# EFFECT OF ORIGAMI-BASED INSTRUCTION ON JUNIOR SECONDARY SCHOOL STUDENTS' RETENTION IN SOLID GEOMETRY IN RIVERS STATE NIGERIA

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## Abstract

*This study examined the effect of origami-based instruction on junior secondary school students' academic retention in Solid Geometry in Rivers State. Two objectives, two research questions and two null hypotheses were answered and tested respectively. The design of the study was quasi experimental. 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 Solid Geometry Retention Test was used for data collection. Kuder- Richardson Formula 20 was used to determine the internal consistency of the instrument which yielded an index of 0.82. Students were administered pretest, posttest and post posttest in Solid Geometry using the validated instrument. Mean, standard deviation and Analysis of Covariance were used for analysis at 0.05 level of significance. Findings showed that the students taught with origami-based instruction in the experimental group had higher retention than students taught with charts. The male students had higher retention than the female students with no statistically significant difference. It was recommended amongst others that Mathematics teachers should teach students geometric concepts with origami because it aided retention in Junior secondary school one.*

**Keywords:** *Origami, Retention, Solid Geometry, Students.*

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## Introduction

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. Society is always changing and it can only take a changing and responsive Mathematics curriculum content to achieve the stated goals and objectives of teaching Mathematics in schools (George & Edekor, 2022).

From the ongoing, it becomes evident that the teaching and learning of Mathematics in schools have not been yielding the expected outcome with regards to the performance of taught contents. This pattern of students' poor performance in Mathematics will have a negative impact on the retention of acquired concepts and applicability to solve the countless societal problems which have been claimed by scholars to be one of the objectives of teaching Mathematics in schools.

Again, another objective of teaching Mathematics is to use mathematical knowledge to solve problems in the environment. Li and Schoenfeld (2019) opined that to employ mathematical knowledge to solve problems implies the application of the learnt mathematical knowledge in real life scenarios. The application of any learnt

knowledge or skill calls for the mastery and retention of that which was learnt. The question of how newly learnt mathematical concepts subsequently goes into the activity of solving problems becomes of utmost importance to Mathematics educators. Retention of learnt mathematical knowledge, therefore, is very crucial to the students as well as all stakeholders of Mathematics education.

Retention simply means the ability to acquire and continue to possess or retain something. Retention of learnt mathematical concepts by students, therefore, becomes the threshold by which the application of concepts comes to play. Students' performance and retention in Mathematics has continuously been researched by Mathematics educators to see how the improvement on them can help solve the individual, economic, organizational and societal problems because it is retention that paves way for the transfer of learning. Edukake (2017) asserted that in education, transfer of learning refers to learning in one context and applying it to another. There is an increasing concern as to what methods of teaching are most appropriate for Mathematics students. Barida (2013) posited that the use of innovative instructional strategies is the answer to improving the academic retention of students in Mathematics.

Uruanya, Reynolds and Bayutara (2014) suggested that the use of models and realia can improve students' academic retention in geometry as against the use of charts. Seyitrewe (2019) posited that children produce origami objects when they play without knowing that there are lots of mathematical concepts involved in the production process. Integrating origami in Mathematics teaching will therefore be a fun way of teaching students' geometrical concepts.

Nwachukwu (2017) defined origami as the craft of folding paper to make objects, animals or people. The origami art or technique of folding paper is carried out to produce a variety of decorative or representational shapes. The production of objects which have shapes in the art of paper folding links origami to geometry. Furthermore, Dannion (2016) posited that the art of paper folding has found itself useful in Mathematics, robotics, architecture and design fields. Professionals in these disciplines have employed paper folding art to develop dummies of models which are later used to manufacture real structures. Kruskal (2020) has maintained that mathematicians and scientists who model with origami do not have any fuss during the experimentation proper. This implies that origami is simpler to develop than most scientific theories and a lot easier to apply.

The use of origami-based instruction to teach concepts in solid geometry could therefore be investigated to ascertain whether it can improve and retain the taught concepts. The role which students' retention play in academics is that it can make students have possession of what they learnt and at the same time apply it to solve a myriad of problems that emanates from the environment. Solving real life problems by applying mathematical knowledge is the crux of every mathematical endeavor.

**Statement of the Problem**

The objectives of teaching Mathematics in junior secondary school are to develop in students' values such as the ability to reason logically, make rational decisions, think critically and creatively and solve problems and recognize situations in day-to-day activities where Mathematics can be applied. For these objectives to be achieved, the students have to acquire a sound knowledge of the subject matter (Mathematics). West African Examination Council (WAEC) Chief Examiner's Report (2017) has specifically pointed out that students' performance in questions related to geometry has continued to be a challenge to students stating that majority of students either skip the questions on geometry or score low for those of them who attempt to answer the questions. This could be as a result of poor retention of learnt concepts to retrieve them and used them when needed. The researcher, therefore, decided to seek other approaches which can be blended with the already known and well researched teaching methods that are employed to teach geometrical concepts. The origami-based instructional approach came to mind since it has to do with paper folding which most students are conversant with, though without knowing that there are mathematical implications involved in paper folding. The problem of the study is to examine if Origami-Based Instruction has effect on Junior Secondary School Students' Academic Retention in Mathematics Port Harcourt Local Government Area of Rivers State, Nigeria.

**Aim and Objectives**

The aim of this study was to examine the effect of origami-based instruction on junior secondary school students' retention in Solid Geometry in Port Harcourt Local Government Area of Rivers State

Specifically, the objectives were to:

1. ascertain if there is any difference in the mean retention score of students taught Solid Geometry using origami-based instructional approach with those taught using charts-based instructional approach.

2. examine the difference between the mean retention score 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 retention score of students taught Solid Geometry using origami-based instructional approach with those taught using charts based instructional approach?

2. What is the difference in the mean retention mean score of the male and the female students taught Solid Geometry using origami-based instructional approach?

**Hypotheses**

Hypotheses were tested at 0.05 significant level.

**$H_{O1}$:** There is no significant difference in the mean retention 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 retention score of the male and the female students taught Solid Geometry using origami-based instructional approach.

**Materials and Method**

Quasi experimental design that involved non-randomization of intact classes was employed. The design made use of pretest, posttest and post posttest treatment of the experimental and control groups. 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 constituted the population for the study. A simple random sampling technique was used to select a sample of 104 JSS1 students.

The instrument used for the collection of data was twenty-five (25) multiple-choice questions in Solid Geometry titled Solid Geometry Retention Test (SGRT). A table of specification was used to allot the test items into the six levels of Bloom's cognitive taxonomy. SGRT was validated by experts in Mathematics education. Kuder-Richardson Formula 20 Was used to establish an internal consistency of 0.82 for SGRT. Students in both experimental groups were first given a pretest of SGRT.

The students in the experimental group were taught solid geometry using the origami-based instructional approach while those in the control group were taught the same topic using chart-based instructional approach. After the treatment, a posttest of SGRT was administered to both groups. To ascertain the retention of students, a post posttest of reshuffled SGRT was administered to the two groups. The three sets of tests were marked upon 100% and collated. The statistical tools used to answer the research questions were the mean and standard deviation while Analysis of Covariance (ANCOVA) was used to test the null hypotheses at 0.05 level of significance.

**Results**

**Research Question 1:** What is the difference in the retention 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 retention mean score of students taught Solid Geometry using OBI with those taught using CBI.**

| | | Post-test | | Post-Posttest | | Gain | |
|---|---|---|---|---|---|---|---|
| **Group** | **n** | **Mean** | **SD** | **Mean** | **SD** | **Mean** | **SD** |
| OBI | 45 | 49.46 | 12.29 | 60.84 | 11.54 | 11.38 | 8.45 |
| CBI | 59 | 46.19 | 7.87 | 48.34 | 12.64 | 2.15 | 1.47 |

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

Table 1 showed that students who were taught Solid Geometry with origami-based instruction in experimental group 1 had retention mean gain of 11.38, SD = 8.45 and those taught using charts in the control group had a mean gain of 2.15, SD = 1.47. The data analyzed in table 1 showed that students taught geometry with origami-based instruction had higher retention than students taught with charts.

**Research Question 2:** What is the difference in the mean retention score of the male and the female students taught Solid Geometry using origami-based instructional approach?

**Table 2: Mean and standard deviation on retention mean score of the male and the female students taught solid geometry using origami-based instruction.**

| | | | Posttest | | Post -Posttest | | Gain | |
|---|---|---|---|---|---|---|---|---|
| **Group** | **Gender** | **N** | **Mean** | **SD** | **Mean** | **SD** | **Mean** | **SD** |
| OBI | Male | 19 | 51.11 | 16.27 | 65.43 | 13.32 | 14.32 | 8.30 |
| | Female | 26 | 47.81 | 12.10 | 56.25 | 12.88 | 8.44 | 4.26 |

Table 2 showed the mean and standard deviation on how the retention 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 retention mean score of 14.32, SD = 8.30 while the female students taught with OBI had retention mean score of 8.44, SD = 4.26. It is evident from table 2 that the male students who were taught solid geometry with OBI had higher retention than their female counterparts in the same group.

**$H_{O1}$**: There is no significant difference in the retention 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 retention of students taught solid geometry using origami-based instructional approach with those taught using charts**

**Dependent variable: post-Posttest**

| Source | Type III Sum of Squares | Df | Mean Square | F | Sig. | Partial Eta Squared |
|---|---|---|---|---|---|---|
| Corrected Model | 9386.62[b] | 2 | 4693.31 | 236.01 | .000 | .014 |
| Intercept | 999.89 | 1 | 999.89 | 50.28 | .000 | .765 |
| Group | 574.81 | 1 | 574.81 | 28.91 | .000 | .013 |
| Posttest | 8145.29 | 1 | 8145.29 | 409.59 | .000 | .001 |
| Error | 2406.25 | 101 | 19.89 | | | |
| Total | 559620.00 | 104 | | | | |
| Corrected Total | 11792.87 | 103 | | | | |

R Squared = .639 (Adjusted R Squared = .781)

Table 3 showed the presentation of the summary of ANCOVA on the difference between the retention of students taught Solid Geometry using origami-based instructional approach with those taught using charts. From the result in table 3, it was revealed that a significant difference exists between the retention mean score of students taught Solid Geometry with origami-based instructional approach and those taught using charts F1, 101=28.91, p=.000; p<.05, Partial eta squared =.013). $H_{O1}$ 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 retention score 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 retention of the male and the female students taught solid geometry with origami-based instructional approach**

**Dependent Variable: Post-Posttest**

| Source | Type III Sum of Squares | df | Mean Square | F | Sig. | Partial Eta Squared |
|---|---|---|---|---|---|---|
| Corrected Model | 3494.248[b] | 2 | 1747.124 | 60.977 | .000 | .103 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Intercept | 3689.749 | 1 | 3689.749 | 128.778 | .000 | .728 |
| Pre test | 3104.057 | 1 | 3104.057 | 108.336 | .000 | .041 |
| Gender | 34.448 | 1 | 34.448 | 1.202 | .279 | .081 |
| Error | 1317.997 | 42 | 28.652 | | | |
| Total | 284200.000 | 45 | | | | |
| Corrected Total | 4812.245 | 44 | | | | |

a. Group = OBI

b. R Squared = .726 (Adjusted R Squared = .014)

Table 4 showed the summary of ANCOVA on the difference between the retention 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 in the retention between the male and the female students that were taught solid geometry with origami-based instruction (F1, 42 = 1.202, p=.279; p>0.05, Partial eta squared = .081. HO2 was therefore retained at 0.05 probability level since the p-value was greater than 0.05.

**Discussion of Findings**

Table 1 showed that students who were taught Solid Geometry with origami-based instruction in experimental group 1 had retention mean gain of 11.38, SD = 8.45 and those taught using charts in the control group had a mean gain of 2.15, SD = 1.47. The data analyzed in table 1 showed that students taught solid geometry with origami-based instruction had higher retention than students taught with charts. When subjected to statistical test, the result revealed that a significant difference exists between the retention mean score of students taught Solid Geometry with origami-based instructional approach and those taught using charts F1, 101=28.91, p=.000; p<.05, Partial eta squared =.013). $H_{O1}$ was rejected at a probability level of 0.05 since the p-value was less than 0.05. This finding is in line with those of Obafemi and Onifade (2019), Kpaniku (2017), Ederinko, Kofi and Gullain (2019), Obi, Agwagah and Agah (2014) and Igwe (2020).

The result presented in table 2 revealed that the male students that were taught solid geometry in the experimental group using OBI had higher retention 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 retention of the male and the female students that were taught solid geometry with origami-based instruction (F1, 42 = 1.202, p=.279; p>0.05, Partial eta squared = .081. $H_{O2}$ 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.

**Conclusion**

Based on the findings of the study, it was concluded that the use of Origami-based instruction enhanced the retention of students in solid geometry than the chart-based instruction and there was no statistically significant difference between the male and female gender concerning retention.

**Recommendations**

The following recommendations were made based on the findings of the study.

1. Mathematics teachers should teach students geometric concepts with origami (paper folding) because it aided retention.
2. Teachers are encouraged to attend conferences, seminars, workshops and symposia organized by the Ministries of Education and professional bodies such as Mathematical Association of Nigeria (MAN), Science Teachers Association (STAN), Curriculum Organization of Nigeria (CON) and National Mathematical Centre (NMC) to learn the effective strategies to incorporate origami-based instruction in Mathematics.

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