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INNOVATIVE STRATEGIES ON TEACHING PLANE GEOMETRY USING GEOGEBRA SOFTWARE IN SECONDARY SCHOOLS IN DELTA STATE

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ABSTRACT

The study investigated the effect of innovative strategy in the teaching and learning of mathematics plane geometry using GeoGebra software. Two research questions and two null hypotheses guided the study. The study is quasi-experimental, using pre-test and posttest control design. The study was carried out in Oshimili-South Local Government Area of Delta State. Purposive sampling of fifty-nine (59) SS2 mathematics students was made from the population of eight hundred and seventy-seven (877) students. The instrument used for the study was a Performance Mathematics Ability Test (PMAT). The reliability coefficient of the instrument was ascertained using Cronbach Alpha and was found to be 0.75. The findings showed that there was a significant difference between the mean performances of students' when taught plane geometry using GeoGebra software and problem based learning but no significant difference with respect to gender. It was recommended that enough mathematics software in schools especially GeoGebra should be provided.

KEYWORDS: Innovative strategies GeoGebra Software and plane geometry,

INTRODUCTION

Technology plays a critical role in changing classroom environment and reforming schools to promote more meaningful and result oriented learning.

Technology is the use of tools, machines, techniques, crafts, systems and methods of organization in order to perform a specific function (Wikipedia encyclopedia, 2014). Technology leads to effective teaching and learning by providing a medium for teachers and students to be continuously involved in the process, regardless of their levels. We are immersed in a society that is becoming increasingly dependent on technology for its survival and as a necessity to compete globally. Teachers are working with learners whose lives have been incorporated into this 21st century media culture. These days learners are digital learners; they literally take in the world through the myriad of computing devices such as digital cameras, music players, phones, handheld gaming devices, laptops, ipads, computers and televisions. Therefore, education ought to be structured to meet the needs of these learners. Technology-based tools transform mathematics concepts to an understandable form for teachers and learners (Niess, 2006). Ndlovu, Wessels and De Villiers (2011) spell out that there is an increasing trend to integrate technology into mathematics education in many countries globally. Integration of technology into the teaching and learning of mathematics brings in new and innovative ideas, particularly when they are supported by appropriate software for both teachers and students. With the technology potentials, educational institutions are now seeking for new paradigms to reform their educational curricula and classroom facilities to bridge the existing technology gap in education. This process however requires effective adoption of technologies into existing environment, in order to provide learners with the required knowledge to promote meaningful learning (Tomei, 2005). The ultimate goals of integrating

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technology into the classroom are to facilitate learning efficiently and create a positive change in students' academic performance.

A lot of Mathematics software have been developed to aid teaching and learning of mathematics which includes: Geometer's Sketchpad Mathematical, Computer Algebra System such as Axiom, Maxima, Reduce, Magma, Giac/xcas, Live math Tm, Mathics, Fermat, Mathematical, Math mechanics, Calc 3D Pro, Graphsketch, and Smath Studio. Dynamic Geometry software such as GeoGebra connect both geometer's sketchpad and computer algebra in one program for mathematics teaching.

The word 'Geo' is taken from Geometry and 'Gebra' derived from Algebra. GeoGebra is a Dynamic Mathematics Software (DMS) for teaching and learning mathematics that combines many aspects of different mathematical packages which can be download from www.geogebra.org(Hohenwarter and Lavicza, 2007). It is a form of freely-available, open-sources educational mathematics software that provides a flexible tool for visualizing mathematical ideas from elementary to university level, ranging from simple to complex constructions (Hohenwarter & Jones, 2007). Abramovich (2013) defines GeoGebra as a free online software application for the study of geometry, algebra, and calculus. This software combines geometry, algebra and calculus into a single easy-to-use package for teaching and learning mathematics from elementary to university level. GeoGebra is a new software system that integrates possibilities of both dynamic geometry and computer algebra in one tool for mathematics education. It allows a closer connection between the symbolic manipulation and visualization capabilities and dynamic changeability (Hohenwarter & Fuchs, 2004). The main idea of using GeoGebra in everyday teaching and learning is to provide opportunities for students of different mathematical skills and levels for better understanding of concepts and fostering them to doing mathematics in new at-tractive ways (Hohenwarter 2008). Therefore, it is in the researcher's interest to know how to make students' understanding of mathematics through the use of GeoGebra to present a new idea and to make connection between the ideas.

Statement of the Problem

The alarming poor state of mathematics in our schools, as revealed by the students' dismal performance in public examinations such as SSCE and JAMB, calls for an urgent need to constantly seek ways of improving the teaching and learning of the subject. Ekwueme (2013) defined mathematics as a means of communication and a tool for solving problems in a wide range context. In this sense, it can be said that one of the important components of efficient mathematics education is to teach and be able to look at concepts and events in multiple ways. Learning Mathematics involves understanding the theories and formulas to describe a phenomenon. In the typical classroom, the challenge for the students is to explore complex problems with advances in multimedia technology; then learning difficulties can be overcome. GeoGebra software would be an alternative that might enable students to transfer new information into their memories in a simpler form. Students' learning strategies vary and GeoGebra is believed to give attention to individual difference of the students as it helps in maximizing their learning performance (Slameto, 2003).

Aims and Objectives of the Study

The aim of this study is to examine the effectiveness of Geogebra software strategies and teaching of plane geometry in secondary schools in Oshimili-South Local Government Area of Delta State.

The specific objectives are to:

i) determine the performance of students when taught plane geometry using GeoGebra software and problem based learning in Oshimili-South LGA of Delta State;
ii) find out the effect of gender on the performance of students taught with GeoGebra software and problem based learning in Oshimili-South LGA of Delta State;

Research Questions

The following research questions were formulated to guide the study

1) What are the pre-test and post-test performance scores of students' when taught plane geometry using GeoGebra software and problem based learning (PBL)?
2) To what extent do pre-test and post-test performance scores of male and female students taught plane geometry using GeoGebra software and problem based learning differ?

Hypotheses

1) There is no significant effect of teaching methods on students' performance in plane geometry.
2) There is no significant effect of gender on students' performance in plane geometry.

Methodology

The design for this study is quasi-experimental with a non-equivalent pre-test and post-test control group design. Quasi-experimental design was chosen because the study used intact groups as subjects (Wiersma, 2000). Pre-test and post-test were given to both experimental and control groups only that the experimental group was exposed to student centered learning strategy while control group was exposed to problem base learning.

	Pre-test		Treatment		Post-test
Experimental Group:	O1	→	X1	→	O2
Control Group:	O3	→		→	O4

O1 –Pre-test score for experimental group
X1 – Treatment, the experimental group
O2 –Post-test score for experimental group
O3 – Pre-test score for control group
O4 – Post-test score for control group

The population of this study consists of all private Senior Secondary two (SS2) students in the 15 private schools in Oshimili-South Local Government area of Delta State, with a population of 877 (Delta state Universal Basic Education Board Statistics for 2013/2014 Session). Two (2) private secondary schools were selected for this study using purposive sampling. All the students in the intact class formed the sample for the study- a total of fifty-nine (59) students. The instrument for the study was a Performance Mathematics Ability Test (PMAT), which included pre-performance test and post-performance test. Face, content and construct validation of the instrument was done by two experts in Curriculum Studies and Educational Technology who critically examined the work and the corrections were reflected on the final draft of the instrument. Reliability of the instrument was ascertained using Cronbach Alpha. A pilot study was carried out in two secondary schools in Oshimili-South Local Government Area of Delta State which are not part of the sample. The reliability coefficient of the instrument was found to be 0.75**.** The data from the performance tests were collected and analyzed by Statistical Packages for Social Sciences 21 (SPSS). The research questions were answered using mean and standard deviation.. The hypotheses were tested using ANCOVA at 0.05 level of significance.

RESULTS

Research Question One

What is the pre-test and post-test performance scores of students when taught Mathematics geometry using GeoGebra application and Problem Based Learning (PSL)?

Table 1: Mean performance scores and Standard Deviation (S.D) of students taught with GeoGebra application and Problem Based Learning (PBL)

Methods	**N**	**Type of test**	**Mean**	**S.D**
GeoGebra	28	Pre-test	37.57	6.888
	28	Post-test	51.68	3.411
		Mean Gain	14.11	
PBL	31	Pre-test	30.00	7.289
	31	Post-test	41.81	7.092
		Mean Gain	11.81	
TOTAL	**59**			

The mean gain of the students taught plane geometry with GeoGebra was 14.11 while that of the students taught with problem based learning method was 11.81. This implies that the students taught mathematical plane geometry using the GeoGebra method improved better in performance when compared with students in the Problem based learning

Research Question Two

To what extent do the pre-test and post-test performance scores of male and female students taught plane geometry using GeoGebra application and Problem Based Learning (PBL)?

Table 2: Mean performance scores and standard deviation (S.D) of male and female students taught with GeoGebra application and Problem Based Learning (PBL)

Gender	Group	N	Pre-test Mean	S.D	Post-test Mean	S.D	Mean Gain
Male	GeoGebra	16	36.50	6.044	53.25	3.000	16.75
	PBL	17	29.29	8.550	42.71	6.669	13.41
	Total	33	32.79	8.188	47.82	7.422	15.03
Female	GeoGebra	12	39.00	7.920	49.58	2.811	10.58
	PBL	14	30.86	5.586	40.71	7.868	9.860
	Total	26	34.62	7.808	44.81	7.483	10.19
Total	GeoGebra	28	37.57	6.888	51.68	3.411	14.11
	PBL	31	30.00	7.289	41.81	7.181	11.81
	Total	59	33.59	8.007	46.49	7.537	12.90

Testing of Hypotheses

The two hypotheses were tested at 0.05 level of significance

Ho_1: There is no significant difference between the mean performance scores of students taught plane geometry using GeoGebra software and problem based learning.

Table 3: ANCOVA result of subject performance scores in GeoGebra application and Problem Based Learning (PBL)

Source	Sum of Squares	df	Mean Square	F	Sig.	Decision at $p < 0.05$
PRE	181.397	1	181.397	6.048	.017	S
METHODS	722.585	1	722.585	24.093	.000	S
Error	1679.549	56	29.992			
Total	130821.000	59				
Corrected Total	3294.746	57				

Table 3, showed that there was a significant difference in mean performance scores of students taught plane geometry using GeoGebra application and Problem based learning ($F(1, 56) = 24.093$, with $P = 0.000$; $P < 0.05$). Therefore, the null hypothesis was rejected at 0.05 level of significant. This implies that there is a significant effect of treatment on students' performance in plane geometry.

Table 4: Post-hoc analysis of performance scores of students' taught Mathematics plane geometry using GeoGebra application and Problem Base Learning (PBL).

Pairwise Comparisons

Dependent Variable: Post-test score on Mathematics plane geometry using GeoGebra application and Problem based learning

S(I) Method	(J) Method	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a] Lower Bound	Upper Bound
GEOGEBRA	PBL	7.970*	1.624	.000	4.717	11.223
PBL	GEOGEBRA	-7.970*	1.624	.000	-11.223	-4.717

The Post hoc analysis on table 4 indicates that the mean difference of performance of students in the GeoGebra group and also in the problem based learning was 7.970 and the mean difference of problem based learning as against GeoGebra was -7. 970. The result shows that the mean difference was significant at 0.05 level. Since the mean performance of students in the GeoGebra group is higher than those in PBL group and the difference is significant, it then follows that the mean difference in the performance of GeoGebra is significantly higher than the one of PBL group. The difference is therefore generalizable.

Ho_2: There is no significant difference of gender on students' performance when taught plane geometry using GeoGebra software and problem based learning.

Table 5: ANCOVA result of performance scores of students with respect to gender

Dependent Variable: post-test on Gender and the methods of instruction

Source	Sum of Squares	df	Mean Square	F	Sig.	Decision at p < 0.05
Pre	232.585	1	232.585	8.341	.006	S
Methods	625.293	1	625.293	22.425	.000	S
Gender	165.280	1	165.280	5.927	.018	S
Methods* Gender	13.680	1	13.680	.491	.487	Ns
Error	1505.718	54	27.884			
Total	130821.000	59				
Corrected Total	3294.746	57				

Table 5, showed that there is no significant difference in the mean performance scores of male and female students taught plane geometry with GeoGebra method and problem based learning method (F (1, 54) = 0.491, with P = 0.487; P > 0.05). Therefore, the null hypothesis was accepted at 0.05 level of significant

DISCUSSION OF FINDINGS

Results on Table 1 showed that GeoGebra application was more effective in improving students' understanding in mathematical plane geometry (mean post-test score = 51.68, mean gain score = 14.11) than the problem based learning (mean post-test score = 41.81, mean gain score = 11.81). This finding is consistent with Emaikwu, Iji and Abari (2015) which showed that the mean pre-test scores for GeoGebra method group was 42.29 ± 7.96 and the mean pre-test for the conventional method group is 41.76 ± 7.72. However, the mean of post- test for the Geogebra method group is 62.60 ± 7.65 while the mean of the post test scores for the conventional method group is 49.24 ± 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.

When the mean difference in the present study was put to statistical test using the ANCOVA, the result in table 3, showed that there is a significant difference between students with GeoGebra application and Problem based learning (F (1, 56) =24.093, with P= 0.000; P< 0.05). Therefore, the null hypothesis was rejected at 0.05 level of significance. This is in line with the study of Ahmad and Rohani (2010) which discovered that the independent-t test comparing the post-test results of the two groups showed that there was a significant difference between mean performance scores of the control group (M=54.7, SD= 15.660) compared to GeoGebra group (M= 65.23, SD= 19.202; t(51) = 2.259, p = .028 < .05). This finding indicated that students who had learned Coordinate Geometry using GeoGebra was significantly better in their performance compared to students who underwent the problem based learning method.

A post-hoc test of Least Significant Difference was used to check the significance of GeoGebra application and problem based learning, and the result showed that the mean difference is significant at the .05 level. The result concurs with Emaikwu, Iji and Abari (2015) in their study that there is no significant difference between the pre-test and post-test performance of students taught Mathematics with the use of GeoGebra software". The study revealed that the students in experimental group gained higher scores in their post-test performance than the pre-test performance. By implication, there was significant difference between the pre-test and post-test performance of students taught Mathematics with the use of GeoGebra software.

Table 2 revealed that the male and female in GeoGebra method group gained better understanding than those in the problem based learning, hence this is no much difference between the male and female mean performance scores in plane geometry, even though the male students slightly outperformed the female in mean gain of GeoGebra application and problem base learning. This study agrees with the assertions that gender difference may happen but a good method of teaching should be employed to eliminate the differences (Etukudo, 2002).

In test of hypothesis 2 in Table 5 revealed that there is no significant difference between the male and female students taught with GeoGebra application and problem based learning. This study is in agreement with Idowu (2012) that there was no significant difference in the students' performance based on gender. However, the study is against the findings of 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. The author concluded that GeoGebra group performed better than the students in the traditional group

CONCLUSION

This study concluded that GeoGebra method of teaching plane geometry enhances students' performance in plane geometry and also motivates their interest in learning of plane geometry more than the problem based learning method. The male and female students in the GeoGebra method group showed more interest in learning plane geometry than the male and female students in problem based learning method. Therefore, students' performance in mathematics irrespective of gender, can be greatly enhanced through the integration of GeoGebra software into mathematics curriculum which will help the students to develop positive attitude towards the learning of mathematics.

RECOMMENDATION

The following recommendations are made sequel to the findings, from the study:

1. Computer should be adequate in each schools
2. Teachers should be well trained in the use of computer in classroom instruction
3. Provision of enough mathematics software in schools especially GeoGebra
4. Regular seminars and workshops should be organized for teachers on the use of softwares.

REFERENCES

Abramovich, S., 2013. Computers in Mathematics Education: An Introduction. Computers in the Schools, 30, (1): 4-11.

Ahmad, F. M and Rohani, A. T., 2010. Effect of Technology enhanced teaching on performance and cognitive load in calculus. International journal of Education and information technologies. 2, (4): 109-119.

Emaikwu, S. O., Iji, C and Abari, M., 2015. Effect of GeoGebra on Senior Secondary School Students' Interest and Achievement in Statistics in Makurdi Local Government Area of Benue State Nigeria. Journal of Mathematics (IOSR-JM). 2, (3), 14-21.

Ekwueme, C. O., 2013. Mathematics Teaching and Learning in Schools. Radiant Ventures Nig Ltd, Calabar.

Etukudo, U. E., 2002. The effect of computer–assisted instruction on gender and performance of junior secondary school students in mathematics. ABACUS, Journal of Mathematical Association Nigeria, 27, (1): 1-8.

GeoGebra.http://www.geogebra.org/

Hohenwarter, M., 2008. GeoGebra.Dynamic mathematics software.http://www.geogebra.org.

Hohenwarter, M and Fuchs, K., 2004. Combination of dynamic geometry, algebra and calculus in the software system GeoGebra. Retrieved July, 27, 2010,fromhttp://www.geogebra.org/publications/pecs_2004.pdf.

Hohenwarter, M and Jones, K., 2007. Ways of linking Geometry and Algebra: The case of Geogebra. Paper presented at the Proceedings of the British Society for Research into Learning Mathematics. University of Northampton: UK.

Hohenwarter, M and Lavicza, Z., 2007. Mathematics teacher development with ICT: Towards an International GeoGebra Institute. Paper presented at the Proceedings of the British Society for Research into Learning Mathematics. University of Northampton: UK.

Idowu, C. B., 2012. Nigeria college students' performance in mathematical biology In Oyo State Journal of Mathematical Association of Nigeria (OSJMAN). 3, (2): 1- 9.

Ndlovu, M., Wessels, D and De Villiers, M., 2011. An instrumental approach to modelling the derivate in Sketchpad. Pythagoras, 32, (2): 1–15. http://dx.doi.org/10.4102/pythagoras.v32i2.52

Niess, M. L., 2006. Preparing teachers to teach mathematics with technology. Contemporary Issues in Technology and Teacher Education, 6, (2): 195–203.

Tomei, L. A., 2005. Taxonomy for the technology domain. USA: Information Science Publishing.

Wikipedia, 2014. Technology. Retrived from Wikipedia, the free encyclopedia.