

Pilot study on the effect of the use of cultural materials and women's stories on the academic achievement of senior secondary school students in geometry in Abuja, Nigeria

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Abstract: *This pilot study was to determine the effect of the use of cultural materials on the achievement of senior secondary school students in geometry. The one group pretest post-test research design was adopted for the study. A purposive sampling procedure was used to sample 25 senior secondary school students. The main instrument for the collection of data was a Researcher questionnaire titled "Geometry Test for SSI students." The logical validity of the instrument was 87%. Also, its reliability was determined using split-half method and the reliability was 80%. The treatment lasted three hours for a duration of two days. The data were analyzed using mean, standard deviation, paired sample t-test and independent t-test. The results of the study revealed that there was a significant difference in the pre- test mean and post-test mean geometry scores of students taught geometry using cultural materials and women's stories. Also, although the mean post test score of male students in geometry is higher than that of the female students, there is no significant difference in the mean post-test mean achievement scores in geometry between the male and the female students taught with the use of cultural materials and women's stories. The study concluded that the use of cultural materials and women's stories in teaching geometry improves the academic achievement of students in general, irrespective of their sex. It was therefore recommended that all mathematics teachers should adopt the use of cultural materials and women stories in the teaching of geometry in secondary schools. Also, all*

mathematics teachers should be made to undergo a capacity building workshop on the use of cultural materials and women stories in the teaching of geometry in secondary schools.

Keywords: Cultural materials, Women's stories, Geometry, Academic Achievement, Senior Secondary School

Background of the study

The importance of Science and Technology in the world today cannot be overemphasized. Science and technology have become an integral part of the World's culture. Hence, the study of mathematics is made compulsory at the Primary and Secondary levels of education in Nigeria (Federal Republic of Nigeria (FRN, 2013) and many other countries of the world. The difference in the level of development between the developed and the underdeveloped countries can be traced to the difference in the teaching and learning of Mathematics in those countries. This is due to the fact that Mathematics is the bedrock of Science and Technology which are the core ingredients for modern development (Ukeje, 2002). Every day human activities are driven by Science and Technology; and undoubtedly, a sound Science, Technology, Engineering, Arts and Mathematics (STEAM) education is the key to good health, development of industries, poverty alleviation, promotion of peace, conservation of environment, and good life for all and improved economic growth and development (Anwukah, 2017). The foundation for a STEAM career is laid early in life, but scientists and engineers are made in colleges and universities. (American Association of University Women (AAUW), 2016). It is an undisputable fact that many students in Nigerian Secondary Schools encounter multiple problems with the study of Mathematics. The trend in the academic achievement of secondary school students in Mathematics in the last two decades has become a source of concern to all stakeholders in the education sector including parents, students, school administrators and the general public. Students have not been performing well in Mathematics in most examinations. It has been asserted that academic failure is not only frustrating to the students and the parents, but its effects are equally grave on the society in terms of dearth of manpower in all spheres of the economy and polity (Aremu, 2000; Morakinyo, 2003).

This problem has two main dimensions. While students on one hand have difficulties in understanding the topics taught, teachers on the other hand equally have difficulties in achieving

effective teaching in our schools. Another dimension of the problem is that in most societies in Nigeria, the girl child education is not in the front burner. Women are left behind in most professions. In particular, the number of women in STEAM education is low when compared with the male counterparts. The striking difference between the number of men and women in Science, Technology, and Mathematics has often been considered as evidence of biologically driven gender differences in abilities and interests. The classical foundation of this is that men “naturally” excel in mathematically demanding disciplines; whereas women “naturally” excel in fields using language skills (AAUW, 2016).

Literature on the achievement in mathematics with respect to gender has remained inconclusive. Some researchers have found that male students perform better than female students in Mathematics (Atovigba, Vershima, O’kwu & Ijenkeli, 2012; Ali, Bhagawati & Sarmah, 2014). Also, Timayi, Ibrahim and Sirajo (2016) in their study found that there was difference in the mean and standard deviation scores of male and female students in favor of the male students in geometry test, but the observed difference was not statistically significant with regard to achievement and gender interaction. Some other researchers (Abubakar & Adebayega, 2012) reported that gender has no significant effect on the achievement of students. But some researchers (Linderberg, Hyde, Petersen & Lin (2010) reported that gender differentials among males and females is converging; hence, they perform similarly. Moreover, the effect of gender requires further research as it may affect achievement especially in Mathematics.

The glaring problems faced by students in the study of Mathematics is evidenced by the poor performances of students in internal and external examinations in Mathematics. For instance, for the years between 2002 and 2014 Nigeria did not record up to 60% credit pass in Mathematics in the West African Senior Secondary School Certificate Examination (West African Examinations Council (WAEC), 2002, 2007, 2011, 2012a, 2012b, 2013, 2014). Also, the head of WAEC National office, Adenikpekum (2017), reported that 59.22% of Nigerian candidates had a minimum of five credits in senior secondary school subjects including Mathematics and English Language. Some of the challenges affecting the teaching and learning of Mathematics in Nigerian schools include: lack of textbooks on the part of students, inadequate Mathematics instructional materials, insufficient mathematics teachers, poor student background, and poor condition of

learning environment (Federal Ministry of Education (FME), 2012). It has been observed that among the factors that influence achievement of learners of school Mathematics, teachers' effectiveness as measured through the acquisition and use of good instructional skills and methodologies appear very prominent (Max, 1988). Studies have shown that high-quality teaching can make a significant difference in students learning and high-quality teaching requires a high-quality workforce (Egbo, 2011; Anwuka, 2017). It is true that no educational system can rise above its teachers because no nation can rise above the standards of its schools (Federal Republic of Nigeria (FRN), 2013). Thus, education is the key that unlocks the door to modernization, but it is the teacher who holds the key to the door.

Mathematics is considered by many to be abstract. Most teachers teach Mathematics abstractly because most schools do not have Mathematics laboratories. For instance, research has shown that many schools have no Mathematics laboratory, and Mathematics teachers indicated that using Mathematics laboratory to teach Mathematics makes abstract topics to be more concrete to the students (Sunday, Akanmu, Salman & Fajemidagba, 2016). There is, therefore, a dare need for special intervention in schools in the area of retraining of teachers and use of innovative teaching materials for teaching Mathematics in schools. For instance, the National Mathematical Centre worked on some schools in some states under the Mathematics Improvement Project (MIP). After the intervention by the Centre, the results of the schools improved tremendously. In Kogi State, the percentage credit pass in Mathematics of G.S.S Icheke-Ogane rose from 7.69% in 2010 to 55.56% in 2012, and that of St Peters' College Idah rose from 33.02% in 2010 to 70.86% in 2012. Also, in Kaduna State, the percentage credit pass in Mathematics of GSS Makarfi rose from 29.9% in 2013 to 99.2% in 2015 after the intervention by the Centre under the Mathematics Improvement Project (National Mathematical Centre, 2015)

One of the new and innovative ways of teaching Mathematics and the Sciences in schools is the use of Cultural materials and women's stories. This is designed for capacity building in STEAM related fields and for fostering entrepreneurship and innovations. This is part of Ethno-mathematics. Ethno-mathematics is defined as "the Mathematics of identifiable cultural group derived from quantitative and qualitative practices like counting, weighing, sorting, measuring and comparing" (D'Ambrosio, 1985). Erukoha (1995) defined Ethno-mathematics as "a discipline

interested in studying Mathematics and Mathematics education in the cultural milieu of the learner.” Aprebo (2016) recommended that the use of teaching aids in our environment for Mathematics teaching. He emphasized that the use of African objects as examples in the teaching of Mathematics makes the learner to identify the application of Mathematics in any subject that he/she handles and make him/her to see the Mathematical composition in any object he/she studies. Also, Ugwuanyi (2014) opined that the use of instructional materials in Mathematics reduces to a large extent the abstract nature of many Mathematical concepts. To sustain students’ interest in Mathematics, the teaching of the subject should be practical, exploratory and experimental which could be carried out in the Mathematics laboratory (Salman, 2002). The use of Ethno-mathematics has been found to improve the achievement and interest of students in geometry and measurement (Kurumeh, 2004). Also, Enuokoha (1995) emphasized that there is no culture in which the rudiments of Mathematics such as counting, measuring, locating, designing, reasoning, exploring, playing games, adding, subtracting, multiplying, dividing, and some other cognitive activities are not carried out There is no corner of any society that there are no materials and activities that are not Mathematical in nature. These can be found in the shapes of our traditional houses and roofs, local pots, bracelets, local woven baskets, furniture, buying and selling, etc. Therefore, the use of cultural materials and stories could be used to improve the effectiveness of teaching and learning of Mathematics in schools.

In Nigeria today, this innovative approach to teaching is not yet utilized by many teachers while in many advanced countries this approach is used for teaching all subjects at all levels. The use of culture and women’s stories are used to concretize educational concepts, arouse and sustain the interest of learners, and to foster entrepreneurship and innovation among learners. With this innovative approach, the achievement of students in the study of STEAM could be improved upon. Unfortunately, many teachers in Nigeria are not employing this approach of teaching.

Now the problem of the teacher in terms of quantity and quality has been fingered as the one of the most important factors affecting the performance of students in Mathematics. In particular, the approach to the teaching of the Mathematical Sciences is an important factor that determines the achievement of students in the Mathematical Sciences. This approach of using cultural materials

and women's stories has been used sparingly in Nigeria. The problems of Mathematics students resulting from the approach of teachers deserve appropriate attention.

Statement of the Problem

Mathematics knowledge is applied to all aspects of human endeavors. Hence, the study of Mathematics is made compulsory at the Primary and Secondary levels of education in Nigeria and many other countries of the world. Unfortunately, the performance of students in Mathematics over the years has remained unsatisfactory. This has prevented many students from studying scientific and technological courses in tertiary institutions and this consequently negates the economic and technological strides of the Country. Mathematics is the main ingredient for the economic and technological development of any nation. One of the major problems facing the teaching and learning of Mathematics is the lack of instructional materials to concretize the mathematical concepts and sustain the interest of learners in the study of the subject. The use of cultural materials and stories has been proposed to be used in the teaching of Mathematics in schools as a means for improving the academic achievement of students and to sustain their interest in the teaching of the subject. But not much research has been done on this in Nigeria. Hence, the need for this study.

Purpose of the Study

The purpose of this study was to determine the effect of the use of cultural materials and women's stories on the academic achievement of senior secondary school students in Abuja. Specifically, the study has the following objectives to:

- I. investigate the effect of the use of cultural materials and women's stories on the mean academic achievement of senior secondary school students in Geometry.
- II. determine the effect of the use of cultural materials and women's stories on the mean academic achievement of male senior secondary school students in Geometry.
- III. determine the effect of the use of cultural materials and women's stories on the mean academic achievement of female senior secondary school students in Geometry.

- IV. investigate the difference in the mean post test scores in geometry between male and female students taught with the use of cultural materials and women's stories

Research Questions

To guide the study, the following research questions were formulated:

- i. how would the use of cultural materials and women's stories affect the mean academic achievement of senior secondary school students in Geometry?
- ii. what is the effect of the use of cultural materials and women's stories on the mean academic achievement of male senior secondary school students in Geometry?
- iii. how would the use of cultural materials and women's stories affect the mean academic achievement of female senior secondary school students in Geometry?
- iv. what is the difference in the mean post-test achievement score in Geometry between male and female students taught with the use of cultural materials and women's stories?

Statement of the Hypotheses

- Ho₁ : There is no significant difference in the pre-test mean and post-test mean academic achievement of senior secondary school students in Geometry taught using cultural materials and women's stories.
- Ho₂ : There is no significant difference in the pre-test mean and post-test mean academic achievement of male senior secondary school students in Geometry taught using cultural materials and women's stories.
- Ho₃: There is no significant difference in the pre-test mean and post-test mean academic achievement of senior secondary school students in Geometry taught using cultural materials and women's stories.
- Ho₄ : There is no significant difference in the post test mean achievement scores in geometry between the male and female students taught with the use of cultural materials and women's stories

Methodology

The research design adopted for the study was the One-Group Pretest Posttest Design. The design was adopted because it was not possible to have a control group for the study at that point in time. The population consisted of all the students of the International Model Science Academy which is the Demonstration School for the National Mathematical Centre, Abuja. However, Convenience sampling was used to sample an intact class of 25 Senior Secondary one students consisting of 12 males and 13 females. It was convenient for the researchers to reach the students since the school was very accessible to the researchers. Being a model Academy, the students are from over six States and Federal Capital Territory (FCT) of Nigeria. Three Mathematics teachers also participated in the project.

The instrument for the study was a Researcher made Questionnaire titled “Geometry Test for SS1 students.” The questionnaire was validated by four experts in Mathematics Education and Mathematics from National Mathematical Centre, Abuja using face validation and table of specification to ensure the content validity. The logical validity was 0.87. Also, the reliability was determined using split half method and the reliability was 0.80. The instrument consisted of 12 short subjective questions. The topics covered were circumference, area, annulus and other properties of circle; volume and capacity of solid shapes; and related financial Mathematics. There were pre-test and post-test. The post-test was a reshuffled pre-test. The pre- test was administered at the beginning of the workshop and the duration was thirty minutes. The questionnaires were collected from the participants after the pre-test and the participants were not informed that there would be a post test. The Researchers had discussion, demonstration and practical lessons with the participants for 3 hours per day for a period of two days. The lessons covered, the teaching of the identified topics using cultural materials such as bracelets, local woven baskets, local pots, etc. At the end of the program, a post-test was given to the participants which lasted for thirty minutes. Both the pre-test and the post-test questionnaires were marked and recorded. The data were analyzed using mean, standard deviation, paired sample t-test and independent t-test.

Presentation of Results

Research Question 1(RQ₁)

How would the use of cultural materials and women's stories affect the mean academic achievement of senior secondary school students in Geometry?

Table 1: Pre-Test, Post-Test Mean and Standard Deviations Geometry Scores of Students Taught with the use of Cultural Materials and Women's stories.

		Mean	N	Std. Deviation	Std.Error Mean
Pair 1	Pre	31.7200	25	17.21801	3.44360
	Post	62.3600	25	21.29335	4.25867

Table 1 shows the Pre-Test, Post-Test Mean and Standard Deviation of Students taught with the use of cultural materials and women's stories. The pre-test mean score was 31.7200 with standard deviation of 17.21 while the post-test mean score was 62.3600 showing increase mean of 31.4400. This implies that students taught with the use of cultural materials and women's stories had improvements in students' mean academic achievement in Geometry.

Null Hypothesis H₀₁

There is no significant difference in the pre-test mean and post-test mean academic achievement of senior secondary school students in Geometry taught using cultural materials and women's stories.

Table 2: Summary of Paired Sample t-Test of the Pre-Test and Post-Test Geometry Scores of Students Taught with the Use of Cultural Materials and Women's stories.

	Mean	Paired Differences				t	df	Sig.(2-tailed)
		Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Pair 1 Pre- Post	-30.64000	19.76714	3.95343	-38.79948	-22.48052	-7.750	24	.000

Table 2 shows the paired sample t-test of the pre-test and post-test mathematics Geometry Scores of Students taught with the use of cultural materials and women’s stories. From the table, significant 2-tailed value (P-value) is 0.000. Since the value of 0.000 is less than 0.05, therefore the null hypothesis is rejected. This implies that there was a significant difference in the pre-test mean Geometry Scores of Students taught with the use of cultural materials and women’s stories and their post-test mean Geometry scores. Thus, the students taught using cultural materials and women’s stories significantly improved their mean academic achievement in Geometry.

Research Question 2 (RQ₂)

What is the effect of the use of cultural materials and women’s stories on the mean academic achievement of male senior secondary school students in Geometry?

Table 3: Pre-Test, Post-Test Mean and Standard Deviations Geometry Scores of Male Students Taught with the Use of Cultural Materials and Women’s stories

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pre	35.7500	12	16.81517	4.85412
	Post	68.7500	12	15.29186	4.41438

Table 3 shows the Pre-Test, Post-Test Mean and Standard Deviations Geometry Scores of Male Students taught with the use of cultural materials and women’s stories. The pre-test mean score

was 35.7500 with standard deviation of 16.815 while the post-test mean score was 68.75 with standard deviation of 15.291 showing in increase mean of 33. This implies that the male Students taught with the use of cultural materials and women's stories had improvements in their mean academic achievement in geometry.

Hypothesis H₀₂

There is no significant difference in the pre-test mean and post-test mean academic achievement of male senior secondary school students in Geometry taught using cultural materials and women stories.

Table 4: Summary of Paired Sample t-Test of the Pre-Test and Post-Test Geometry Scores of Male Senior Secondary School Students in Geometry Taught Using Cultural Materials and Women's stories.

	Mean	Std. Deviation	Paired Differences		t	df	Sig. (2-tailed)	
			Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Pair 1 Pre- Post	-33.0000	17.16233	4.95434	-43.90442	-22.09558	-6.661	11	.000

Table 4 shows the paired sample t-test of the pre-test and post-test geometry scores of male senior secondary school students in Geometry taught using cultural materials and women's stories. From the table, significant 2-tailed value (P-value) is 0.000. Since the value of 0.000 is less than 0.05, therefore the null hypothesis is rejected. This implies that there was a significant difference in the pre- test mean geometry scores of male senior secondary school students in Geometry taught using cultural materials and women's stories and their post-test mean Geometry scores. Thus, the male senior secondary school students taught using cultural materials and women's stories significantly improved their mean academic achievement in Geometry.

Research Question 3 (RQ₃)

How would the use of cultural materials and women's stories affect the mean academic achievement of female senior secondary school students in Geometry?

Table 5: Pre-Test, Post-Test Mean and Standard Deviations Geometry Scores of Female Students Taught with the Use of Cultural Materials and Women's stories

		Mean	N	Std. Deviation	Std. Mean Error
Pair 1	Pre	28.0000	13	17.39253	4.82382
	Post	56.4615	13	24.77773	6.87211

Table 5 shows the pre-test, post-test mean and standard deviations Geometry scores of female students taught with the use of cultural materials and women's stories. The pre-test mean score was 28.00 with standard deviation of 17.39 while the post-test mean score was 56.46 with standard deviation of 24.78 showing in increase mean of 28.46 This implies that the female Students taught with the use of cultural materials and women's stories had improvements in their mean academic achievement in Geometry.

Hypothesis H₀₃

There is no significant difference in the pre-test mean and post-test mean academic achievement of female senior secondary school students in Geometry taught using cultural materials and women's stories.

Table 6: Summary of Paired Sample t-Test of the Pre-Test and Post-Test Geometry Scores of Male Senior Secondary School Students in Geometry Taught Using Cultural Materials and Women’s stories.

	Mean	Paired Differences				t	df	Sig. (2-tailed)
		Std. Deviation	Std. Error	95% Confidence Interval of the Difference				
				Lower	Upper			
Pair 1 pre - post	-28.46154	22.37787	6.20651	-41.98435	-14.93872	-4.586	12	.001

Table 4 shows the paired sample t-test of the pre- test and post-test-geometry scores of female senior secondary school students in Geometry taught using cultural materials and women’s stories. From the table, significant 2-tailed value (P-value) is 0.001. Since the value of 0.001 is less than 0.05, therefore the null hypothesis is rejected. This implies that there was a significant difference in the pre- test mean geometry scores of female senior secondary school students in Geometry taught using cultural materials and women’s stories and their post -test mean geometry scores. Thus, the female senior secondary school students taught using cultural materials and women’s stories significantly improved their mean academic achievement in Geometry.

Research Question 4 (RQ4)

What is the difference in the mean post-test mean achievement score in Geometry between male and female students taught with the use of cultural materials and women’s stories

Table 7: Post- Test Mean and Standard Deviations Geometry Scores of Male and Female Students Taught with the Use of Cultural Materials and Women’s stories

	Group	N	Mean	Std. Deviation	Std. Error Mean
Score	Male	12	68.7500	15.29186	4.41438
	Female	13	56.4615	24.77773	6.87211

Table 7 shows the post-test mean and standard deviations Geometry scores of male and female students taught with the use of cultural materials and women’s stories. The table shows that male students had mean post-test score of 68.75 with standard deviation of 15.29 while the female students had mean post-test score of 56.46 with standard deviation of 24.78. This shows that the male students perform better than female students in the Geometry test.

Hypothesis H₀₄

There is no significant difference in the post-test mean achievement scores in Geometry between the male and female students taught with the use of cultural materials and women’s stories

Table 8: Summary of Independent Sample t-test of the Post-test Geometry Scores of Male and Female Senior Secondary School Students Taught Using Cultural Materials And Women’s stories.

Variable	N	Mean	SD	S Error	Mean difference	df	t-value	p-value	Decision
Male	12	68.75	15.29	4.41					
					12.29	23	1.48	0.153	Ho Not rejected
Female	13	56.46	24.78	6.87					

Table 8 shows the summary of independent sample t-test of the post-test Geometry scores of male and female Senior Secondary School Students taught using cultural materials and women's stories. The P-value is 0.153. Since, $0.153 > 0.05$, then the null is upheld. This implies that there is no significant difference in the post- test mean achievement scores in Geometry between the male and female students taught with the use of cultural materials and women's stories.

Discussion of Results

The results of the study showed that the use of cultural materials and women's stories improve the academic achievement of both male and female students in Geometry. This study supports the finding by Kurumeh (2004) that the use of Ethno mathematics improves the achievement and interest of students in Geometry and Measurement (Kurumeh, 2004). It also lends support to Aprebo's (2016) recommendation that the use of teaching aids in our environment for Mathematics teaching and the use of African objects as examples in the teaching of Mathematics make the learners bring out the applications in any subject that he/she handles and make him/her to see the mathematical composition in any object he/she studies Also, it supports Ugwuanyi (2014) who opined that the use of instructional materials in Mathematics reduces to a large extent the abstract nature of many mathematical concepts. When the Mathematics topics are made less abstract, the understanding and retention of concepts are improved upon and this leads to higher academic achievement.

The result of the study also shows the mean score of students in Geometry is higher than that of the female students but there is no significant difference in the mean post-test mean achievement scores in Geometry between the male and female students taught with the use of cultural materials and women's stories. This finding supports some researchers (Atovigba, Vershima, O'kwu & Ijenkeli, 2012; Ali, Bhagawati & Sarmah, 2014) who found that male students perform better than female students in Mathematic, and Timayi, Ibrahim and Sirajo (2016) who in their study found that there was difference in the mean and standard deviation scores of male and female students in favour of the males students in geometry test but the observed difference was not statistically significant with regard to achievement and gender interaction. However, this result does not

support some other researchers Linderberg, Hyde, Perersen & Lin (2010) who reported that gender differentials among males and females is converging; hence, they perform similarly.

Conclusion

From the results of the study, the use of cultural materials and women's stories in teaching Geometry improves the academic achievement of students in general, irrespective of the gender of the students. Also, although the post-test mean score of students in Geometry is higher than that of the female students, there is no significant difference in the post-test mean achievement scores in Geometry between the male and female students taught with the use of cultural materials and women's stories.

Recommendations:

It is hereby recommended that:

- a) all Mathematics teachers should adopt the use of cultural materials and women's stories in the teaching of Geometry in secondary schools.
- b) all Mathematics teachers should be made to undergo a capacity building workshop on the use of cultural materials and women's stories in the teaching of geometry in secondary schools.

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