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GEOGEBRA AND SECONDARY SCHOOL STUDENTS' PERFORMANCE IN MATHEMATICS IN AKWA IBOM NORTH-WEST SENATORIAL DISTRICT OF NIGERIA

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ABSTRACT: *This study was designed to investigate the effectiveness of GeoGebra instructional package on students' performance in secondary school mathematics. Six research questions and six null hypotheses were formulated. The research design was quasi experimental, specifically the pre –test, post-test non-randomized control groups design was used. A total of 500 students from six out of the 85 public secondary schools in Akwa Ibom North West Senatorial District, with student's population of 361,486 students were used for the study. Intact classes were used as experimental and control groups in each of the six schools. Mathematics Achievement Test consisting of 50 items multiple choice items developed by the researcher was used as instrument for data collection and was validated by experts and the Kuder Richardson's formula 21 (KR-21), reliability coefficient was 0.89. The GeoGebra Software and demonstration method lesson plans were used as instructional tools for the study. Results were analyzed using mean, standard deviation and ANCOVA. From the findings, it was observed that GeoGebra Mathematics software enhanced more and significantly the performances of students in Mathematics than demonstration method in Akwa Ibom state. It is recommended that the use of GeoGebra should be used as a viable alternative or supplement to demonstration method of teaching in Akwa Ibom State.*

KEYWORDS: GeoGebra; Educational Media; Measurement, Evaluation; Learning

INTRODUCTION

Mathematics is one of the cross cutting core subject in both the Junior and senior secondary school curriculum. Mathematics contributes immensely to the modern culture of science and technology especially as there is always Mathematics content in science, and modern technology.

Stressing on the importance of mathematics, Fajemidagba, Salman and Ayinla (2012), described Mathematics as a tool for the development of any science-based discipline. Ayinla (2011) sees it as the pillar of knowledge and Onwuachu and Nwakonobi (2009) described it as the foundation on which the whole essence of life revolves. However, the students' interest and weakness in mathematics learning could affect the efforts of various sectors in achieving the Sustainable Development Goals (SDGs) of making Nigeria a fully developed nation by 2020.

Despite the importance attached to mathematics, researchers Amazigo, 2000; Joseph, 2012; had observed that students lack interest in the subject and perform poorly in it. It is observed that mathematics is one of the most poorly taught, widely hated and abysmally understood subject in secondary schools and students run away from the subject (Aprebo, 2002; Okafor and Anaduka, 2013; Ado and Umo Abasi 2014).

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The West Africa Examination Council (WAEC) Examiners 2011, 2012, 2013, 2014, and 2015 consistently reported candidates' lack of skill in answering almost all the questions asked in General Mathematics and poor performance specifically in Geometry themes like circles and 3- dimensional problems and Algebra. Researchers like Okereke (2006) attributed students' poor performance to factors such as the society viewing Mathematics is difficult, lack of Mathematics laboratory, lack of adequate and qualified teachers and poor teaching methods. The WAEC Chief Examiner's Report (2005) suggested that students' performance in mathematics could be improved through meaningful and proper teaching strategies. The integration of the Computer in the classroom especially with Mathematics software like GeoGebra could enable students to produce quick calculations and assist them in abstracting Mathematical concepts. Teaching and learning of Mathematics with the use of computer has many advantages such as providing greater learning opportunities for students (Robert, 2012); enhancing students engagement (White, 2012), and encouraging discovery learning.

GeoGebra is a Dynamic Mathematics Software (DMS) developed by Markus Hohenwarter in 2002 for teaching and learning Mathematics which combines many aspects of different mathematical packages(Hohenwarter, 2006, .0.2010). GeoGebra dynamically joins Geometry, Algebra and Calculus offering these features in a fully connected software environment (Hohenwarter and Lavicza, 2007). The most noticeable feature of GeoGebra is that of multiple representations. It offers two representations of every object: every expression in the algebra window corresponds to an object in the geometry window and vice versa providing a deeper insight in the relations between geometry and Algebra (Hohenwarter and Jones, 2007).

Hutkemri and Zakaria (2012) conducted a study on the effect of GeoGebra on students conceptual and procedural knowledge of function. The purpose of the study was to identify the conceptual and procedural knowledge on the topic of function based on types of group and gender. This research involved 284 students from two upper-secondary schools in Rokan Hulu, Riau, Indonesia. Among these students, 138 were placed in the experimental group (use of GeoGebra software) while the remaining 146 students were in the control group. Data were collected using the conceptual and procedural test on the topic of function. T-test, one-way analysis of variance (ANOVA), and two-way ANOVA, were employed using the Statistical Package for the Social Sciences (SPSS 19.0). The findings of the study showed that there were significant differences in the conceptual and procedural knowledge of students based on the type of group. However, there was no significant difference in students' conceptual and procedural knowledge based on gender. The findings of the study give implications to the use of GeoGebra in learning mathematics.

The effectiveness of some technological tools which enables the linking of visualization to linear equation such as GeoGebra was examined in many studies. Kabaca, Çontay and İymen (2011) purposed to construct the concept of parabola with the relationship between its algebraic and geometric representation by using GeoGebra. A learning environment supported by GeoGebra including 4 phases was prepared and the lesson was implemented in one class hour. GeoGebra was used as a presentation tool and students examined the algebraic and geometric representation of a parabola in the fourth phase. The 11th grade level class (SS2) including 23 students was videotaped during this hour. The students' important reactions were reported and interpreted. As a result, the 4 phases learning environment supported by GeoGebra was found practical and beneficial in terms of examining some advanced properties of a parabola.

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Another research study involving the use of GeoGebra was conducted by Zulnaidi and Zakaria (2012). They examined the effects of GeoGebra on students' conceptual and procedural knowledge of function. 124 high school students participated in the study. The study used quasi-experimental non-equivalent pretest posttest control group design. The results revealed a significant difference between groups. It was concluded that GeoGebra improved high school students' not only conceptual knowledge but also procedural knowledge.

Doktoroglu, 2013 investigated the effect of teaching Linear equation with Dynamic mathematic software. The purpose of the study was to investigate the effects of teaching linear equations with Dynamic Mathematics Software (GeoGebra) on seventh grade students' achievement compared to the regular instruction. Randomized posttest-only control group design was utilized in the study. 60 seventh grade students (32 girls and 28 boys) of a public school in Yenimahalle district in Ankara participated in the study. The study was conducted in 2011-2012 fall semester, lasting 9 class hours in three weeks. The data was collected by three Mathematics Achievement Tests: Cartesian coordinate system achievement test (MAT1), linear relation achievement test (MAT2) and graph of linear equation achievement test (MAT3). The quantitative analysis was conducted by using analysis of covariance (ANCOVA). The results revealed that teaching Cartesian coordinate system and linear relation by using Dynamic Mathematics Software had no significant effect on seventh grade students' achievement compared to the regular instruction. On the other hand, the results also indicated that teaching graph of linear equations by using Dynamic Mathematics Software had a significant effect on seventh grade students' achievement positively.

The foregoing background information constitute the theoretical rationale for testing the effectiveness of GeoGebra and demonstration method on students' academic performance in mathematic in Secondary School in Akwa Ibom North West Senatorial District.

Research Questions

1. What is the difference in the mean score of students in Mathematics when taught using GeoGebra and demonstration method in the Mathematics Achievement Test?

2. What is the difference in the mean score of students in Linear Inequality when taught using GeoGebra feedback and demonstration method in the Mathematics Achievement Test?

3. What is the difference in the mean score of students in gradients to the curve when taught using GeoGebra virtual manipulatives and demonstration method in the Mathematics Achievement Test?

4. What is the difference in the mean score of students in area under the curve when taught using GeoGebra visualization and demonstration method in the Mathematics Achievement Test?

5. What is the difference in the mean score of students in construction of triangles when taught using GeoGebra problem-solving strategy and demonstration method in the Mathematics Achievement Test?

6. What is the difference in the mean score of students in construction of tangent to a circle when taught using GeoGebra modeling and demonstration method in the Mathematics Achievement Test?

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Null Hypotheses

1. There is no significant difference in the mean score of students in Mathematics when taught using GeoGebra and demonstration method in the Mathematics Achievement Test.
2. There is no significant difference in the mean score of students in Linear Inequality when taught using GeoGebra feedback and demonstration method in the Mathematics Achievement Test.
3. There is no significant difference in the mean score of students in gradient to the curve when taught using GeoGebra virtual manipulatives and demonstration method in the Mathematics Achievement Test.
4. There is no significant difference in the mean score of students in area under the curve when taught using GeoGebra visualization and demonstration method in the Mathematics Achievement Test.
5. There is no significant difference in the mean score of students in construction of a triangle when taught using GeoGebra problem-solving strategy and demonstration method in the Mathematics Achievement Test.
6. There is no significant difference in the mean score of students in construction of tangent to a circle when taught using GeoGebra modeling and demonstration method in the Mathematics Achievement Test.

METHODOLOGY

The Study employed quasi experimental Pre-test Post-test design with non-randomization of the subjects. The specific design used for the study was pre-test, post-test nonrandomized control group design

Design of the Experiment

Group		**Treatment**	
GeoGebra	1	X1	3
Demonstration	2	X2	4

The population of this study consisted of all the 361,486 secondary school students in the 85 Public Secondary Schools in the Akwa Ibom North West Senatorial District in the 2014/2015 school session. The study sample consisted of 500 SS II students that offered Mathematics. This sample was drawn from six intact classes in the six selected secondary schools in the study area. Criterion sampling technique was used to select the six schools from 85 public secondary schools in the study area that meets the following criteria. The school must be co-educational, have professional graduate teachers of mathematics with at least B.Sc (Ed.) degree teaching the SS II class, must have computer laboratory with at least 20 functional computers or laptops, must have a steady source of electricity power generation. In each of the six schools, two intact

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classes were chosen by simple random sampling (Balloting with replacement). Six intact classes were assigned to experimental and control groups. The distribution of samples is shown in Appendix A_2.

The instrument that was used in this study was the 50 items researcher developed multiple choice mathematics test titled, Mathematics Achievement Test (MAT). It was constructed in line with the content of the curriculum for SS II which includes: Linear Equation, Quadratic Equation, Linear Inequality, Simultaneous Linear Equation, Simultaneous One Linear , One Quadratic Equation, construction of triangle, gradient to a curved, Area under the curve, tangent to a circle to reveal strength and weaknesses in students mathematical abilities.

Instructional packages for the mathematics consisted of prepared lessons plan on selected mathematic topic, and GeoGebra was used as a tool for instruction for the experimental group while Demonstration method of instruction was given to the control group.

This instrument Mathematics Achievement Test consisted of (50) multiple choice items with options A-E having four distractors and one correct option. The researcher scored the instrument immediately after its administration and each correct option was scored two (2) marks while any wrong option was scored zero (0).

GeoGebra and the demonstration method lesson plans and the Mathematics Achievement Test (MAT) were faced and content validated by three research experts one from the Mathematics Department and two from Educational Foundation Department in the University of Uyo, Uyo. They were requested to assess the content coverage; the suitability of the items, language used, and item arrangement in logical sequence.

The items were trial–tested on 40 SS II students in one of the schools in the study area that met the criteria but did not participate in the main study. The scores obtained from the trial-test were subjected to item analysis to determine the reliability indices of the instrument. Kuder Richardson's formula 21 (KR-21), was used to determine the reliability coefficient of the instrument. The result showed reliability coefficient of 0.89. Since there was a high reliability index, the instrument was deemed suitable to be used in conducting the study.

In the Six secondary schools chosen for the study, two intact classes each were exposed to experimental and control group respectively. The treatment was implemented, which is GeoGebra for experimental group and demonstration method for the control group in eight weeks, totaling eight class hours for each group in 2014- 2015 session was used. Students in both groups took the treatments in regular school hours.

Pre-test was administered before the treatment at the same time for both groups in their regular classrooms. One day after the last day of the treatment, MAT was implemented, as a post-test. The experimental groups were exposed to GeoGebra software instructions and the control groups were taught with Demonstration method. The same topics were taught to both the GeoGebra and Demonstration groups. But groups received their lessons in their classes, but the GeoGebra group received theirs with the use of computer and computer software.

Pre-existing differences in overall academic ability using the test as parameter between the GeoGebra and Demonstration groups were accounted for through the pretest administration on the two groups. (GeoGebra and Demonstration groups) and the result was used as the covariate measures. The 50 multiple choice test items for both the pretest and port-test were drawn from the nine topics chosen from the SS II mathematics syllabus for senior secondary schools.

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The Mathematics teachers of SS II chosen from the selected schools were co-opted to assist as research assistants. To qualify the teachers as research assistants, the researcher used one month and one of the schools in the study area as the centre to train them on how to teach their respective groups using the researcher developed lesson packages. This was done during the long vacation. The training focused on instructional packages. This includes teaching using the specified instructional methods (GeoGebra and Demonstration) and sequence, following the topics in the lesson plans. The scoring of the instrument was handled by the researcher to avoid bias and experimental contamination. All these were carried out to check against extraneous variables.

The research involved two main stages, which were the administration of pre-test and post-test that contained the same questions arranged in different order. Teachers had been trained on the use of the GeoGebra method of instruction. The study was conducted for a period of eight weeks during which nine topics, via; construction of triangle, linear equation, Quadratic equation, simultaneous equation, linear inequalities, gradient to a curve, area under the curve, simultaneous one linear one quadratic and construction of a tangent to the circle were taught.

The pre-test was administered in the first week of the research exercise to the whole students before the GeoGebra and Demonstration groups were subjected to treatments. After the administration of the pre-test, students in the experimental groups were taught using GeoGebra, while those in control group were taught using demonstration method of instruction. The two groups were taught by their regular teachers.

Data generated were analyzed using mean and standard deviation to answer the research questions. Analysis of Covariance (ANCOVA) was used in testing all the hypotheses at .05 levels of significance. ANCOVA is a method of data analysis that ensures comparability and equality of groups before treatment. The groups involved were statistically equated on the basis of critical variable known as covariates (Udo, 2003). In this study, the groups were equated on the basis of pretest scores.

RESULTS

Table 1: Pretest-Post Test achievement test scores of GeoGebra and Demonstration groups in mathematics

Variable	Group	N	Pre-Test		Post-Test		Mean Diff.	Diff. of Mean Diff.
			$\bar{X}$	SD	$\bar{X}$	SD		
Mathematics	GeoGebra	257	40.07	11.72	79.65	15.72	39.16	31.55
	Demonstration	243	36.20	12.29	43.81	12.30	7.61	

From Table 1 the mean of Pre-Test was ($\bar{X}$ =36.20 SD= 12.29) for Demonstration group while the mean of Pre-Test was ($\bar{X}$ =40.07, SD=11.72) for GeoGebra group. The GeoGebra group in the Pre-Test, was almost the same with that of the Demonstration group. The difference of the mean differences is 31.55 a very high mean gain.

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The hypothesis was tested to find out whether the difference in mean found in research questions is significant or not. The result of the analysis is presented in Table 2

Table 2 : Result of ANCOVA – Tests of between GeoGebra and Demonstration Group

Source	Adjusted Sum of Square	df	Mean Square	F	Sig.
Covariates	7267.087 (a)	1	7267.087	1.160	
Main Effect	126564.110	1	126564.110	20.20	.016
Error	3120214.830	498	6265.492		.000
Total	3246778.94	499			

(a) R Squared = .190 (Adjusted R. Squared = .080) (f – critical = 3.84)

As it is seen in Table 1, there was a statistically significant mean different between GeoGebra ($\bar{X}$ =79.65, SD=15.72) and Demonstration ($\bar{X}$ = 43.81, SD = 12.30) in respect to post-test scores in mathematics. This means that Geogebra usage had a significant effect on performance of student in mathematics positively.

Table 3: Pretest-Post Test achievement test scores of GeoGebra and Demonstration groups in Linear Inequality

Variable	Group	N	Pre-Test		Post – Test		Mean Diff.	Diff. of Mean Diff.
			$\bar{X}$	SD	$\bar{X}$	SD		
Linear Inequality	GeoGebra	257	2.23	2.20	4.19	2.51	1.96	1.05
	Demonstration	243	2.39	2.60	3.30	2.84	0.91	

From Table 4 the mean of Pre-Test was ($\bar{X}$ =2.39SD= 2.60) for Demonstration group while the mean of Pre-Test was ($\bar{X}$ =2.23, SD=2.20) for GeoGebra group. The difference of the mean differences is 1.05.

The hypothesis was tested to find out whether the difference in mean found in research questions is significant or not. The result of the analysis is presented in Table 4.

Table 4: Result of ANCOVA – Tests of between Linear Inequalities

Source	Adjusted Sum of Square	Df	Mean Square	F	Sig.
Covariates	217.6806 (a)	1	217.6806	3.447	.971
Main Effect	1018.07	1	1018.07	16.123	.000
Error	31446.6842	498	63.1460		
Total	32464.760	499			

R Squared = .057 (Adjusted R. Squared = .052) (f – critical = 3.84)

As it is seen in Table 4, there was a statistically significant mean different between GeoGebra

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($\bar{X}$ =4.19, SD=2.51) and Demonstration($\bar{X}$ = 3.30, SD = 2.84) in respect to post-test scores in Linear Inequality. This means that Geogebra feedback usage had a significant effect on performance of student in Linear Inequality positively.

Table 5: Pretest-Post Test achievement test scores of GeoGebra and Demonstration groups in Gradients to the curve

Variable	Group	N	Pre-Test		Post – Test		Mean Diff.	Diff. of Mean Diff.
			$\bar{X}$	SD	$\bar{X}$	SD		
Gradients to the curve	GeoGebra	257	7.12	1.58	11.57	2.03	4.45	2.12
	Demonstration	243	6.82	1.67	9.15	2.01	2.33	

From Table 6 the mean of Pre-Test was ($\bar{X}$ =6.82SD= 1.67) for Demonstration group while the mean of Pre-Test was ($\bar{X}$ =7.12, SD=1.58) for GeoGebra group. The difference of the mean differences is 2.12.

The hypothesis was tested to find out whether the difference in mean found in research questions is significant or not. The result of the analysis is presented in Table 6

Table 6: Result of ANCOVA – Tests of between Gradient

Source	Adjusted Sum of Square	df	Mean Square	F	Sig.
Covariates	479.353(a)	1	479.3530	19.066	.346
Main Effect	466.3671	1	466.3617	18.550	.000
Error	12520.3409	498	25.1412		
Total	12986.708	499			

R Squared = .125 (Adjusted R. Squared = .011) (f – critical = 3.84)

As it is seen in Table 6, there was a statistically significant mean different between GeoGebra

($\bar{X}$ =11.57, SD=2.03) and Demonstration ($\bar{X}$ = 9.15, SD = 2.01) in respect to post-test scores in Gradients to the Curve. This means that Geogebra visualization usage had a significant effect on performance of student in Gradients to the Curve positively.

Table 7: Pretest-Post Test achievement test scores of GeoGebra and Demonstration groups in Area under the curve

Variable	Group	N	Pre-Test		Post – Test		Mean Diff.	Diff. of Mean Diff
			$\bar{X}$	SD	$\bar{X}$	SD		
Area under a curve	GeoGebra	257	8.30	2.05	10.96	2.41	2.66	0.64
	Demonstration	243	6.70	1.88	8.72	3.58	2.02	

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From Table 8 the mean of Pre-Test was ($\bar{X}$ =6.70SD= 1.88) for Demonstration group while the mean of Pre-Test was ($\bar{X}$ =8.30, SD=2.05) for GeoGebra group. The difference of the mean differences is 0.64.

The hypothesis was tested to find out whether the difference in mean found in research questions is significant or not. The result of the analysis is presented in Table 8

Table8: Result of ANCOVA-Tests of between Areas

Source	Adjusted Sum of Square	df	Mean Square	F	Sig.
Covariates	927.9561(a)	1	927.9561	5.598	.000
Main Effect	1865.6489	1	1865.6489	11.255	.000
Error	82551.8271	498	165.7667		
Total	84417.476	499			

R Squared = .243 (Adjusted R. Squared = .135) (f – critical = 3.84)

As it is seen in Table 13, there was a statistically significant mean different between GeoGebra ($\bar{X}$ =10.96, SD=2.41) and Demonstration($\bar{X}$ = 8.72, SD = 3.58) in respect to post-test scores in Area under a curve. This means that Geogebra virtual manipulatives usage had a significant effect on performance of student in Area under a curve positively.

Table 9: Pretest – Post Test achievement test scores of GeoGebra and Demonstration groups in construction of triangle

Variable	Group	N	Pre-Test		Post-Test		Mean Diff.	Diff. of Mean Diff.
			$\bar{X}$	SD	$\bar{X}$	SD		
Construction of a Triangle	GeoGebra	257	6.23	1.81	11.82	1.15	5.59	4.14
	Demonstration	243	5.77	2.09	7.44	1.59	1.45	

From Table 10 the mean of Pre-Test was ($\bar{X}$ =5.77SD= 2.09) for Demonstration group while the mean of Pre-Test was ($\bar{X}$ =6.23, SD=1.81) for GeoGebra group. The mean differences were 4.14. The hypothesis was tested to find out whether the difference in mean found in research questions is significant or not. The result of the analysis is presented in Table 10.

Table 10: Result of ANCOVA – Tests of between Construction Triangles

Source	Adjusted Sum of Square	df	Mean Square	F	Sig.
Covariates	3989.737 (a)	1	389.7370	3.836	.095
Main Effect	1353.4578	1	1353.4578	13.322	.000
Error	50595.7582	498	101.5979		
Total	51949.216	499			

R Squared = .102 (Adjusted R. Squared = .034) (f – critical = 3.84)

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As it is seen in Table 10, there was a statistically significant mean different between GeoGebra ($\bar{X}$ =11.82, SD=1.15) and Demonstration($\bar{X}$ = 7.44, SD = 1.59) in respect to post-test scores in Construction of a Triangle. This means that Geogebra problem-solving strategies usage had a significant effect on performance of student in Construction of a Triangle positively.

Table 11: Pretest-Post Test achievement test scores of GeoGebra and Demonstration groups in construction of tangent to the circle

Variable	Group	N	Pre-Test		Post -Test		Mean Diff.	Diff. of Mean Diff.
			$\bar{X}$	SD	$\bar{X}$	SD		
Construction of Tangent to the circle	GeoGebra	257	7.12	1.59	13.26	1.12	6.14	3.94
	Demonstration	243	6.72	1.75	8.92	1.46	2.20	

Analysis on Table 11 shows that the Pre-Test and Post-Tests of students in construction of tangent to the circle. The mean of Pre-Test was ($\bar{X}$ =6.72,SD= 1.75) for Demonstration group while the mean of Pre-Test was ($\bar{X}$ =7.12, SD=1.59) for GeoGebra group. The difference of the mean differences is 3.94.

Hypothesis 10: There is no significant difference in the mean score of students in construction of tangent to a circle when taught using Geogebra and Demonstration method in the mathematic achievement test.

The null hypothesis tested was at 0.5 level of significance. The hypothesis was tested to find out whether the difference in mean found in research questions is significant or not. Also the hypothesis ten was used to find out the interaction effects of Geogebra and Demonstration method as measured by mean performance score in the Post-test.

The result of the analysis is presented in Table 12

Table 12: Result of ANCOVA – Tests of between GeoGebra and Demonstration Construction

Source	Adjusted Sum of Square	df	Mean Square	F	Sig.
Covariates	894.8083 (a)	1	394.8083	14.342	.088
Main Effect	5771.5496	1	5771.5496	20.97	.000
Error	13079.3764	498	27.5289		
Total	19480.926	499			

a. R Squared = .103 (Adjusted R. Squared = .035)

As it is seen in Table 12, there was a statistically significant mean different between GeoGebra ($\bar{X}$ =13.26, SD=1.12) and Demonstration($\bar{X}$ = 8.92, SD = 1.46) in respect to post-test scores in Construction of Tangent to the circle. This means that Geogebra modeling usage had a significant effect on performance of student in Construction of Tangent to the circle positively.

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DISCUSSION OF FINDINGS

The summary of the data analysis revealed that GeoGebra group that used GeoGebra had a higher mean gain score of 39.16 in post - test while the mean gain score of 7.61 for Demonstration group that used Demonstration method was low.

To find out if the difference in the mean gain score among the two groups is significant or not ANCOVA test was used which showed that a significant main effect was observed for teaching method with respect to post- test $F(1,498) = 20.20$, $P < 0.00$. This revealed significant difference between the mean performance score of students taught mathematics with GeoGebra and those students taught with Demonstration method, in favour of GeoGebra. Thus, the hypothesis that there is no significant difference in the mean scores of students taught mathematics with GeoGebra and Demonstration method in the Mathematics Achievement Test was rejected.

The finding made an emphatic premise which gave support to what was earlier stated by (Zulnaidi and Zakaria, 2012). That GeoGebra improve students' performance in mathematics more than ordinary Demonstration method. It also improves students' motivation with positive effect. Also, the result of this study agreed with that of (Hohenwarter and Lavicza, 2007). Who proved GeoGebra application in mathematics classroom more effective than ordinary teaching method and Dikovic (2009) who reported that GeoGebra can be a powerful tool for visualization and simulation, leading to an understandable mathematics solution. (Hohenwarter and Fuchs, 2004, Hohenwarter and Jones, 2007, Hohenwarter. 2006, 2009, 2010, Hohenwarter and Hohenwarter, 2012).

A great deal of researchers, Hutkemri and Zakaria, 2012 had earlier given support to the use of GeoGebra. According to Saha, AyubLuban and Tarmizi (2010) research, GeoGebra group achieved significantly higher than the expository group; affirmed GeoGebra method to be significantly more effective, suitable and productive in teaching and learning of mathematics in large classes than Demonstration method. These reports may be one of the learners need guide to explore and visualize mathematics concept, therefore GeoGebra can help to minimize this gap between teachers and mathematics learning(Hohenwarter and Fuchs, 2004, Hohenwarter and Jones, 2007, Hohenwarter. 2006, 2009, 2010, Hohenwarter and Hohenwarter, 2012).

In this study, the effect of using GeoGebra on student's performance in learning geometry was examined. With the current exponential development in information and communication technology in the field of education, the present study examines the effectiveness of using GeoGebra as a tool in teaching and learning mathematics. The results of the study indicated that there was a significant difference between the performance of the Demonstration group, which underwent the Demonstration method of teaching, and the GeoGebra group, which was taught utilizing GeoGebra. The results of this study are consistent with the study by (Hohenwarter and Fuchs, 2004, Hohenwarter and Jones, 2007, Hohenwarter. 2006, 2009, 2010, Hohenwarter and Hohenwarter, 2012) which showed a positive effect of using Mathematical learning software GeoGegra thus motivating the students towards Geometry learning((Zulnaidi and Zakaria, 2012; Hohenwarter and Lavicza, 2007).

This software can support the mainstream of teaching and learning. It is also observed that there was an improvement in the reasoning and visualization skills of the students. This finding is supported by (Zulnaidi and Zakaria, 2012). GeoGebra helped the students in representation

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of mathematical concepts in different ways, which can catalyse the power of learners for learning Mathematics. This is consistent with the study done by (Hohenwarter and Lavicza, 2007).

Grandgenett (2008) and Hohenwarter, Jarvis and Lavicza (2009). GeoGebra is an effective tool in the education process of secondary school students for: the demonstration, teaching and the learning of basic mathematical processes. It can be viewed as a supplement for teaching and learning of geometry.

The aim of this research was to try to check, on the basis of the scores the students obtained on a test, if there was a positive effect of using GeoGebra virtual manipulative and visualization in the differential calculus teaching. The test in question consisted of simple tasks, chosen in order to check the elementary knowledge of students in differential calculus: what is the "accumulation point" of a sequence, computing some basic limits of the functions, computing left-hand and right-hand limit of the functions, understanding the of the function on a interval, understanding the instantaneous rate of change of function at a point, geometrical interpretation of derivative, etc.

Since the statistical analysis of ANCOVA showed that the scores at the post-test were significantly better, it confirmed the fact that the use of the virtual manipulative applets created with the help of GeoGebra and used in differential calculus teaching, had a positive effect on the understanding knowledge and performance of the students.

That further shows that GeoGebra can be a powerful tool for visualization and stimulation of the key notions of differential calculus (the slope of tangent line, connection between slope of the tangent line and graph of the gradient function, continuity/discontinuity of function, connection between differentiability and continuity etc.); the fact that helped the students improve their knowledge. This finding is supported by (Zulnaidi and Zakaria, 2012).

CONCLUSION

In preparing students for being successful mathematical problem solvers, both for school mathematics as well as beyond school, rich problem solving experiences starting from the elementary school and continuing to secondary school needs to be implemented and appropriate technological tools like GeoGebra needs to be effectively used in solving these real-world based problems. Results from research work like provide students, teachers and curriculum designers with details of evidence on how computer-based modeling activities can assist students in accessing higher order mathematical understandings and processes, for improved performance.

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