the effect of 4MAT instructional model on students' performances and interest on algebra, specifically in Bauchi State. Therefore, this study investigates the effect of 4MAT instructional model on the

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academic achievement and interest among junior secondary school students in Bauchi metropolis.

Algebra is a topic in mathematics that is mostly failed in schools especially in secondary schools. Scholars have revealed that one of the factors that affect students' achievement in mathematics (algebra in particular) is students' lack of interest which is affected by teachers' methodology. This is because interest refers to inclination of the student towards a particular subject or the state of attention towards a particular subject. Without interest, there will be no achievement but effective teaching strategy translates meaningful learning which enhance the interest of the learners. This has prompted many mathematics researchers to introduced some innovative strategies which includes explicit instruction strategy, 5Es Instructional strategy, problem solving strategy, 4MAT instructional strategy, etc. all these innovative strategies have tried in mathematics and have found to be effective but no research work ever known by the researchers have investigated on the effect of 4MAT instructional strategy in mathematics in Bauchi State. Hence, there is a need for the researchers to investigate the effect of 4MAT instructional strategy on junior secondary school students' performances and interest on algebra. The researchers choose algebra topic because Algebra is a branch of mathematics that its knowledge is very important in understanding so many topics in mathematics such as Geometry, Trigonometry, and Statistics among others.

Aim and objectives of the study

The aim of the study is to examine the effect of 4MAT instructional model on the academic performance and interest of upper basic secondary school students in algebra within Bauchi metropolis. Specifically, the objectives are: -

1. To find out the effect of 4MAT instructional model on Upper Basic Secondary School Students' Academic Achievement in Algebra.
2. To determine the effect of 4MAT instructional model on Upper Basic secondary School Students' Interest in Algebra.
3. To examine the gender effect of 4MAT instructional model on Upper Basic Secondary School Students' Academic Achievement in Algebra.
4. To examine the gender effect of 4MAT instructional model on Upper Basic Secondary School Students' Interest in Algebra.

Research Question

In order to carry out this study the following research question were raised.

1. What is the mean difference between the Academic Achievement of Upper Basic Secondary School Students taught Algebra using 4MAT instructional model and those taught using lecture method?
2. Is there any difference between the mean interest of Upper Basic Secondary School Students taught Algebra using 4MAT instructional model and those taught using lecture method?
3. What is the gender effect of 4MAT instructional model on the Academic Achievement of Upper Basic Secondary School Students in Algebra?
4. Is there any difference on the gender interest of Upper Basic Secondary School Students taught Algebra using 4MAT instructional model and those taught using lecture method?

Research Hypothesis

In view of the problem under study the following hypotheses are formulated to be:

1. There is no significant difference between the Academic Achievement of Upper Basic Secondary School Students taught Algebra using 4MAT instructional model and those taught using lecture method.
2. There is no significant difference between the interest of Upper Basic Secondary School Students taught algebra using 4MAT instructional model and those taught using lecture method.

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METHODOLOGY

The design employed for this study was quasi experimental design, which involves a pre-test, post-test, non-randomized and non-equivalent control group. One group was taught using 4MAT instructional model (Experimental) while the other group was taught using Lecture method (Control). The population of the study was all the 34 upper basic secondary schools within Bauchi metropolis in Bauchi state during the 2020-2021 academic sessions with the total of 10271 upper basic secondary school students 3. From the population, two 2 schools were selected using simple random sampling. One served as the experimental group with 70 students and the other was the control group with 80 students. Two instruments were used in the study. Algebra achievement test (AAT) and algebra interest inventory questionnaire (AIIQ). The algebra test consists of 45 multiple choice questions and the interest inventory questionnaire consists of 20 questions, 4point Likert scale. The validity of the instruments was obtained by given to experts from mathematics education and measurements and evaluation and their observations were effected accordingly. The reliability of the instrument was determined by pilot testing the instrument on selected sample of schools that were not located within the area of the study on two different occasions, 0.78 and 0.87 reliability coefficient were obtained. The data were collected by the researcher and with the help of research assistant. Two schools were used in the data collection. The first school served as the experimental group and the second school as control group. The experimental group receives treatment on 4MAT instructional model. Pre-test on the academic achievement and interest was given at the same time to both experimental and control group, then treatment was given only to the experimental group after which post-test was given to both groups for the academic achievement and also for the interest. The data was analyzed through the use of Mean and standard deviation to answer the research questions. Then ANCOVA was used to answer the hypothesis at $p \leq 0.05$ level of significant.

RESULTS

Research Question 1. What is the mean difference between the academic achievement of upper basic secondary school students taught algebra using 4MAT instructional model and those taught using lecture method?

Table 2: Pretest and post-test Mean and standard deviation of Performance scores of pupils taught algebra using 4MAT instructional model and those taught using lecture methods.

Group	N	PRE-TEST		POST-TEST		Mean Gain
		Mean	S.D	Mean	S.D	
Experimental	70	12.07	2.33	24.17	3.65	12.10
Control	80	10.24	2.11	13.29	3.49	3.05
Total	150					

Table 2 above showed that the mean gain in the experimental group was 12.10 while the mean gain for the control group was 3.05, with the difference of the mean gain 9.05 which indicate that the experimental group performed better than the control group.

Research Questions 2. Is there any difference between the mean interest of upper basic secondary school students taught algebra using 4MAT instructional model and those taught using lecture method?

Table 3: Pretest and post-test Mean interest scores and standard deviation in AIIQ of pupils in the experimental and control groups.

Group	N	PRE-TEST		POST-TEST		Mean Gain
		Mean	S.D	Mean	S.D	
Experimental	70	52.63	3.40	66.83	5.46	14.20
Control	80	52.04	3.32	52.45	3.18	0.41
Total	150					

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Table 3 shows the mean interest scores and the standard deviation in AIIQ of pupils in the experimental and control groups. From table 4.2, it could be seen that the mean interest scores of the pupils taught with 4MAT instructional model was 52.63 and 66.83 in pre interest and post interest respectively and standard deviation of 3.40 and 5.46 in the AIIQ. For the pupils who were taught with Lecture method, it was observed that they had mean scores of 52.04 and 52.45 in pre interest and post interest respectively and standard deviation of 3.32 and 3.18 in that order. It was further seen that the mean gain interest score for the experimental and control groups stood at14.20 and 0.41 respectively. This implies that pupils have increased interest in algebra when taught with 4MAT instructional model than when taught with Lecture methods.

Research Questions 3. What is the gender effect of 4MAT instructional model on the academic achievement of upper basic secondary school students in algebra?

Table 4: Pretest and post-test Mean scores and standard deviation of male and female pupils taught algebra using 4MAT instructional model and those taught using lecture methods.

Group	PRE-TEST				POST-TEST			Mean Gain
	Gender	N	Mean	S.D	N	Mean	S.D	
Experimental	Male	41	12.32	2.15	41	25.73	3.11	13.41
	Female	29	11.72	2.56	29	21.97	3.23	10.25
Control	Male	38	10.18	2.15	38	13.34	2.64	3.16
	Female	42	10.29	2.10	42	13.24	4.14	2.96
Total		150			150			

Table 4 shows the mean scores and standard deviation of male and female pupils in the experimental and control groups. From table 4.3, it could be seen that the mean scores of the male pupils taught with 4MAT instructional model were 12.32 and 25.73 in pretest and posttest respectively and standard deviation of 2.15 and 3.11 in the performance test. For the female pupils, it was observed that they had mean scores of 11.73 and 21.97 in pre-test and post-test respectively and standard deviation of 2.56 and 3.23 in that order. It was further observed that the mean gain scores for male and female pupils stood at 13.41 and 10.25 respectively. This implies that the male pupils perform better than their female counter part when exposed to 4MAT instructional model. Similarly, from table 4.3, it could be seen that the mean scores of the male pupils taught with Lecture method were 10.18 and 13.34 in pretest and posttest respectively and standard deviation of 2.15 and 2.64 in the performance test. For the female pupils, it was observed that they had mean scores of 10.29 and 13.24 in pre-test and post-test respectively and standard deviation of 2.10and 4.14 in that order. It was further observed that the mean gain scores for male and female pupils stood at 3.16 and 2.96 respectively. This implies that the male pupils perform better than their female counter part when exposed to Lecture methods.

Research Questions 4. Is there any difference on the gender interest of upper basic secondary school students taught algebra using 4MAT instructional model and those taught using lecture method?

Table 5: Pretest and post-test Mean interest and standard deviation of male and female pupils taught algebra using 4MAT instructional model and those taught using lecture methods.

Group	PRE-TEST				POST-TEST			Mean Gain
	Gender	N	Mean	S.D	N	Mean	S.D	
Experimental	Male	41	52.39	3.29	41	66.95	5.42	14.56
	Female	29	52.97	3.58	29	66.66	5.60	13.69

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Control	Male	38	51.95	3.22	38	52.42	3.14	0.47
	Female	42	52.12	3.44	42	52.34	3.17	0.22
Total		150			150			

Table 5 shows the mean interest and standard deviation of male and female pupils in the experimental and control groups. From table 4.4, it could be seen that the mean interest of the male pupils taught with 4MAT instructional model were 52.39 and 66.95 in pre-interest and post-interest respectively and standard deviation of 3.29 and 5.42 in the AIIQ. For the female pupils, it was observed that they had mean interest of 52.97 and 66.66 in pre-interest and post -interest respectively and standard deviation of 3.58 and 5.60 in that order. It was further observed that the mean gain interest for male and female pupils stood at 14.56 and 13.69 respectively. This implies that the mean interest of male pupils is a little bit better than their female counter part when exposed to 4MAT instructional model. Similarly, from table 4.4, it could be seen that the mean interest of the male pupils taught with Lecture method were 51.95 and 52.42 in pre-interest and post-interest respectively and standard deviation of 3.22 and 3.14 in the AIIQ. For the female pupils, it was observed that they had mean interest of 52.12 and 52.34 in pre-interest and post-interest respectively and standard deviation of 3.44and 3.17 in that order. It was further observed that the mean gain interest for male and female pupils stood at 0.47 and 0.22 respectively. This implies that both the male and female have a small or negligible gain in interest when exposed to Lecture methods.

Hypotheses Testing

The following presentation analyses the data collected in order to address each of the null hypotheses as presented below.

Research Hypothesis 1. There is no significant difference between the academic achievement of upper basic secondary school students taught algebra using 4MAT instructional model and those taught using lecture method.

Table 6: Analysis of Covariance (ANCOVA) on mean scores of pupils taught algebra using 4MAT instructional model and those taught using Lecture method.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Decision
Corrected Model	4422.505[a]	2	2211.253	172.687	.000	
Intercept	1977.116	1	1977.116	154.402	.000	
PreAPT	.002	1	.002	.000	.989	
Method	3773.576	1	3773.576	294.697	.000	S
Error	1882.328	147	12.805			
Total	56905.000	150				
Corrected Total	6304.833	149				

a. R Squared = .701 (Adjusted R Squared = .697)

From the result of the ANCOVA above in table 4.5, it was observed that Method which was the main effect gave an f-value of 294.697 and was significant at 0.000. Since 0.000 is less than 0.05, this means that at 0.05 level, the f-value is significant. Therefore, we reject hypothesis 1 and conclude that there is a significant difference in the pupils' performance on algebra in mathematics between the experimental-group applied the 4MAT instructional model and the control group applied lecture teaching model.

Research Hypothesis 2. There is no significant difference between the interest of upper basic secondary school students taught algebra using 4MAT instructional model and those taught using lecture method.

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Table 7: Analysis of Covariance (ANCOVA) on mean scores of pupils taught algebra using 4MAT instructional model and those taught using Lecture method.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Decision
Corrected Model	8695.288[a]	2	4347.644	340.878	.000	
Intercept	232.450	1	232.450	18.225	.000	
PreAIIQ	976.871	1	976.871	76.592	.000	
Method	7184.118	1	7184.118	563.273	.000	S
Error	1874.872	147	12.754			
Total	535556.000	150				
Corrected Total	10570.160	149				

a. R Squared = .823 (Adjusted R Squared = .820)

From the result of ANCOVA in table 7, it was observed that Method which is the main effect gave an f-value of 563.273 and was significant at 0.000. Since 0.000 was less than 0.05, this means that at 0.05 level, the f-value was significant. Therefore, hypothesis 2 is rejected. Hence, the study concludes that there is a significant difference in the pupils' interest in algebra between the experimental-group and the control group.

SUMMARY OF FINDINGS

Following the analyses of data collected and subsequent testing of the hypotheses formulated, the study reveals that:

1. There is a significant difference in the academic achievement of upper basic secondary school students taught algebra using 4MAT instructional model and those taught using lecture method.
2. There is a significant difference in the interest of upper basic secondary school students taught algebra using 4MAT instructional model and those taught using lecture method.

DISCUSSION OF FINDINGS

The study examined the effect of 4MAT instructional model on the academic achievement and interest of upper basic secondary school students in algebra in Bauchi metropolis, Bauchi State.

The result of the study indicates that there is a significant difference between the mean academic achievement of upper basic secondary school students taught algebra using 4MAT instructional model and the control group taught using lecture method. This finding is in agreement with the work of (Ovez, 2012) whose results suggested that algebra teaching based on the 4MAT teaching model was more successful in increasing student success. Furthermore, the study also revealed that there is a significant difference between the interest of the pupils towards algebra in the experimental group to whom the 4MAT instructional model has been applied and that of the control group to whom Lecture methods has been applied. This result is in line with the findings of (Uyangor,2012) whose study suggested that the teaching provided upon the learning styles can affect the students' success and attitude in a positive way and that 4MAT as a learning style that take in to consideration the learners' individual difference can help them benefit from there interest and capability. In addition, the mean interest of the pupils towards algebra in the experimental group is higher than the mean interest of the students towards algebra in the control group and the difference is in the favor of the experimental group.

CONCLUSION

From the results of the study, major findings showed that 4MAT instructional model used in teaching algebra has a significant effect in the learning process, thereby improving the achievement and enhancing the interest of the learners.

RECOMMENDATIONS

Based on the findings of the study, the following recommendations were made

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1. Mathematics teachers should be encouraged to adapt 4MAT instructional model as part of their teaching methods.
2. The curriculum planners, Ministry of Education and its policy makers should recognize the value of 4MAT instructional model and consider its inclusion in the learning styles to be used in eliminating lack of interest and thereby improving academic performance in mathematics.

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