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Effect of Geogebra on Senior Secondary School Students' Interest and Achievement in Statistics in Makurdi Local Government Area of Benue State, Nigeria

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Abstract: *The study determined the effect of geogebra on senior secondary school students' interest and achievement in statistics. The study was carried out in Makurdi local government area of Benue state. A sample size of two hundred and forty two (242) senior secondary one students was used. The study was a quasi-experimental design. Data were collected from the subjects using two (2) instruments namely: Statistics Achievement Test (SAT) and Statistics Interest Inventory (SII). The SAT and SII had reliabilities of 0.62 and 0.71 using Kuder-Richardson formula 20 and Cronbach Alpha coefficient respectively. Four research questions and four research hypotheses were formulated to guide the study. The research questions were answered using mean and standard deviation while the hypotheses were tested at 5% level of significance using a 2-way analysis of covariance (ANCOVA). Results from the study revealed that students taught statistics using the geogebra teaching method achieved higher and also showed greater interest in learning statistics than those taught with conventional teaching approach. The study also revealed that both male and female students in experimental group achieved the same and also showed similar interest in statistics. The study recommended among others that teacher education institutions should be encouraged to include geogebra as a method in teaching secondary school statistics.*
Keywords: *Geogebra, Senior Secondary School Students, Interest, Achievement, Benue state.*

I. Introduction

Recent research on learning indicates that technology can play a critical role in changing classroom environment and restructuring schools to promote more meaningful and result oriented learning. Some of the widely used technologies in the classrooms are computers and their associated software, videos and projectors. According to Odili (2006) learning with the help of computers will lead not only to the development of skills but a sense of enjoyment in the process of learning. He continued by saying that the current software development allows teachers and students to use computers without necessarily understanding the more technical hardware components. It is therefore within the purview of mathematics educators to develop instructional strategies that will interest students in learning Statistics in the secondary school. There is a widespread belief that technologies have an important role to play in changing and modernizing educational systems and ways of learning. When one looks at the current widespread diffusion and use of Information and Communication Technology (ICT) in modern societies, especially by the youth, it becomes clear that ICT will affect the complete learning process today and in the future. Voorst (1999) stated that technology is useful in helping students view Statistics less passively as a set of procedures and more actively as reasoning, exploring, solving problems, generating new information and asking new questions. Furthermore, he claimed that technology helps students to visualize certain mathematics concepts better and that it adds a new dimension to the teaching of Statistics.

It is in concert with the trend of the use of technology in the classroom that Torhurst (1995) observed that mathematics educators are now introducing more and various forms of software and multimedia presentation into their classroom activities. One of such software is Geogebra which has proven through various researches to be effective mathematics software in learning Statistics as noted by Dikorich (2007). It is innovative, open-source mathematics software that can be freely downloaded from www.geogebra.com. Geogebra works on a wide spectrum of operating system platforms which has Java virtual machine installed on. It was created in 2002 by Markus Hohenwarter and a team of programmers for the teaching and learning of mathematics from middle school through college to university level (Hohenwarter & Prener, 2007). After the creation of Geogebra at the University of Salzburg, Austria; a lot of research has been carried out on it in Asia, Europe and America. Specifically, teachers in Malaysia, Austria, Germany and North Korea started using Geogebra for teaching concepts in mathematics after it was published on the internet in 2002. Geogebra which offers geometry, algebra, calculus and statistics features in a fully connected, compacted and easy-to-use software environment is designed specifically for educational purposes and can help students grasp experimental, problem oriented and research oriented learning of mathematics (Dikorich, 2007). Geogebra basic interface is divided into four components which are; Input bar, Algebraic view, Graphic view and Spreadsheet view. Data and objects are entered into geogebra environment through the input bar and the spreadsheet view using the keyboard while graphic and algebraic views display the graphical representation of data and their algebraic equivalence respectively. The basic idea of Geogebra's interface is to provide two presentations of each statistical object in its algebra and graphic windows. If an object is changed in one of these windows, its presentation in the other will be immediately updated. According to Hohenwarter and Jones (2007), the multiple presentations of objects in geogebra environment captivates student's interest in learning and encourages experimental and guided discovery learning. They also added that the components of Geogebra are designed to help Students to actively participate in constructing their own statistical knowledge, practice what they are intended to learn, confront their misconceptions in statistics and work with real data in realistic contexts.

Perney and Ravid (1990) noted that Statistics as a mathematics concept does not awaken great delight among secondary school students and this affect their overall achievement and their subsequent interest in it at the higher level of their studies. Perhaps one of the reasons for the lack of students' interest in statistics and subsequent low achievement in mathematics in secondary school could be attributed to the absence of innovative teaching. And once a student's mind is not captured in the classroom, there is little or nothing any teacher can do to improve the achievement of such a student. According to Ezike and Obodo (1991), interest is the feeling of intentness, concern or curiosity about an object and could also be referred to as the quality which arouses concern or curiosity which holds a child's attention on an object. Students' interest must be captured in the classroom to facilitate their achievement not only in Statistics but other concepts in Mathematics. Abimbade (1995) opined that reasons for the observed poor achievement in mathematics is lack of mathematics teaching equipment and materials, fright and anxiety, low level of interest and some government policy. Interest is an important variable in learning because when one becomes interested in an activity, one is likely to be more deeply involved in that activity. Interest is a subjective feeling of concentration or persisting tendency to pay attention and enjoy some activity or content (Imoko & Agwagah, 2006).

Significant researches have indicated the influence of gender on interest and academic achievement of students. Agwagah (1993) had reported that female students perform significantly better than their male counterparts in Mathematics. On the contrary, Harbour-Peters (2002) share the view that boys outperform girls in mathematics while Abiam and Odok (2006) found no significant relationship between gender and achievement in number and numeration, algebraic processes and statistics. Meanwhile, other research findings have argued the idea of gender disparity in interest and achievement in mathematics (Olangunju, 2001). Consequently, Sinnes (2006) opined that for gender inequality to be removed in the class room, methods that encourage the active participation of students' in the class should be employed by the teachers. This is in agreement with Etukudo (2002) who emphasized that gender disparity exists in the face of weak methods. Therefore, the search for a good instructional delivery strategy that may stimulate the interest of students' in Statistics and facilitate their overall achievement in Mathematics cannot be overemphasized. The process of learning statistics is a very complex cognitive task that can be very imposing on the students; it is therefore pertinent that Mathematics educators examine the opportunities and challenges of new technologies in other to enhance their teaching styles, capture the interest of students in the classroom and facilitate the subsequent achievement of students'. Several researches have been carried out with Geogebra amongst them is Ahmed and Rohani (2010) who conducted a quasi experimental study with non equivalent control group to examine the effect of Geogebra in the learning of coordinate Geogebra among secondary school students in Malaysia and found out that there was a significant difference in mathematical achievement between the Geogebra group and the traditional teaching strategy group. His findings showed that the students in Geogebra group performed better than the students in the traditional group.

In this regard, the main purpose of this study is to find out if the adoption of geogebra in teaching will help in improving students' interest and achievement in statistics.

Specifically the study seeks to:

i. Determine the effect of geogebra on students' achievement in statistics in senior secondary school.
ii. Determine the effect of geogebra on students' interest in statistics in senior secondary school.
iii. Determine the effect of geogebra on male and female students' achievement in statistics in senior secondary school.
iv. Determine the effect of geogebra on male and female students' interest in statistics in senior secondary school.

Research Questions: To carry out the study the following research questions were posed:

1. What is the mean achievement scores in statistics of students taught statistics in the experimental and control group?

2. What is the mean interest rating in statistics of senior secondary school students in the Geogebra method and conventional method group?
3. What are the mean achievement scores in statistics of male and female student's statistics in the experimental group?
4. What is the mean interest rating in statistics of male and female senior secondary school student in the Geogebra method groups?

Research hypotheses

The following hypotheses are formulated and tested at 5% level of significance:

1. There is no significance difference in the mean achievement scores of senior secondary students taught statistics in experimental and control group.
2. There is no significance difference in the mean interest rating in statistics of students in the Geogebra method and conventional method groups.
3. There is no significance difference in the mean achievement scores between the male and female students in experimental group.
4. There is no significance difference in the mean interest rating in statistics of male and female student in the Geogebra method group.

II. Methodology

The design adopted for this study was quasi– experimental design of non-equivalent group.

The population of the study was all the 2,412 Senior Secondary School one (SS1) students in the 18 government co-educational Secondary Schools in Makurdi Local Government Area of Benue State (BSTSB, 2010). The sample for this study was 242 out of 2,412 students drawn from four secondary schools out of 18 government co-educational schools in Makurdi Local Government Area. Multistage sampling technique was used for the study. Two instruments were developed for the collection of data namely; Statistics Achievement Test (SAT) and Statistics Interest Inventory (Sll). The Statistics Achievement Test (SAT) and Statistics Interest Inventory (Sll) constructed for the study were validated by 5 experts. The data of the trial testing was used to calculate the reliability coefficient of SAT using Kuder Richardson formula 20.The value obtained was 0.62. This shows a good degree of stability of the items of the SAT instrument. The data collected from the SII was also subjected to analysis and a Cronbach Coefficient Alpha reliability of 0.71 was obtained. This implied that the instrument was appropriate for the study.

The researchers and the research assistants administered the pre-SAT and pre-SII for all the SSl students in the two groups. The pre-SAT and pre-SII was administered to the selected groups at the same time to avoid the students' discussing the test items and also to avoid leakages. At the end of the fourth week of study, the post SAT and post SII was administered to both groups collected and collated for analysis. Data collected were analyzed using descriptive Statistics of mean and standard deviation to answer the research questions asked while the hypotheses were tested at 5% significance level using the analysis of covariance (ANCOVA).

III. Results

Results of this study were presented according to the research questions and followed with related hypotheses.

Question 1: What is the mean achievement scores in statistics of students taught statistics in the experimental and control group?

Table 1

The mean achievement scores and standard deviation of subjects in the experimental and control groups

Teaching method	Type of test	Mean	Standard deviation
Geogebra	Pretest	42.29	7.96
	Posttest	62.60	7.65
Conventional	Pretest	41.76	7.72
	Posttest	49.24	6.54

In table1, the mean pretest scores for Geogebra method group is 42.29 with a standard deviation of 7.96 and the mean pretest for the conventional method group is 41.76 with a standard deviation of 7.72. However, the mean of post test for the Geogebra method group is 62.60 with a standard deviation of 7.65 while the mean of the post test scores for the conventional method group is 49.24 with a standard deviation of 6.54. From the mean scores for both groups it could be seen that the Geogebra method group has a higher mean score in statistics than the conventional method group. To prove if the mean difference in the achievement scores of the students in statistics between the two groups is significant, hypothesis 1 was tested at $\alpha = 0.05$

Hypothesis 1: There is no significance difference in the mean achievement scores of senior secondary students taught statistics in experimental and control group. The result of this hypothesis is presented in table 2.

Table 2: ANCOVA result of subject achievement scores in SAT

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	10784.038[a]	3	3594.679	78.184	.000
Intercept	28530.518	1	28530.518	620.544	.000
Pretest	123.398	1	123.398	2.684	.103
Method	10762.654	1	10762.654	234.090	.000
Pretest*Method	9.052	1	9.052	0.450	0.504
Error	10942.443	238	45.977		
Total	773811.000	242			
Corrected Total	21726.481	241			

a. R Squared = .496 (Adjusted R Squared = .492)

In table 2 the result shows that the covariance is not significantly the same with the dependent variable thus a sig value of 0.103. However, the significant value of the dependent variable (Post test) in the two methods is 0.000. Since this value is less than the level of significance of 0.05, the null hypothesis is rejected. It shows that there is a statistical significant difference in the mean achievement scores of senior secondary school students taught statistics in experimental group and control group.

Research Questions 2: What is the mean interest rating in statistics of senior secondary school students in the Geogebra method and conventional method group?

Table 3: Mean Rating and Standard Deviation of Students in Geogebra Method and Conventional Method Groups.

Teaching Method	Type of Test	Mean	Standard Deviation
Geogebra	Pre SII	31.70	2.71
	Post SII	52.01	5.46
	Mean Gain	20.31	
Conventional	Pre SII	29.59	4.23
	Post SII	38.27	2.85
	Mean Gain	8.68	

Results in table 3 shows that the mean interest scores of students taught statistics with Geogebra method was 52.01 with a standard deviation of 5.46, while those taught statistics with Conventional approach was 38.27 with a standard deviation of 2.85. The mean gain of the students taught statistics with Geogebra was 20.31 while that of the students taught statistics with conventional approach was 8.68. Therefore the mean interest rating of the students taught statistics with the Geogebra method is higher than those taught statistics with the conventional method. This implies that the students taught statistics using the Geogebra method showed higher interest in learning statistics than the students in the conventional method group. To show if the mean interest rating in statistics of students between the experimental and control group is significant, hypothesis2 was tested at 0 .05 level of significance.

Hypothesis 2: There is no significance difference in the mean interest rating in statistics of students in the Geogebra method and conventional method groups.

Table 4: Ancova Result On Subjects Post Interest Rating In Sii.Test Of Between Subjects Effects

Tests of Between Subjects Effects Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	56871.755[a]	3	18957.252	1386.218	.000
Intercept	442.113	1	442.113	32.329	.000
Method	198.472	1	198.472	14.513	.000
Pre-SII	110.910	1	110.910	8.110	.015
method * preSII	83.330	1	83.330	6.093	.014
Error	3254.774	238	13.676		
Total	440160.000	242			
Corrected Total	60126.529	241			

In table 4, the result shows that the covariance is not significantly related to the dependent variable thus a significant value of 0.015.However, the significant value of the post interest in the two methods is 0.000 and the value is less than the level of significance of 0.05. Thus, null hypothesis is rejected. It therefore means that Geogebra method aroused more interest in the students to learn statistics than conventional method.

Research Question 3: What are the mean achievement scores in statistics of male and female student's statistics in the experimental group?

Table 5: Mean achievement scores and standard deviation of male and female students in Experimental group

Teaching method	Sex	Type of test	Mean	Standard deviation
Geogebra	Male	Pre test	43.71	7.31
		Post test	62.17	6.71
		Pre test	42.10	8.43
	Female	Post test	62.91	7.33

In table 5, the mean achievement score in statistics of male and female students in the Geogebra method pre-test is 43.71 and 42.10 with standard deviation of 7.31 and 8.43 respectively. This implies that both the male and female students in the Geogebra method were almost at the same level of knowledge in statistics before the treatment. However, the mean achievement scores in statistics for the male and female students in the post test of the Geogebra method group is 62.17 and 62.91 with a standard deviation of 6.71 and 7.33. This result shows that the male and female students in the Geogebra method group recorded a mean gain of 18.46 and 20.86. This implies that both the male and female student in Geogebra method group improved upon their interest in statistics However, there is no much difference between the male and female students mean achievement scores in statistics even though the female students slightly achieved above their male counterpart. To ascertain the significance of this finding, hypothesis3 was tested at 5% level of significance.

Research Hypothesis 3: There is no significance difference in the mean achievement scores between the male and female students in experimental group.

Table 6. :ANOVA Result on Subjects' Post Achievement Scores in SAT

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	312.735[a]	3	104.245	1.149	.330
Intercept	26299.894	1	26299.894	289.979	.000
Gender	103.835	1	103.835	1.145	.286
Pretest	14.409	1	14.409	.159	.691
gender * pretest	55.989	1	55.989	.617	.433
Error	21585.612	238	90.696		
Total	778572.000	242			
Corrected Total	21898.347	241			

a. R Squared = .714 (Adjusted R Squared = .712)

In table6, the result shows that the covariance is not significantly the same with the dependent variable thus a sig value of 0.159. However, the significance value of post test of male and female students in statistics within the groups is 0.286. Hence 0.286 is greater than 0.005, the null hypothesis is not rejected. This result shows that there is no significance difference in the mean achievement scores in statistics between male and female students in Geogebra method group. This implies that both the male and female students achieved equally in the statistics taught during this study. This therefore implies that Geogebra method of teaching statistics can reduce gender gap in achievement of students.

Research Question 4: What is the mean interest rating in statistics of male and female senior secondary school student in the Geogebra method groups?

TABLE 9: Result of SII for Male and Female Student in Experimental Group

	N	Pre SII		Post SII		Mean Difference
		$\bar{x}_1$	SD_1	$\bar{x}_1$	SD_2	
Male	52	29.65	2.70	51.73	2.65	22.08
Female	69	29.54	4.97	51.66	4.82	22.12
Total	**121**					

Results in Table 9 shows that the mean interest rating of the male and female students in the Geogebra method was 51.73 and 51.66 respectively. However the mean gain of the male and female students in statistics was 22.08 and 21.12. Therefore, the difference in the mean interest rating between the male and female students in statistics is 0.04. Conclusively, the result implies that there is no much difference between the male and female students' mean interest rating in statistics. However, hypothesis 4 will be tested to determine if the difference in the mean interest rating between male and female students' is statistically significant or not.

Hypothesis 4: There is no significance difference in the mean interest rating in statistics of male and female student in the Geogebra method group.

Table 8: Ancova Result On Subjects Post Interest Rating In Sii

ANCOVA Result on Subjects Post Interest Rating in SII					
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	57353.285a	3	19117.762	1633.857	.000
Intercept	429.643	1	429.643	36.717	.000
preSII	8.436	1	8.436	0.721	.397
Gender	14.755	1	14.755	1.261	.263
PreSII* gender	31.405	1	31.405	2.684	.103
Error	2773.244	238	11.701		
Total	440160.000	242			
Corrected Total	60126.529	241			
a. R Squared = .954 (Adjusted R Squared = .953)					

From table 8, the result shows that the covariance (PreSII) is not the same as the dependent variable thus a significant value of 0.397.The significance value of post statistics interest inventory of male and female students in statistics within the groups is 0.263. Hence 0.263 is greater than 0.05, the null hypothesis is not rejected. This result shows that within the groups there is no significance difference between the male and female students' interest in statistics. This implies that both the male and female students in experimental group indicated a similar level of interest in statistics.

IV. Discussion

In table1, the mean pretest scores for Geogebra method group is 42.29 and the mean pretest for the conventional method group is 41.76. From the mean scores, it is revealed that the subjects of the study were almost at the same entry level in their knowledge of statistics before the commencement of the treatment. However, the mean of post test for the Geogebra method group is 62.60 while the mean of the post test scores for the conventional method group is 49.24. From the mean scores for both groups it could be seen that the Geogebra method group has a higher mean score in statistics than the conventional method group. Hypothesis 1 confirms this in table 2 where the significant value of the dependent variable (Post test) in the two methods is 0.000. This value is less than the level of significance of 0.05, thus the null hypothesis is rejected. It shows that there is a statistical significant difference in the mean achievement scores of senior secondary school students taught statistics in experimental group and control group. This reveals that students taught statistics with Geogebra improved on their achievement in statistics more than those taught statistics with the conventional teaching method. This result is in agreement with Ahmed and Rohani (2010) who conducted a quasi experimental study with non equivalent control group to examine the effect of Geogebra in the learning of coordinate Geogebra among secondary school students in Malaysia and found out that there was a significant difference in mathematical achievement between the Geogebra group and the traditional teaching strategy group. His findings showed that the students in Geogebra group performed better than the students in the traditional group. These findings disagree with High (1998) who found that there is no significant difference in students achievement in statistics between the student taught statistics with traditional method and those taught with Computer.

In table 3, the pre-SII result for both the control group and the experimental group was homogeneous; meaning that the students' in the two groups had a similar level of interest in statistics before the commencement of the study. However, the mean interest scores of students taught statistics with Geogebra method was 52.01 with a standard deviation of 5.46, while those taught statistics with Conventional approach was 38.27 with a standard deviation of 2.85. The mean gain of the students taught statistics with Geogebra was 20.31 while that of the students taught statistics with conventional approach was 8.68. Therefore the mean interest rating of the students taught statistics with the Geogebra method is higher than those taught statistics with the conventional method. This implies that the students taught statistics using the Geogebra method showed higher interest in learning statistics than the students in the conventional method group. Hypothesis 2 was tested at α=0 .05 to confirm that the mean interest rating in statistics of students between the experimental and control group is significant. The result shows that the significant value of the post interest in the two methods is 0.000 and the value is less than the level of significance of 0.05. Thus, null hypothesis was rejected. It therefore means that Geogebra method aroused more interest in the students to learn statistics than conventional method.

From the result, the mean interest rating of the students in the Geogebra teaching method group is higher than that of the students in the conventional teaching method group. This implies that Geogebra method arouses more interest in the students to learn statistics than the conventional method. This finding is in agreement with Odili (2006) who asserted that learning with the help of computer will lead not only to the development of skills but also a sense of enjoyment in the process of learning. This finding also agree with Ahmad and Rohan i(2010) who suggested that educators need to make their teaching and learning of statistics easy for students to learn and enjoy in the class. That way, the students may sustain their interest in statistics and devote more time to study it. He also said that educators need to help students to develop their confidence and ability to solve statistics problems by preparing them to do well in statistics and to use the available technology in order to have a better understanding of the subject; this could help to prepare students to compete and function in this high-tech world. He concluded that the integration of mathematical software in teaching and learning is important due to its ability to do quick calculations and also helping students to visualize difficult and abstract mathematical concepts.

In table 5, the mean achievement score in statistics of male and female students in the Geogebra method pre-test is 43.71 and 42.10. This implies that both the male and female students in the Geogebra method were almost at the same level of knowledge in statistics before the treatment. However, the mean achievement scores in statistics for the male and female students in the post test of the Geogebra method group is 62.17 and 62.91. This result shows that the male and female students in the Geogebra method group recorded a mean gain of 18.46 and 20.86. This implies that both the male and female student in Geogebra method group improved upon their interest in statistics. However, there is no much difference between the male and female students mean achievement scores in statistics even though the female students slightly achieved above their male counterpart. To confirm the significance of this finding, hypothesis 3 in table 6 was tested at 5% level of significance. In table6, the result shows that the significance value of post test of male and female students in statistics within the groups is 0.286. Hence 0.286 is greater than 0.005, the null hypothesis is not rejected. This result shows that there is no significance difference in the mean achievement scores in statistics between male and female students in Geogebra method group. This implies that both the male and female students achieved equally in the statistics taught during this study. This therefore implies that Geogebra method of teaching statistics can reduce gender gap in achievement of students.

The mean achievement scores of male and female students using geogebra method did not differ statistically significantly. This indicates that both the male and female students achieved equally, though the female students in Geogebra teaching method achieved slightly higher than their male counterparts. This therefore implies that the use of geogebra can attenuate the gender gap in performance of the secondary school students in statistics. This findings agrees with Abiam and Odok (2006) who found no significant relationship between gender and achievement in number and numeration, algebraic processes and statistics. Results in table 9 showed that the mean interest ratings of the male and female students in the Geogebra method were 51.73 and 51.66 respectively. However, the mean gain of the male and female students in statistics was 22.08 and 21.12. Therefore, the difference in the mean interest rating between the male and female students in statistics is 0.04.

The result implies that there is no much difference between the male and female students' mean interest rating in statistics. In table 8, hypothesis 4 was tested to determine if the difference in the mean interest rating between male and female students' is significant. From the table, the result shows that the significance value of post statistics interest inventory of male and female students in statistics within the groups is 0.263. Hence 0.263 is greater than 0.05, the null hypothesis is not rejected. This result shows that within the groups there is no significance difference between the male and female students' interest in statistics. This implies that both the male and female students in experimental group indicated a similar level of interest in statistics. This findings further reveal that the female can produce exactly the same scientific knowledge and interest as the males provided that sufficient rigor is undertaken in scientific enquiry. These findings are in agreement with Sinnes (2006) who opined that for gender inequality to be removed in the class room, methods that encourage the active participation of students' in the class should be employed by the teachers.

V. Conclusion

Based on the findings of this study the following conclusions are made, the findings of this study provide an empirical support that the Geogebra method of teaching statistics enhanced students' achievement in statistics and also improve upon their interest in the learning of statistics than the conventional teaching method. The male and female students in the Geogebra teaching method group achieved more and showed more interest in learning statistics than the male and female students in conventional teaching method. It therefore means that this method of instruction enhanced both the male and female students' achievement and interest in statistics equally. From the aforementioned findings, it therefore means that the method of teaching statistics affects the students' level of achievement and interest.

Also, if students are given more opportunity to be involved in the learning process using Geogebra method, they will perform significantly better than those exposed to conventional teaching method. On a similar note, if teachers are trained in the use of Geogebra teaching method in teaching statistics, it will go a long way in improving the achievement of students in statistics.

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