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Origami Teaching Strategy and Student Retention of Geometry Concepts

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Abstract
This study investigated the effect of the origami teaching strategy on students' retention in geometry in secondary schools in Rivers State. Three research questions and three hypotheses guided the study. The study adopted a quasi-experimental design. Simple random sampling was used to select a sample size of one hundred (100) SS2 students for this study. The population for this study was 6961 students. The instrument for data collection was the Geometry Achievement Test (GAT). Data collected were analyzed using mean and standard deviation for the research questions, while ANOVA was used to test the hypotheses. The findings revealed that the use of origami proved superior to conventional instruction in promoting students' performance and enhancing students' retention of geometry concepts. It also showed that male students performed better than female students in retaining concepts taught in geometry using the origami teaching strategy. Based on the findings, the following recommendations were made: the use of origami should be adopted in the teaching of geometry at the primary, secondary, and tertiary levels of education. Seminars, workshops, and conferences should be held on how origami can be used effectively by mathematics teachers in the teaching and learning of mathematics.

Keywords: Origami Teaching Strategy, Retention and Geometry

Introduction

Origami is defined as the art of folding papers into Mathematical shapes for Mathematics instruction. Ori means to fold while gami means paper. Origami construction is defined as the practice of making geometric shapes through the folding of pieces of paper. According to Rachel (2016), origami is a Japanese expression meaning paper folding. Ori is paper and Kami is folding. Both ori and kami form what is called origami. It is an ancient art form being handed over from parents to children through several generations. Origami involves the folding of paper to form shapes such as folding paper into shapes that represent aquatic and terrestrial animals. According to Rachel (2016), the art of making paper originated from China in the year 102 A.D. It later became more pronounced to the masses. Folding paper into objects or shapes started in China years before it was imported into Japan by a Buddhist Monk. The crane is a well-known Origami model in Japan used for conveying stories. A crane is an origami model where paper is folded to convey a story of event, procedures for performing tasks, etc. Today, it is no longer called crane but Storigami.

Retention of concept is being able to recall or remember a previously learned concept. Retention of knowledge is defined as the ability to retain, remember and reproduce the learnt concept when the knowledge is required. Sternberg (1999) stated that retention is the way we remember previous knowledge to use it in the present. It involves the structures and processes for retaining and retrieval of knowledge. Aysegal (2016) studied Origami by conveying stories with Origami in Turkey, using a population of 110 students with a sample of 48 students', using stratified random sampling. The instrument used was the Mathematics Achievement Test. The design was quasi- experimental design. The study confirmed that conveying a story through Origami is a viable instructional method for teaching many topics in Mathematics. Origami is an instructional material. For any instructional material to be effective in geometry instruction, it should be one that can be felt and touched, for learners to see and perceive their position and size. Arici and Aslan (2015) studied 'The Effect of Origami Based Instruction on Spatial Visual of Geometry Achievement and Geometry Reasoning' in Minna, Nigeria. They used stratified random sampling to select a sample of 40 students. The design used was quasi- experimental design. The study revealed that origami-based instruction had a significant effect on spatial visualization, geometry achievement and geometric reasoning.

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Rybczynski et al. (2013) studied the 'Effect of Instructional Model on Students' Attitude in an Introductory Biology Laboratory' in the USA, used a sample of 137 students, selected through random sampling, and used an inquiry method. The study reported that instructional models were not as important as other factors in driving students' attitudes such as interaction for confidence, usefulness or motivation, instead grades and teachers' attitudes played a great role in determining students' attitudes than a laboratory. Sedanur et al. (2013) carried out a study in Turkey, using a sample of 48 students from a population of 110 students. Stratified random sampling was used. The instrument was a Mathematics Achievement Test, and the designs were quasi experimental and descriptive survey designs. The study showed that students developed positive opinions about origami-based instruction and its relation to Mathematics. Sukran et al. (2015) who studied the effect of Teaching Mathematics Creatively on Academic Achievement, Attitude towards Mathematics and Mathematics Anxiety in Turkey used stratified random sampling to collate a sample of 42 students. The instrument was a Mathematics Achievement Test, and the design was quasi-experimental. The study confirmed that employing teaching Mathematics creatively in 6th grade Mathematics affected the learners moderately in increasing Mathematics achievement and attitudes towards Mathematics and decreasing Mathematics anxiety. Hakki (2016) studied 'The Effect of Manipulative Skills on Mathematics Achievement and Attitudes of Secondary School Students' in Turkey and used stratified random sampling to extract a sample of 48 students. The instrument was Mathematics Achievement Test and Students' Attitude Inventory. The design was quasi-experimental design. The study revealed that manipulative skills affected the attitudes and Mathematics achievement of secondary school students.

Retention of Mathematics knowledge is the ability of learners to retain, remember and reproduce the learnt concept when the knowledge is required, after a given period. Improving the students' achievement level in Mathematics implies improving retention of Mathematics concepts. Therefore, retention is very important for good Mathematics performance. Van (2014) studied 'The Effect of Cooperative Learning on the Achievement and Knowledge Retention of Students' in Giang University, Vietnam. Stratified random sampling was used to collate a sample of 110 students. The design is quasi-experimental. The study reported that instruction using cooperative learning achieved significantly high scores on achievement and knowledge retention. Considering gender using problem-based learning for achievement and retention of Mathematics concepts, Ajai and Imoko (2015) revealed from their findings that male and female students taught using problem-based learning do not significantly differ in achievement and retention scores. Given the constructivist learning environment and long-term knowledge retention in Mathematics. Narli (2011) opined that learning in a constructivist learning environment, students are capable of retaining knowledge for a long time. Instructional materials/modern learning methods when effectively used enhance retention and Mathematics achievement in Mathematics instruction. Modern learning methods/instructional materials such as computer-based instructional puzzle; Adedoja and Fakokunde (2015), Origami (Obi et al., 2014), cooperative learning (Van, 2014), laboratory activities and peer tutoring (Muhammad & Abraham, 2014), computer animation, and geometric instructional models. Gambari et al. (2014) conducted a study titled 'Influence of Laboratory Activities and Peer Tutoring on Slow Learners' Achievement and Retention in Senior Secondary School Geometry' in Kebbi State, Nigeria. The population was 84,573 students with a sample of 382 students. The study used purposive sampling. The tools for data analysis were ANOVA and t-test. The design was quasi-experimental design. The study confirmed a positive effect on student retention.

Teaching techniques, instructional materials and methods of teaching used by Mathematics teachers and students towards the concept can contribute to learners' inability to understand and retain basic Mathematics procedures, calculations and applications; they can contribute to low achievement of students in solving Mathematics problems. Based on this, Mathematics instructors have been searching for appropriate ways of solving the existing increase of failure in Mathematics. It is currently observed that there are preferable ways of learning Mathematics that are better than the conventional practice. Mathematics teachers are increasingly directing their teaching to include the ways students learn. Most instructional methods of transferring knowledge have been revealed to be significantly ineffective in retaining important concepts towards a concept. Therefore, the problem is the inability of students to retain Mathematics concept taught them in geometry. To address this problem, the study therefore examined the effect of origami teaching strategy on students' retention in geometry in secondary schools.

Aim and Objectives of the Study

The study aims to determine the effect of origami teaching strategy on students' retention in geometry in secondary schools in Rivers State. Specifically, the objectives are to determine the:

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1. extent does origami teaching strategy affect students' performance in geometry
2. extent do geometry retention scores of students exposed to origami teaching strategy differ from the conventional approach
3. difference between male and female students' retention of geometry concepts when taught geometry using an origami teaching strategy in senior secondary schools

Research Questions

By the objectives of this study, the following research questions were raised:

1. To what extent does origami teaching strategy affect students' performance in geometry?
2. To what extent do geometry retention scores of students exposed to origami teaching strategy differ from the conventional approach?
3. What is the difference between male and female students' retention of geometry concepts when taught geometry using an origami teaching strategy in senior secondary schools?

Hypotheses

$H0_1$: There is no significant difference in the mean performance score of students taught geometry, using the origami teaching strategy and those taught using the conventional approach.

$H0_2$: There is no significant difference in the mean retention scores of students taught with the origami teaching strategy and those of the conventional approach.

$H0_3$: There is no significant difference in retention scores of male and female students taught geometry using the origami teaching strategy.

Methodology

The research design was quasi-experimental design. The quasi experimental design has one experimental and one control group. The research involved a pre-test, post-test and retention test in which the independent variable was manipulated to observe the effect on the dependent variables. The dependent variable was retention while the independent variable is origami teaching strategy. The population of the study was 6,961 students of all eleven (11) senior secondary school students. The purposive sampling technique was used to select five schools for this study and out of the five schools, a simple random sampling was used to collate twenty (20) students from each of the five schools selected, made up of a sample of one hundred (100) students The respondents were randomly drawn from a group of senior secondary school two (SS2) students in the five secondary schools, with a sample of 100 students for this study. The instrument for data collection was the Geometry Achievement Test (GAT). The GAT had fifteen (15) items. The face and content validity of the Geometry Achievement Test (GAT) was established by two experts. Kuda-Richardson (KR-21) was used to test for the reliability of the instrument (GAT) and a reliable value of 0.66 was obtained. Mean was used to answer the research questions, while ANOVA was used to test the hypotheses at a 5% significant level.

Results

Research Question One: To what extent does the origami teaching strategy affect students' performance in geometry?

Table 1: Mean and standard deviation of students' performance

Group	**N**	**Pretest**		**Posttest**		**Mean Gain**
Control	48	Mean	Sd	Mean	Sd	
		32.01	1.02	36.21	0.91	4.2
Experimental	52	54.12	1.12	70.06	1.02	15.94

The result in table 1 showed that the mean of students exposed to the origami teaching strategy was 70.06 (post-test) while those with the conventional teaching method had a mean of 36.21 for the post-test. The mean gain is 4.2 for conventional and 15.94 for origami teaching strategy. Hence students exposed to origami teaching strategy had a higher mean and performed better than the conventional teaching method.

Research Question Two: To what extent do geometry retention scores of students exposed to origami teaching strategy differ from the conventional approach?

Table 2: Mean and standard deviation on students' retention of geometry concept

Group	N	Posttest		Post-Posttest		Mean Gain
Control	48	Mean	Sd	Mean	Sd	
		36.21	0.91	42.71	1.07	6.5
Experimental	52	70.06	1.02	74.18	1.02	4.12

The results in Table 2 showed that the mean gain of students exposed to the Origami teaching strategy was 4.12 (Retention)while the mean gain of students exposed to the conventional method was 6.5(control group). This implies that students retained geometry concepts taught using the Origami teaching strategy rather than the conventional method.

Research Question Three: what is the difference between male and female students' retention of geometry concepts when taught geometry using an origami teaching strategy in senior secondary schools?

Table 3: Mean and standard deviation of students' retention of geometry concept based on gender

Gender	N	Posttest		Post-Posttest		Mean Gain
Male	27	Mean	Sd	Mean	Sd	
		59.08	1.02	72.52	0.95	13.44
Female	25	57.16	0.88	69.6	0.69	12.44

The results in Table 3 showed that the retention of the geometry concept of Male students exposed to the Origami teaching strategy obtained a mean score of 72.52 while their Female counterparts had a mean score of 69.6. Their mean gain scores were 13.44 for males and 12.44 for females. It is therefore deduced that Male students retained geometry concept taught than their Female students in origami teaching strategy.

H01: There is no significant difference in the mean performance score of students taught geometry, using the origami teaching strategy and those taught using the conventional approach.

Table 4: Analysis of one-way ANCOVA of students' taught geometry, using origami teaching strategy and those taught using the conventional approach.

Source of Variance	SS	df	MS	F	p	η2
Corrected Model	643.387[a]	1	321.694	32.388	.000	.499
Intercept	1573.331	1	1573.331	158.402	.000	.709
GROUP	70.789	1	70.789	3.94	.010	.099
Error	645.613	98	9.933			
Total	32722.000	100				
Corrected Total	1289.000	99				

Table 4 shows that the calculated F-value for the group is 3.94 at degrees of freedom of 1 and 98 and it is significant at 0.010 probability level which is less than 0.05 level of probability ($p= 0.010$, $df =1/98$, $p<0.05$). Hypothesis one was however rejected. Therefore, there is a significant difference in the mean score of students taught geometry, using origami teaching strategy. This shows that the origami teaching strategy wields a positive influence on students' Mathematics achievement than the conventions method in geometry.

H02: There is no significant difference in the mean retention scores of students taught with origami teaching strategy and those of the conventional approach.

Table 5: Analysis of one-way ANCOVA of students' retention on origami teaching strategy and those of the conventional approach.

Source of Variance	SS	df	MS	F	p	η2
Corrected Model	643.387[a]	1	321.694	32.388	.000	.499
Intercept	1573.331	1	1573.331	158.402	.000	.709
GROUP	70.789	1	70.789	3.94	.016	.099
Error	645.613	98	9.933			
Total	32722.000	100				
Corrected Total	1289.000	99				

Table 5 shows that the calculated F-value for the group is 3.94 at degrees of freedom of 1 and 98 and it is significant at 0.016 probability level which is less than 0.05 level of probability ($p= .016$, $df =1/98$, $p<0.05$). Hypothesis two was however rejected. Therefore, there is a significant difference in the mean retention scores of students taught with origami teaching strategy. This means that students retained geometry concept taught using origami teaching strategy than conventional method.

HO_3: There is no significant difference in retention scores of male and female students taught geometry using the origami teaching strategy.

Table 6: Analysis of ANOVA in the difference in retention scores of male and female students using origami teaching strategy.

Source	SS	Df	MS	F	p	η2
Corrected Model	52.205[a]	1	26.102	3.913	.032	.218
Intercept	831.034	1	831.034	124.591	.000	.817
GENDER	8.751	1	8.751	4.03	.032	.045
Error	186.763	50	6.670			
Total	18143.000	52				
Corrected Total	238.968	51				

The results in Table 6 showed that the calculated F-value for the effect of gender is 4.03 at degrees of freedom of 1 and 50. The calculated p-value is significant at 0.032 probability level which is less than 0.05 level of probability ($p=0.032$, $df= 1/50$, $p>.05$). Hypothesis three is therefore rejected, meaning that there is a significant difference between the male and female students on the origami teaching strategy. This implies that male students perform better using origami teaching strategies than female students.

Discussion

The findings have shown that using an origami teaching strategy for the teaching of geometry results in improved achievement in mathematics. The findings are in accordance with the following studies: Narli (2011), and Van (2014). The findings reveal that the students in the experimental group obtained higher mean scores and significant values than those in the control group. This shows that the experimental group retained more of the geometry content taught than the control group. This was further confirmed by the ANOVA result, which reveals that the experimental group significantly retained a higher value than the control group in the geometry concepts taught. The findings of this study align with those of Adedoja and Fakokunde (2015), Obi et al. (2014), Van (2014), Muhammad and Abraham (2014), and Gambari et al. (2014) who confirmed that the use of new practical approaches enhances students' retention. The results of this study have shown that using origami for the teaching of geometry results in retaining the concepts learned and also improves achievement in mathematics. The findings are in accordance with the works of Narli (2011) and Van (2014), who proposed that to achieve at least 90% retention of knowledge concepts, the instructional activity (treatment variable) should be done through practice by doing coupled with formulated learning groups for students to teach and learn from one another. Findings have shown that male students retained more of the geometry concepts taught with the origami teaching strategy than their female counterparts. This study is in accordance with the findings of Hakki (2016), who revealed that manipulative skills had a positive effect on the attitude and mathematics achievement of secondary school students. Additionally, the findings of Sedanur et al. (2013) suggested that students formed favorable opinions about origami-based instruction and its connection to mathematics. John and Benjamin (2015) revealed that male and female students taught using problem-based learning do not significantly differ in achievement and retention scores.

Conclusion

Based on the results obtained, it can be concluded that the use of origami proved superior to conventional instruction in promoting students' performance and achievement in geometry concepts taught during the study. The use of Origami as an instructional approach significantly enhances students' retention in geometry when compared to the conventional instructional approach. The study also showed that male students performed better than female students in retaining concepts taught in geometry using origami instructional strategy.

Recommendations

According to the findings, it is recommended that:

(1) The use of Origami should be adopted in the teaching of geometry at the primary, secondary, and tertiary levels of education.
(2) Seminars, workshops and conferences should be held on how Origami can be used effectively by Mathematics teachers in the teaching Mathematics.

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