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Effects of GeoGebra Software Package on the Mathematics Performance of Senior Secondary Students with Dyscalculia in Bayelsa State Nigeria

Oti, Blessing Onyinyechi[1]; George, Nchelem Rosemary PhD[2]

[1]Department of Mathematics, Royal Palm Academy Azikoro Town Yenagoa, Bayelsa State Nigeria
[2]Department of Mathematics/Statistics, Ignatius Ajuru University of Education Port Harcurt, Rivers State Nigeria

ABSTRACT

This study investigated the effects of GeoGebra software package on the mathematics performance of senior secondary students with dyscalculia in Bayelsa State Nigeria. Two research questions and two null hypotheses were answered and tested at 0.05 significant level respectively. The pretest post test quasi experimental research design was employed. Wechsler Intelligence Scale for Children- Fifth Edition (WISC-V) was used to identify and select a sample of 38 students with dyscalculia. TCAT was used to measure students' performance in Trigonometry. The KR-21 was used to obtain a reliability index of 0.81.The descriptive statistic and Analysis of Covariance (ANCOVA) were employed for statistical data analysis. The study found that the use of GeoGebra software package improved the performance of dyscalculic students in trigonometry than those who were taught with deductive teaching method. The study also found that there no significant difference between effect of the use of GSP to teach the male and the female dyscalculic students trigonometry over the use of DIM. It was therefore recommended that mathematics teachers should embrace the use of technology (Geogebra software) and other innovative instructional strategies to enhance the academic performance of students with dyscalculia.

KEYWORDS: *Mathematics, GeoGbra software, dyscalculia, trigonometry, students*

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INTRODUCTION

Mathematics is an inevitable school subject which is utilized in every aspect of human activities. Ozofor and Onos (2018) asserted that mathematics affects every area of human activity and as such its teaching in school should be carried out so as to improve the problem solving skills of students. The knowledge of mathematics helps to develop in students the skills of clarity, brevity, accuracy, logical and creative reasoning, precision and certainty in expression and solution to basic and applied problems. The capability of students to develop the afore mentioned skills is focused and directed towards both ability and disability students. This is because the main objective of the secondary school mathematics curriculum is to prepare every student for higher education or a successful work life.

There are varied methods of teaching mathematics in the school. The particular method employed by the teacher depends on factors such as the topic to be taught, the ability level of the students, the class size (Anyaozu, 2017). The method of teaching mathematics is broadly classified into the traditional teaching method and the innovative teaching methods. The use of traditional teaching method to teach students mathematics has left us with nothing more than to produce students who dwell in memorization of mathematical facts and processes. The traditional teaching method makes students to understand mathematics concepts instrumentally without knowing the how and why of doing the mathematics process. This may suggest why Saye (2010) opined that traditional teaching method has impacted negatively on students and this has contributed to the poor performance of students in the subject.

The method of teaching mathematics changes from time to time and in line with the societal trend and wave. Thus Charles-Ogan and George (2015) opined that the mathematics curriculum should always be revisited by curriculum planners to reform and address the call of trending societal problems. The world is presently functioning at the technological and digital level; an era where technological gadgets are integrated into our daily activities in all sectors. Thus, Ebisine (2013) asserted that re-engineering mathematics education for technological development in Nigeria will be of great benefit to the economy.

Eyyam and Yaratan (2014) opined that the use of technology to carry out instruction in mathematics is critical because it allows teachers to provide immediate feedback, individualization of learning opportunities, motivation of students, flexible and collaborative learning. Mathematics

softwares which are oriented to teach different mathematical concepts abound. Examples of mathematics softwares are Geometer Sketchpad, GeoGebra, maxima, Colour mathematics, Graph Sketch, REDUCE, Maple 15, Dplot Graphing, Mathematica, MatLab, Origin, Sage math et cetera. GeoGebra software is a mathematics software which was invented for the educational purpose to execute mathematical problems related to trigonometry, algebra, statistics, calculus application and Geometry. It possesses components that make it interactive and user friendly and as such can be used to teach and learning of mathematics from primary school to tertiary institution (Gamage & Charles-Ogan, 2019).

Since GeoGebra software is user friendly and interactive, it then becomes essential that it can be integrated in the teaching of trigonometry to students with dyscalculia. Dyscalculia is a term which is used to describe learning problems which is associated with mathematics. It is a specific developmental disorder which is seen in students who struggle to understand mathematics related concepts during the acquisition of mathematical knowledge. Students with dyscalculia find it difficult to:

1. Understand and manipulate numbers
2. Perform mathematical computations
3. Understand mathematical concepts and facts
4. Apply mathematical formula to solve real life problems.

The students with dyscalculia possess a form of disability which needs to be catered for as against neglecting them to drown in their disability. Employing innovative instructional strategies therefore becomes the response to this situation.

The research findings of Emaikwu, Iji and Abari (2015) on the effect of GeoGebra on senior secondary school students' interest and achievement in Statistics in Benue state, Nigeria found that students who were taught with GeoGebra had a higher interest and achievement than those taught with the conventional method. Adelabu, Makgato and Ramaligela (2019) researched on the dynamic geometry computer software and learners' performance in geometry and the result revealed that the use of technology had a positive effect on the performance of those taught with it than those without technology. The findings of Onaifo and Ekwueme (2017) who conducted a study on the effect of innovative strategy in the teaching and learning of plane geometry using GeoGebra software showed that there was no significant difference in the performance of students who were taught with GeoGebra with respect to gender. This study therefore sought to investigate the possible effect which GeoGbra software package could have on senior secondary school students with dyscalculia.

Statement of the Problem

The researchers have observed that one of the major challenges of teaching and learning mathematics in schools is how to teach and ensure that students of all ability levels comprehend the mathematics concepts to facilitate effect retrieval and application when needed. The mathematics teachers teach the students mathematics concepts without employing teaching methods that can cater for the needs and interest of the ability and disability students. The society is in the digital era where every activity carried out in all sectors is done in technological driven environment. Also, the students in today's classroom are all digital residents and as such, they love to use technology with all pleasure. Since the students with dyscalculia in today's classroom are digital residents, the researchers decided to investigate the possible effect that the use of GeoGebra software package can have on their academic performance in trigonometry.

Objectives of the Study

The objectives of this study were to:

1. Determine if there is any difference in the performance of students with dyscalculia who were taught trigonometry using GeoGebra Software Package (GSP) and those who were taught without GeoGebra software package but taught using Deductive Instructional Method (DIM).
2. Find out whether there is any difference in the performance of the male and the female students with dyscalculia who were taught trigonometry using GeoGebra software package and those who were taught without GeoGebra software package but taught using deductive instructional method.

Research Questions

1. What is the difference in the performance mean score of students with dyscalculia who were taught trigonometry using GeoGebra software package and those who were taught using deductive instructional method ?
2. What is the difference in the performance mean score of the male and female students with dyscalculia who were taught trigonometry using GeoGebra software package and those who were taught using deductive instructional method?

Hypotheses

Two null hypotheses were tested at 0.05 significant level.

H_{01}: There is no significant difference in the performance mean score of students with dyscalculia who were taught trigonometry using GeoGebra software package and those who were taught using deductive instructional method.

H_{02}: There is no significant difference in the performance mean score of the male and the female students with dyscalculia who were taught trigonometry using GeoGebra software package and those who were taught using deductive instructional method.

Research Design

The research utilized the pretest, posttest non randomized, non equivalent intact class quasi experimental design. The decisive factor for utilizing this design was because the experiment was carried out on students who are human beings.

Population of the Study

A total of 2,813 senior secondary one students in the 20 public senior secondary schools in Yenagoa Local Government Area of Bayelsa State in Nigeria constituted the population of the study.

Sample and Sampling Technique

A sample of 38 public senior secondary one students with dyscalculia was used for the study. A purposive sampling technique was used to select two schools from the school population. Co-educational public schools that operate in technological driven environment was the criterion for selection of school. Wechsler Intelligence Scale for Children-Fifth Edition (WISC-V) was used to identify and select

students with dyscalculia. Simple random sampling was used to assign one of the sample school to experimental group and the other to control group.

Instrument for Data Collection

A 25-item multiple choice questions were used to construct the instrument which was used to collect data for the study. The instrument was constructed by the researchers based on the trigonometric concepts that were taught (basic trigonometric ratios and the derived trigonometric ratios). The instrument which was an achievement test was named Trigonometric Concepts Achievement Test with the acronym TCAT. The 25 items in TCAT had four options from the lower case first four English alphabets (a, b, c, d). Only one out of the four options was the correct answer for each item of TCAT. Each correct answer attracted 4marks while each incorrect answer attracted zero mark. TCAT was scored over a total of 100. To ensure an evenly distributed test items to measure the lower and higher order cognitive learning outcomes, a test blue print was used to prepare TCAT.

The researchers prepared two different lesson plans which were used to teach the two groups. The lesson plan for the experimental group was used to teach the experimental group whereas, the lesson plan for the control group was used to teach students in the control group. The lesson plan for the experimental group was prepared by integrating the GeoGebra software package and the lesson plan for the control group did not integrate the GeoGebra software package but rather employed the deductive instructional method.

Validation of Instrument

TCAT was validated by two experts in mathematics education. The constructive inputs of the experts were used to modify the instrument before administration to the sample.

Reliability of the Instrument

Ten students with dyscalculia who were not participants in the study were used for this. The Kuder- Richardson, KR-21 was used to obtain a reliability coefficient 0.81 for TCAT.

Procedure for Data Collection

The students were first given a pretest of TCAT. After the pretest, both groups were taught trigonometry using the two lesson plans that were prepared by the researchers. The intact class mathematics teachers were briefly trained by the researchers on how to carry out the teaching. The students in the experimental group were taught trigonometry with the use of GeoGebra software package while the students in the control group were taught same trigonometric concepts without the use of GeoGebra software package but rather with the conventional deductive instructional method. After the treatment a post test of TCAT was administered to both groups in a reshuffled form. The pre test and post test scripts were collated, marked and graded.

Statistical Tool for Data Analysis

The mean and standard deviation were used to answer the research questions while the Analysis of Covariance (ANCOVA) was used to test the hypotheses at 0.05 significant level.

Results

Table 1: Descriptive statistic on the performance learning gain of dyscalculic students taught trigonometry using GeoGebra software package and those taught using DIM

		GSP N = 20		DIM N = 18	
		Statistic	Std. Error	Statistic	Std. Error
Mean		30.27	2.31	22.64	1.97
95% CI for Mean	Lower Bound	24.83		18.47	
	Upper Bound	32.70		23.55	
Median		31.00		22.00	
Std. Deviation		10.63		10.07	
Minimum		14.00		5.00	
Maximum		57.00		42.00	

CI = Confidence Interval

Table 1 showed that the performance learning gain of students with dyscalculia who were taught trigonometry using GSP was 30.27 ± 10.63 and the 95% CI moved from 24.83 to 32.70. The performance learning gain of the students with dyscalculia who were taught trigonometry without GSP but DIM was 22.64 ± 10.07 and the 95% CI moved from 18.47 to 23.55.

Table 2: Descriptive statistic on the performance learning gain of the male and the female dyscalculic students taught trigonometry using GSP and those taught using DIM

Sex			GSP		DIM	
			Statistic	Std. Error	Statistic	Std. Error
Male	Mean		32.41	2.18	24.51	1.85
	95% CI for Mean	Lower Bound	27.25		20.74	
		Upper Bound	36.40		28.91	
	Median		33.00		22.00	
	Std. Deviation		8.74		10.36	
	Minimum		22.00		30.00	
	Maximum		57.00		42.00	

Female	Mean		28.13	2.74	20.77	3.01
	95% CI for Mean	Lower Bound	18.38		16.43	
		Upper Bound	34.85		25.72	
	Median		18.00		25.00	
	Std. Deviation		11.42		9.74	
	Minimum		14.00		5.00	
	Maximum		45.00		42.00	

Table 2 reveals that the performance learning gain of the male students with dyscalculia who were taught trigonometry using GSP was 32.41 ± 8.74 and their 95% CI moved from 27.25 to 36.40. The performance learning gain of the male students with dyscalculia who were taught trigonometry using DIM was 24.51 ± 10.36 and their 95% CI moved from 20 to 28. However, on same table 2, it was shown that the performance learning gain of the female students with dyscalculia who were taught trigonometry using GSP was 28.13 ± 11.42 and their 95% CI moved from 18.38 to 34.85. The performance learning gain of the female students with dyscalculia who were taught trigonometry using DIM was 20.77 ± 9.74 and their 95% CI moved from 16.43 to 25.72.

Table 3: Summary of ANCOVA on the effect of sex on the performance learning gain of dyscalculic students taught trigonometry using GSP and those taught using DIM

Source	Type III Sum of Squares	Df	Mean Square	F	p-value	η^2
Corrected Model	7041.802a	2	3520.901	28.635	.000	
Intercept	4467.445	1	4467.445	36.333	.000	
Pre TCAT	2775.019	1	2775.019	22.569	.000	.003
Group	4280.049	1	4289.049	34.882	.000	.284
Error	4303.592	35	122.960			
Total	132425.000	38				
Corrected Total	11345.395	37				

a. R^2 = .621 (Adjusted R^2 = .599)

Table 3 showed that there was a significant effect of the use of GSP to teach dyscalculic students trigonometry over the use of DIM (F1, 35 = 34.882, p = .000, Partial eta squared = .284). H_{01} was therefore rejected at .05 significant level. The rejection of HO1 indicated that there was a significant difference between performance mean score of students with dyscalculia who were taught trigonometry using GeoGebra software package and those who were taught using deductive instructional method.

Table 4: Summary of ANCOVA on the effect of sex on the performance learning gain of dyscalculic students taught trigonometry using GSP and those taught using DIM

Source	Type III Sum of Squares	Df	Mean Square	F	p-value	η^2
Corrected Model	595.586b	2	297.793	1.655	.220	
Intercept	6096.727	1	6096.727	33.877	.000	
Pre TCAT	560.377	1	560.377	3.114	.096	.003
Sex	10.820	1	10.820	.060	.809	.000
Error	3059.414	35	179.966			
Total	92100.000	38				
Corrected Total	3655.000	37				

b. R^2 = .163 (Adjusted R^2 = .064

Table 4 showed that there was no significant effect of the use of GSP to teach the male and the female dyscalculic students trigonometry over the use of DIM (F1, 35 = .060, p = .809, Partial eta squared = .000). H_{02} was therefore retained at .05 significant level. Retaining H_{02} indicated that there was no significant difference between the performance mean score of the male and the female students with dyscalculia who were taught trigonometry using GeoGebra software package and those who were taught using deductive instructional method. This finding is in agreement with pervios finding of

Discussion of Findings

The result presented in table 1 revealed that the students with dyscalculia who were taught trigonometry using GSP had a higher mean performance than those who were taught using DIM. The finding specifically revealed that the students taught using GSP had a performance learning gain of 7.63 more than those taught using DIM. This result shows that the use of Geogebra Software Package had the capability to improve the performance of students with dyscaulia in trigonometry. Putting this result to statistical test, table 2 showed that there was a significant difference in the performance mean score of students with dyscalculia who were taught trigonometry using GeoGebra software package and those who were taught using deductive instructional method. This finding is in agreement with previous research findings of Emaikwu, Iji and Abari (2015); Adelabu, Makgato

and Ramaligela (2019); Onaifo and Ekwueme (2017); Bwalya (2019) and Charles-Ogan and gamage (2019) which examined the use of mathematical softwares to teach students varied mathematical concepts. However this finding varies with the finding of Amerta and Yellan (2018) whose finding indicated that the use of mathematics software had no significant effect on students performance in mathematics.

The result in table 3 showed that the male students with dyscalculia who were taught trigonometry the GSP gained more than their counters who were taught using DIM. The finding specifically revealed that the male students who were taught using GSP gained more than their male counterparts who were taught with DIM with a learning gain of 7.9. The finding also specifically revealed that the female students who were taught using GSP gained more than their female counterparts who were taught with DIM with a learning gain of 7.4. This result shows that the use of Geogebra Software Package had the capability to improve the performance of both the male and the female dyscalculic students in trigonometry. When subjected to statistical test, that there was no significant difference between the performance mean score of the male and the female students with dyscalculia who were taught trigonometry using GeoGebra software package and those who were taught using deductive instructional method. This finding is in disagreement with the previous finding of Adelabu, Makgato and Ramaligela (2019); Onaifo and Ekwueme (2017); Bwalya (2019); Pavethira and Leong (2017) and Akanmu (2015).

Conclusion

Based on the findings of this study, it was concluded that the use of GeoGebra software package to teach students with dyscalculia improved their performance in trigonometry and there was n significant difference in the performance of the male and the female students who were taught trig

Recommendations

The findings of the study made the researchers to recommend that

1. Mathematics teachers should use of technology (Geogebra software) and other innovative instructional strategies should be embraced to enhance the academic performance of students with dyscalculia.
2. Mathematics teachers should ensure that both the male and the female students with dyscalculia are meaningfully engaged in the class during classroom instruction.

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