CHECKMATING GENDER DIFFERENTIALS IN PUPILS' ACHIEVEMENT AND RETENTION IN MATHEMATICS USING ORIGAMI TEACHING AID IN NSUKA EDUCATION ZONE

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ABSTRACT

The differential achievement of male and female in mathematics has continuously raised doubts amongst researchers as to how to bridge the disparity and achieve gender equality in the subject. Therefore the purpose of this study was to examine gender differential in pupil's achievement and retention in fractions using origami. Pretest and post test non- equivalent control group quasi experimental research design was adopted to achieve this purpose. The study was guided by two research questions and hypotheses. The population of the study was all primary one pupils in Nsukka education one. Sample consisted of 100 pupils from two intact classes. Data was collected using Fraction Achievement Test (FAT) and Fraction Retention Test (FRT) having reliability coefficients of 0.77 and 0.84 respectively. The research questions were answered using descriptive statistics while the hypotheses were analyzed using Analysis of Covariance (ANCOVA) at $P \leq 0.05$ level of significance. The findings revealed that there was no significant difference in male and female achievement and retention in fraction when taught using Origami. It was concluded that Origami is gender friendly and effective in the teaching and learning of fractions. Based on these findings it was recommended that teachers should explore Origami in the teaching of fractions and other topics in mathematics to boost pupils' achievement and retention in mathematics in general. Also workshops and seminars for mathematics and science teachers should be organized by the ministry of education on the use of Origami.

KEYWORDS: Origami, Achievement, Retention, Gender differential, Fractions, Mathematics

INTRODUCTION

Gender differences in mathematics achievement, interest and retention have always been highly debatable among researchers and education stakeholders. Knowing the importance of mathematics in every discipline, there is need to bridge the gender gap between the males and females as required by the Millennium Development Goals (MDG) and Education For All (EFA) mandate. In view of the inconclusive state in gender issues, this study focused on the trends in the retention and achievement of males and females in mathematics.

Retention is defined as the ability to remember things (Obi, Agwagah & Agah, 2014). In the context of this study, retention is the ability to retain what has been learnt which can be aided through the art of paper folding. This implies that before retention comes into play, learning must have taken place. According to Ogbonna in Obi (2014), "when a person engages in practice of training activities and when observation of his performance shows that there is a change in performance, learning is usually assumed to have occurred, the change in behaviour being the result of a combination of practice operation with practice conditions". Simply put, learning is an observable change in behaviour and when one is able to recall what has been learnt as the need arises, it can be said that retention has taken place. The performance of a student is proportional to the amount of information retained and therefore the extent of achievement has to do with the degree of retention (Ugwanyi, 2016). This is in agreement with Iji (2003) who stated that, to correctly and effectively use or apply whatever one had learnt, retention comes to play an important role. Retention therefore has a bearing on achievement.

Achievement according to Bitrus (2014) is an act of achieving a result gained by efforts, the quality and quantity of students' works. Achievement is a very strong word which is often used in so many areas .For example achievement in mathematics, which is the focus of this study, is

viewed as a very important factor in teaching and learning of mathematics and it refers to students' cognitive achievement and psychomotor skills, which are measured in terms of pass or fail. When achievement is below expectation, it is referred to as under-achievement or poor achievement. When students are successful in mathematics examination they will have the feeling of pride that they made success with their own efforts and skills. Small success can give students a sense of achievement. Achievement and retention has been unstable between male and female students.

From the many researches carried out on the achievement and retention of students in mathematics; some of the results were in favour of boys than girls while others showed that gender has no significant effect on student's ability in understanding mathematical concepts. As a result of variations, the issue has remained inconclusive. Obi (2014), observed no significant difference in the mean achievement scores of male and female students in Geometry using Origami. In another study Ugwanyi (2016) found no significant difference in the mean retention score of male and female students when exposed to algebraic factorisation game. Iji, Abakpa & Takor (2015) reported that no statistically significant difference was found in the mean achievement scores of male and female students in algebra with the use of manipulative. This view was in line with the findings of Ojose and Lindsey (2009) and Achor, Imoko & Ajai (2010) who found that using manipulative materials in teaching mathematics positively affects the achievement of all students regardless of sexual orientation, socioeconomic status, academic level and disability.

However, in another development, Harbor-Peters (2001), asserted that gender issues in mathematics have been a source of aversion, and that mathematics has been male-stereotyped since it was regarded as abstract, difficult and has attributes which boys were attracted to. Usman & Musa (2015) observed that male students performed better than their female counter parts in algebra with the use of inquiry method. According to Zembar & Blume in Timayi, Ibrahim & Sirajo (2016) the greatest differential in achievement between male and female students is exhibited in mathematical reasoning and geometry; this follows because male students were found to display greater confidence in their mathematics skills, which is a strong predictor of mathematics performance. Steen (2003) for instance, had documented male superiority over females in spatial ability. Nevertheless, some studies like Meremikwu (2002), found among other things that the mathematics achievement of girls was significantly better than their male counterparts.

Moreover, Iji, Ogbole & Uka in Timayi, Ibrahim & Sirajo (2016) asserted that gender differences in mathematical reasoning have begun to decline due to the enrollment of more female students in mathematics and science courses. In spite of this positive move, there is still doubt as to whether female students have had the same opportunity to apply the mathematics skills needed for success in mathematics related fields such as science, engineering and technology (Amelink, 2009). From the researchers experiences as mathematics classroom teachers for many years, it has been observed that in the early years of secondary school(junior secondary school), female students perform better in mathematics but at the senior secondary level the males take over and better than the females. Statistics have shown that there are fluctuations in males and females achievement in mathematics. These fluctuations result from so many factors which include among others the topic, teaching methods and materials, students' and teachers' beliefs, social and physiological factors. According to Timayi, Ibrahim & Sirajo (2016), many factors are responsible for the dominance of male students in mathematics which include gender imbalance, task difficulty, cognitive competence, perceived negative attitude towards female students by their teacher and influence of gender on interest for mathematics among others.

From the above assertions the researchers observed that most of the studies focused on secondary school students and not considering the primary school where the foundation for any future development of the child lies. Brunner (1966) suggested that a child can be taught any concept once it is presented in an honest manner. At the primary level the child is still in the neutral form, teachers should therefore use instructional materials that expose pupils to wide variety of

concrete objects to stimulate their senses which could enhance females' achievement in mathematics. This may be made possible through the use of Origami. Origami is the Japanese art of paper folding and it may strengthen mathematical concepts like fractions.

A fraction is a number which can tell us about the relationship between two quantities. These two quantities provide information about the parts, the units we are considering and the whole. Fraction is one of the topics that pose a lot of challenges to both teachers and students and achievement and retention in this topic has been very low. For instance students achievement at the Basic Education Certificate Examination (BECE) for five years running has remained very low (NECO, 2010, 2011, 2012, 2013, 2014). According to Chief Examiners' reports, many students avoided questions from Number and Numeration and those whose attempted question from it failed woefully. Similar report from the examination unit of the Enugu State Ministry of Education, the Examination Development Centre, EDC (2010, 2011, 2012, 2013, 2014) indicated that the achievement of students in mathematics in Junior school certificate examination (JSCE) is less than 40%.

It is applicable in other areas and a shaky grounding in fractions can prevent individuals from pursuing advanced mathematics and shut students off from a significant number of career opportunities in later life (Bruce, Chang & Flynn, 2013). The search for result oriented materials for teaching fractions (mathematics) that are gender friendly is therefore crucial and in demand. Moreover, one of the Millennium Development Goals (MDG) and the education for all (EFA) goals is to promote gender equality and empower women. The present research investigated gender differentials in pupils' achievement in fractions using origami.

OBJECTIVES OF THE STUDY

The objective of the study is to determine the gender differentials in the achievement of pupils in fraction. Specifically the study seek to

-Determine the gender differentials in the achievement of male and female pupils when taught fractions using origami

-Determine the gender differentials in the retention of male and female pupils when taught fractions using origami

RESEARCH QUESTIONS

The following research questions guided the study

i. what is the difference in the mean achievement scores of male and female pupils taught fractions using origami?

II.what is the difference in the mean retention scores of male and female pupils taught fractions using origami .

RESEARCH HYPOTHESES

The following null hypotheses were tested at $P \leq 0.05$ level of significance

Ho_1 : There is no significant difference in the mean achievement scores of male and female pupils taught fractions using origami.

Ho_2: There is no significant difference in the mean retention scores of male and female pupils taught fractions using origami.

LITERATURE REVIEW

A fraction can represent a part-part relationship, in which case it is comparing the size of two measures. In a part-part relationship, the whole is the sum of the parts. Part-part relationships can be represented using linear, continuous or discrete models. A fraction is also a *quotient*, or a division statement. Fractions involve difficult-to-learn and difficult-to-teach concepts that present ongoing pedagogical challenges to the mathematics education community ((Bruce, Chang & Flynn,

2013). These difficulties begin early in the primary years (Empson & Levi, 2011) and persist through middle school, then into secondary and even tertiary education (Orpwood, Schollen, Leek, Marinelli-Henriques, & Assiri, 2011). Gould, Outhred, & Mitchelmore (2006) posited that the challenges and misconceptions students face in understanding fractions persist into adult life and pose problems in such wide-ranging fields as medicine and health care, construction and computer programming.

According to Eze (2010), academic achievement is something you do or realise at school, university or college, in class, in a laboratory, library or fieldwork. According to Bruce, Chang & Flynn (2013) helping students to achieve a solid grounding in mathematics in general and fractions in particular has long- term high- stakes ramifications, suggesting that it is worth spending the time and effort to enhance student understanding in the elementary years in order to ensure student success in later mathematics, career and life. One way of achieving this is by exposing pupils to instructional materials that may sustain their retention in fractions. The implication of this is that any instructional material or approach which is effective in making students retain concepts in mathematics can as well help students achieve excellently in mathematics. Retention is the ability to remember things. An instructional material which may have potentials of improving achievement and retention in mathematics is Origami.

Origami (the art of paper folding), is widely used in developed countries to teach children to think logically and to follow directions. According to Wu Joseph (2004), the widespread popularity of modern origami grew mainly out of the efforts of one man, Japanese origami master, Akira Yoshizawa, who in the early 1950s began to publish books illustrating how to fold non-traditional models of his own invention. Akira also developed a set of origami diagram Yoshizawa's work around the world introduced origami to many people and led to the formation of origami associations, including the Origami Center of America (now Origami USA) and the British Origami Society. What has mathematics to do with paper folding? What kind of fractions of a given length can be folded? Pupils fold: squares of paper into halves, thirds and other parts. They compare fractions by comparing lengths folded. Pupils investigate: how to generalize a method to fold 1/3, 1/5, 1/7, …To start pupils fold 1/3, fold straight lines, extend to 1/5, generalise to any fraction. Origami has been found to strengthen mathematics concepts like geometry and fractions and is a great way to merge science, technology, engineering, art and mathematics all together. Origami has been shown to improve spatial visualization skill using hands-on learning. Such skills allow children to comprehend, characterize, and construct their own language for the world around them. It is worth checking if these skills are acquired evenly or if there exist any disparity between male and female pupils in such skills.

METHODOLOGY

This study adopted the quasi- experimental non – randomised research design. The population of the study comprised of all the primary one (1) pupils in Nsukka education zone. In this zone, two primary schools were purposely sampled and assigned to experimental and control groups by random sampling. A sample of 100 pupils which was drawn from two intact classes also selected by simple random sampling by balloting was used for the study.

EXPERIMENTAL PROCEDURE

The experimental group was taught fraction using Origami while the control group was taught with the conventional method (without Origami). The experiment lasted for five weeks and the pupils were taught by their regular mathematics teachers under the supervision of the researchers. The teachers also administered the Fraction Achievement Test (FAT) before and after the experiment as well as the Fraction Retention Test (FRT) which was administered two weeks later after the post test.

RESEARCH INSTRUMENT AND DATA COLLECTION

Data collection was made using the researchers developed Fraction Achievement Test (FAT).The FAT was face validated by three experts, two in mathematics education and one in measurement and evaluation all from the department of science education, university of Nigeria, Nsukka. The content validity was established using test blue print. The reliability of the instrument was established using kuder-Richardson (K-R $_{20}$) formula for the objectives after trial testing. This was found to be 0.71 for FAT and 0.80 for FRT. Test – retest was re administered after two weeks interval to the same pupils and the scores were to determine the stability of FAT. This was found to be 0.73.

RESULTS

The research questions were answered using mean and standard deviation. Analysis of Covariance (ANCOVA) was used to test the hypotheses at 5 % level of significance. The results of the study are presented in the following tables.

Research question one

What is the difference in the mean achievement scores of male and female pupils taught fractions using origami?

Table 1: Mean achievement scores of gender on experimental groups in pre –test and post- test (FAT)

Group		pre-test	Post-test	Mean gain
Male	Mean	6.17	10.09	3.92
	Standard deviation	1.27	2.79	
	N	23	23	
Female	Mean	6.59	10.32	3.73
	Standard deviation	1.18	1.86	
	N	22	22	

From table 1 above, it was observed that the mean pre- test (PRE-FAT) scores of the male pupils in the experimental group was 6.17, with a standard deviation of 1.27 while that of their female counterparts was 6.59 with a standard deviation of 1.18. This means that at the beginning of the study the females seem to have a better Background with the mean score of 6.59 against 6.17 for the male. The table also shows that the female in the experimental group achieved higher (10.32) than the male in the post- test (post FAT). Although the female achieve higher in the post test, the mean gain of the male (3.92) is higher than the mean gain of the female (3.73). The results revealed that both male and female pupils taught using Origami were positively affected in their achievement. This implies that, the use of Origami as instructional material is relatively effective in enhancing achievement of male and female pupils in fraction. However, the mean achievement scores of the female pupils are slightly higher than that of the males. The difference seems to suggest that teaching pupils with origami favored the females more than their male counterparts.

Research question two

What is the difference in the mean retention scores of male and female pupils taught fractions using origami?

Table 2: Mean retention scores of male and female pupils in the experimental group

Gender	No	Mean	Standard Deviation
Male	23	13.70	1,72
Female	22	14.73	2.10

Table 2 shows the mean retention scores of male and female pupils in the experimental group .From the table, it could be observed that the mean retention scores of the male and female pupils are 13.70 and 14.73 respectively with corresponding standard deviation of 1.72 and 2.10. The difference in the mean of male and female pupils in the FAT is 1.03 in favor of the female.

Hypothesis 1

H_{o1}: There is no significant difference in the mean achievement scores of male and female pupils taught fraction using origami.

Table 3: Two – way Analysis of Covariance of the control and experimental group on Fraction Achievement Test due to method and gender

Source	Type III sum of squares	df	Mean square	F	Sig.
Corrected Model	82.206a	4	20.552	7.230	.000
Intercept	273.957	1	277.957	97.787	.000
Pre-test	0.529	1	0.529	.186	.667
Gender	4.199	1	4.199	1.477	.227
Method	75.734	1	75.734	26.644	. 0
GenderMethod	1.094	1	1.094	.384	.536**
Error	270.034	95			
Total	8890.000	100			
Corrected total	352.240	99			

R squared = .233 (Adjusted R squared = .201

*= significant at .05 level of probability

**= Not significant.

Table 3 indicates that the value of the significance of F on achievement of male and female is .536. This is greater than the already set alpha value of .05 level of significance for 1 df. The implication of this is that the null hypothesis of no significant difference in the mean achievement scores of male and female pupils is not rejected. This means that, the difference in the mean achievement scores of male and female pupils in the PRE- FAT and POST- FAT is not statistically significant.

Hypothesis two: There is no significant difference in the mean retention scores of male and female pupils taught fractions using origami.

Table 4: Analysis of Covariance (ANCOVA) of the control and experimental group pupils on fraction retention test due to method and gender.

Source	Type 111 sum of squares	Df	Mean square	F	Sig.

Correlated Model	245.651a	4	61.413	15.803	.000
Intercept	697.160	1	697.160	179.394	.000
Pre- test	7.684	1	7.684	1.977	.163
Gender	11.687	1	11.687	3.007	.086
Method	232.442	1	232.442	59.812	.000 *
Gender * Method	4.642	1	4.642	1.194	.277**
Error	369.189	95	3.88b		
Total	16340.000	100			
Corrected Total	614.840	99			

a.R squared = .400 (Adjusted R squared = .374)

From table 4, it is observed that the value of significance of F on mean retention scores of male and female pupils of the experimental group is .277 as against the already set alpha level of 0.05 for 1 df. This is greater than the already set alpha value of 0.05 level of significance. The implication of this is that the null hypothesis of no significant difference in the mean retention scores of male and female pupils is accepted. This means that the mean retention scores of male and female pupils in FAT is not statistically significant.

T- test will be appropriate for the analysis, I really understood your claim of choice of t- test because of two levels of gender(male and female). However, we should not forget in a hurry that the study made use of pretest and post test as well as using intact class which Analysis of Covariance (ANCOVA) is the most appropriate. ANCOVA statistics therefore eliminates the initial differences between groups so that the selected or pretested groups can be considered as being equivalent in te intact classes (Ali, 1996).

SUMMARY OF FINDINGS

From the analysis of data presented, it was found that:

(1) Though difference occurred in the mean achievement scores of male and female pupils in FAT, it was not statistically significant.

(2) The difference in the mean retention scores of male and female pupils in the FRT, in the experimental group was not statistically significant.

DISCUSSION OF FINDINGS

The result shown in Table 1 reveals that female students recorded higher mean achievement score than the males, in the experimental POST FAT. This mean difference was not statistically significant as revealed in the ANCOVA result (Table 3).This implies that gender does not have a significant effects on pupils' achievement in fractions. The findings of this study seem not to agree with that of Ogbonna (2007), Adekonye (2008) whose studies found the female to achieve higher than boys in mathematics and geometry achievement. However, the result of this present study is in compliance with the findings of Amadi & Charles- Ogan (2015), Iji, Abakpa & Takor (2015) which revealed no significant effect of male and female students' achievement in mathematics.

On the other hand, Table 2 reveals that female pupils in the experimental group, obtained a higher mean retention score than their male counterparts. However, Table 4 shows that gender is not significant in students' retention as reflected in the outcome of the concept of fraction taught during the origami.

The result of this study is not in line with Iji (2003) who found gender to be statistically significant in students' retention in mathematics. On the other hand, the result of the study, agrees with Ogbonna (2007) & Ugwanyi(2016) who pointed out that gender was not statistically significant in students' retention in mathematics. The result of no significant difference may be attributed to the effects of Origami which is practical in nature and rooted in the constructivist principles of teaching

and learning. Moreover, the ability of pupils to discover the relationship between mathematics real world and daily life activities using Origami, created new learning environment that exposed them to the applicability and practicability of mathematics in concrete situation. Again, both male and female pupils improved significantly in their mean retention scores as was observed from the difference that existed between the POST FAT and FRT making origami to be gender friendly.

CONCLUSION

It was concluded in this study that the use of Origami as instructional approach did not only significantly enhance students' achievement in fraction when compared with the conventional instructional approach, it also enhanced their retention. It led to a significant reduction in gender-gap in achievement in fraction. Similarly, use of origami proved superior to the conventional instruction in promoting pupils' retention and the fraction concepts taught during the study. Gender had no significant influence over pupils' achievement and retention in fraction. This implies that, the relative superiority of origami in fostering achievement and retention was uniform for both male and female.

RECOMMENDATIONS

Based on the findings of this study, the following recommendations were made:

1. Teachers should explore Origami in the teaching of fractions and other topics in mathematics to boost pupils' achievement and retention in mathematics in general.
2. Also workshops and seminars for mathematics and science teachers should be organized by the ministry of education on the use of Origami.
3. Government and curriculum planners should incorporate origami into the curricula of mathematics education in universities and teacher training colleges, to ensure proper training of teachers in the new concept.

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