Origami-Based Instruction and Junior Secondary School Students' Academic Performance in Mathematics in Rivers State

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Abstract- ***This study investigated Origami-based Instruction and Junior Secondary School Students' Academic Performance in Mathematics in Rivers State. Two research questions and two null hypotheses were answered and tested respectively. The design of the study was quasi experimental research which involved pretest, treatment and posttest. A sample of 104 students was drawn from a population of 4,584 Junior secondary school one students in government owned secondary schools in Port Harcourt Local Government Area of Rivers State. The research instrument titled Geometry Performance Test was used for data collection. Kuder- Richardson Formula 20 was used to determine the consistency of the instrument and the reliability index of 0.82 was obtained. Mean and standard deviation was used to answer research questions while the null hypotheses were tested using Analysis of Covariance at 0.05 level of significance. Findings showed that students taught with origami-based instructional approach in the experimental group had a higher performance than those taught with chart in the control group with a statistically significant difference. The male students performed better than the female students in the experimental group with no statistically significant difference It was recommended amongst others that origami-based instructional approach should be used to teach Solid Geometry in Junior secondary school one.***

Indexed Terms- ***Origami, Geometry, Performance, Instruction***

I. INTRODUCTION

It is globally acknowledged that education is the tool or instrument for national development which can be achieved through learning and character inculcated in the students for them to eventually fit into the society after schooling. What students are taught in schools are encapsulated in the various school subjects. Mathematics happens to be one of the school subjects which are taught and made compulsory in both primary and secondary schools.

The broad goal of secondary education is to prepare students for higher education and a useful living in society. Mathematics as a subject keyed into the broad goal of secondary education to outline the objectives of teaching Mathematics in schools. Mathematics education has the potential of making individuals relate their knowledge to everyday problems which are encountered in society. It also has the potential of developing the individual to a level of being logically, intellectually and economically stable. Odetola and Salman (2014) posited that despite the importance of Mathematics to personal, organizational and societal activities, the performance of students in the subject has been persistently low. Several scholars have attributed the low performance of students in Mathematics to factors such as scarcity of instructional materials in schools, low teachers' qualifications, the nature of the subject, myths that surround the subject, inappropriate teaching methods and overload of Mathematics curriculum (Amadioha, 2016 and George & Zalmon, 2019).

Nigerian Educational Research and Development Council (2007) has spelt out the contents of the subject thematically and the various instructional approach that can be used to teach the contents to produce optimal academic performance among students in schools. The themes in junior secondary school Mathematics curriculum are Number and Numeration, Basic Operations, Algebraic Processes, Mensuration, Geometry and Everyday Statistics.

Geometry is an aspect of Mathematics that deals with shapes and measurements. It has to do with the sizes and shapes of objects, position and dimension of objects in the environment. Geometry goes further to establish the relationship amongst the variables. Ogu (2017) defined Geometry as an area of Mathematics that deals with space and its co-domains. The knowledge of Geometry provides leverage for students to understand other areas of Mathematics such as trigonometry, calculus, mechanics and mensuration (Omus, 2015). The application of Geometry is also seen in other academic subjects such as Physics, Economics, Biology, Chemistry, Technical drawing and Fine arts. The application of Geometry is also useful in most professional and vocational callings.

One of the objectives of teaching geometry in schools is to develop the skills of spatial visualization, critical thinking, deductive reasoning and logical argument in students. This, therefore, makes it crucial that geometrical concepts should be taught using geometrical activities that students come in contact with during their play period. It has been observed that students' poor performance in Mathematics, especially in geometry, is a result of teachers failed methods that do not arouse students' interest and activities due to lack of exploration of geometrical objects (Unodiaku,2017). The conventional teaching activities which teachers employ to teach concepts in geometry are the use of charts and chalkboard drawings. These conventional activities lack pure exploration of the geometrical concepts. Mathematics teachers should therefore look out for other well researched activities in which students can be engaged during the teaching of geometrical concepts to enhance students' performance in Geometry.

There is an ancient Japanese art that has to do with paper folding. This art of paper folding is known as origami. Origami is an ancient Japanese cultural heritage. Pope (2016) opined that origami-based instruction can be employed to teach students of all age grades geometry in an explorative form. Oslon (2016) added that there are so many geometrical concepts that can be taught with the use of origami. The activities involved in origami inspire the creativity of students and at the same time build their spatial geometrical understanding which can be applied in certain professions and vocations. The research investigation of Boakes (2015) revealed that origami can be used to teach students mathematical concepts and also explore the mathematics that is inherently embedded and linked to artistic designs.

The junior secondary school students are at the foundational stage of learning geometry by geometrical argument. To succeed in geometrical argument, students need to be sound, versatile and flexible with and in the use of geometrical terms or concepts. Maduaku (2018) investigated the performance of students in Mathematics in Basic Education Certificate Examination (BECE) and Junior School Certificate Examination (JSCE) and found out that even though students perform well in Mathematics, their performance in questions that are geometry related was poor. This may suggest why George (2020) posited that students should be taught Mathematics concepts using a mastery learning instructional approach.

Given that all these suggestions have been embarked upon by teachers, the West African Examination Council, WAEC Chief Examiner reported in 2015, 2016 and 2017 that students' performance in geometric questions has continuously remained poor because of non-mastery of geometric concepts. The report suggested that teachers should teach students geometry for mastery of geometrical concepts. Origami-based instructional approach involves the art of paper folding. Students are creative and enjoy paper work when at play. Many mathematical concepts are encapsulated in the art of paper folding. This study, therefore, investigated the possible effect that origami-based instruction could have on the performance of students in Geometry.

- Statement of the Problem

The continuous poor performance of students in geometric questions is worrisome to the researcher who thinks that it could be as a result of students' non-exploration of geometric figures for mastery at the early stage of junior secondary school (Ugwu, 2018). Origami which is the art of paper folding with a lot of mathematical inclination embedded in it could be employed to salvage students' poor performance in geometry. This is because students at the junior secondary level are at the age of playing with paper

work such as the construction of aeroplanes, ships, butterflies, dresses, guns et cetera. This formed the backdrop against which this study was conducted. This study, therefore, investigated Origami-Based Instruction and Junior Secondary School Students' Academic Performance in Mathematics in Port Harcourt Local Government Area of Rivers State, Nigeria.

- Aim and Objectives

The aim of this study was to investigate the effect of Origami-Based Instruction on Junior Secondary School Students' Academic Performance in Mathematics in Port Harcourt Local Government Area of Rivers State

Specifically, the objectives were to:

1. examine if there is any difference in the mean performance score of students taught Solid Geometry using origami-based instructional approach with those taught using charts based instructional approach.
2. find out the difference between the mean performance scores of the male and the female students taught Solid Geometry using origami-based instructional approach

- Research Questions

1. What is the difference in the mean performance score of students taught Solid Geometry using origami-based instructional approach with those taught using charts based instructional approach?
2. How does the mean performance scores of the male and the female students taught Solid Geometry using origami-based instructional approach differ?

- Hypotheses

Two null hypotheses were tested at 0.05 significant level.

H_{O1}: There is no significant difference between the mean performance score of students taught Solid Geometry using origami-based instructional approach with those taught using charts based instructional approach.

H_{O2}: There is no significant difference in the mean performance scores of the male and the female students taught Solid Geometry using origami-based instructional approach.

II. MATERIALS AND METHOD

The research design employed for this study was pretest and posttest quasi experimental non-randomized, non-equivalent intact class design. One experimental and one control group were presented. The experimental group was taught Geometry with origami-based instruction while the control group was taught with chart-based instruction. The population of the study comprised of all the four thousand five hundred and eighty-four (4,584) junior secondary school one (JSS1) students in the eighteen (18) public junior secondary schools in Port Harcourt Local Government Area of Rivers State. The multistage sampling technique was employed to draw a sample of one hundred and four (104) JSS1 students from the population.

The instrument used to collect data was titled Geometry Performance Test (GPT) which was made up of twenty-five (25) multiple-choice questions in Solid Geometry. The regular teachers of the intact classes were employed as research assistants to carry out the teaching to reduce teacher-effect. GPT was validated and had a reliability index of 0.82 using Kuder-Richardson Formula 20. The mean and standard deviation were used to answer the research questions while the null hypotheses were tested using Analysis of Covariance (ANCOVA) at 0.05 level of significance.

III. RESULTS

- Research Question 1: What is the difference in the performance mean score of students taught Solid Geometry using origami-based instructional approach with those taught using charts based instructional approach?

Table 1: Mean and Standard Deviation on Performance mean score of Students taught Solid Geometry using OBI with those taught using CBI.

		Pretest		Post-test		Gain	
Group	N	Mean	SD	Mean	SD	Mean	SD
OBI	45	29.36	8.89	49.46	12.29	20.10	10.73
CBI	59	31.79	9.71	46.19	7.87	14.40	9.36

Key: OBI= Origami-Based Instruction, CBI= Chart-Based Instruction

Table 1 showed that students who were taught Solid Geometry with origami-based instruction in the experimental group had a performance mean gain of 20.10, SD = 10.73 and those taught with charts in the control group had a mean gain of 14.40, SD = 9.36. The data analyzed in Table 1 showed that students taught Solid Geometry with origami-based instruction performed better than students taught with charts.

- Research Question 2: How does the mean performance scores of the male and the female students taught Solid Geometry using origami-based instructional approach differ?

Table 2: Mean and standard deviation on how performance mean scores of the male and the female students taught solid geometry using origami-based instruction differ.

			Pretest		Posttest		Performance Gain	
Group	Gender	N	Mean	SD	Mean	SD	Mean	SD
OBI	Male	19	26.11	8.47	48.53	11.74	22.42	8.26
	Female	26	31.73	8.58	50.15	12.86	18.42	10.41

Table 2 showed the mean and standard deviation on how the performance mean score of students taught solid geometry with origami-based instruction differ by gender. The data in Table 2 revealed that the male students that were taught with OBI had a performance mean score of 22.42, SD = 8.26 while the female students taught with OBI had a performance mean score of 18.42, SD = 10.41. It is evident from Table 2 that the male students who were taught solid geometry with OBI out-performed their female counterparts in the same group.

H_{O1}: There is no significant difference between the performance mean score of students taught Solid Geometry using origami-based instructional approach with those taught using charts.

Table 3: Summary of ANCOVA on the difference in the performance of students taught solid geometry using origami-based instructional approach with those taught using charts

Dependent variable: Posttest

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	3605.358[b]	2	1802.679	23.250	.000	.425
Intercept	1683.3871		1683.387	21.712	.000	.256
Group	3310.6831		3310.683	42.700	.000	.069
Pretest	360.587	1	360.587	4.651	.035	.404
Error	4884.581	101	77.533			
Total	353520.000	104				
Corrected Total	8489.939	103				

R Squared = .425 (Adjusted R Squared = .406)

From the result in Table 3, it was revealed that a significant difference exists between the performance mean score of students taught Solid Geometry with origami-based instructional approach and those taught using charts F1, 101=42.700, p=.000; p<.05, Partial eta squared =.069). H_{O1} was rejected at a probability level of 0.05 since the p-value was less than 0.05.

H_{O2}: There is no significant difference in the mean performance scores of the male and the female students taught Solid Geometry using origami-based instructional approach.

Table 4: Summary of ANCOVA on the difference between the performance of the male and the female students taught solid geometry with origami-based instructional approach

Dependent Variable: Posttest						
Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	340.759[b]	2	170.380	1.287	.295	.101
Intercept	14612.024	1	14612.024	110.411	.000	.828
Pre test	94.605	1	94.605	.715	.407	.030
Gender	235.852	1	235.852	1.782	.195	.072
Error	3043.856	42	132.342			
Total	128000.000	45				
Corrected Total	3384.615	44				

a. Group = OBI

b. R Squared = .101 (Adjusted R Squared = .022)

Table 4 showed the summary of ANCOVA on the difference between the performance mean score of students taught solid geometry with origami-based instructional approach when analyzed based on gender. The result presented in Table 4 showed that there is no significant difference between the male and the female students that were taught solid geometry with origami-based instruction (F1, 42 = 1.782, p=.195; p>0.05, Partial eta squared = .072. H_{O2} was therefore retained at 0.05 probability level since the p-value was greater than 0.05.

IV. DISCUSSION OF FINDINGS

Table 1 showed that students who were taught Solid Geometry with origami-based instruction in experimental group 1 had a performance mean gain of 20.10, SD = 10.73 and those taught with charts in the control group had a mean gain of 14.40, SD = 9.36. The data analyzed in Table 1 showed that students taught Solid Geometry with origami-based instruction performed better than students taught with charts. This finding is in agreement with the research findings of Ezendu (2021), Boakes (2019), George (2018), Akayuure, ASiedu-Addo and Alebna (2016), Wares (2019) and Kogce (2020) which revealed that students taught various Mathematics concepts with origami-based instruction performed better than their counterparts taught with traditional lecture method.

When subjected to statistical analysis, it was revealed that a significant difference exists between the performance mean score of students taught Solid Geometry with origami-based instructional approach and those taught using charts F1, 101=42.700, p=.000; p<.05, Partial eta squared =.069). H_{O1} was rejected at a probability level of 0.05 since the p-value was less than 0.05. This is also in agreement with the results of Ezendu (2021), Boakes (2019), Akayuure, ASiedu-Addo and Alebna (2016), Wares (2019) and Kogce (2020) which found out that there was a significant difference between the performance of students taught geometry with origami instruction and those taught with chart-based instruction. However, the finding of George (2018) is not in agreement with this finding.

The result presented in Table 3 revealed that the male students that were taught solid geometry in experimental group using OBI performed better than their female counter part who were taught the same concept in the same group. When subjected to statistical analysis, the result in Table 4 showed that there was no significant difference between the male and the female students that were taught solid geometry with origami-based instruction (F1, 42 = 1.782, p=.195; p>0.05, Partial eta squared = 0.072. As a result of this, H_{O2} was therefore retained at 0.05 probability level since the p-value was greater than 0.05. This finding is in agreement with the finding of Ezendu (2020), Fyum and Suleiman (2015) which showed that the male students who were taught with origami-based instruction performed better than their female counter part in the same group. Also in agreement with this finding is the finding of Salami (2016) whose result revealed that the male students who were taught geometry with paper folds achieved higher than the female students who were also taught the same geometry topics using the same paper folds. However, this finding is not in agreement with the finding of Zulleta and Nunu (2015) whose result

revealed that the female students who were taught geometric visualization and reasoning using paper folds had a higher mathematical reasoning ability in mensuration when compared with their male counterparts. Furthermore, the research findings of Ezendu (2020), Salami (2016), Fuyum and Suleiman (2015), Zulleta and Nunu (2015) are all in agreement with this finding which revealed that there was no significant difference between the male and the female students that were taught solid geometry with origami-based instruction

CONCLUSION

Based on the findings of the study, it was concluded that the use of Origami-based instruction enhanced the performance of students in geometry than the chart-based instruction and there was no statistically significant difference gender wise.

RECOMMENDATIONS

1. Origami-based instructional approach should be used to teach Solid Geometry in Junior secondary school one.
2. The Ministries of Education should equip the public schools with materials that can enable teachers and students to practice origami-based instructional approaches.

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