Effectiveness of Fishing Tools Instructional Approach in Enhancing Students' Achievement and Retention in Senior Secondary School Geometry

U. N. V. Agwagah & S. E. Ojoko

Abstract

This study was designed to determine the effect of fishing tools instructional approach on students' achievement and retention in senior secondary school geometry. Four (4) research questions and four (4) hypotheses were formulated to guide the study. The study employed a quasi-experimental, non-equivalent control group design and was restricted to Andoni Local Government Area, Rivers State, Nigeria. A sample of 200 SS1 students (104 males and 96 females), drawn from four public and co-educational schools using purposive sampling technique, was involved in the study. The instrument for data collection was geometry achievement test (GAT) which was used as the pre-test, post-test and geometry retention test (GRT). The post-test and GRT were reshuffled versions of the GAT. Data collected were analyzed using mean, standard deviation and analysis of co-variance (ANCOVA). The result of the study revealed among others, that the use of fishing tools instructional approach in teaching geometry of two and three dimensional objects to senior secondary one (SS1) students enhanced their achievement and retention in geometry. Based on the findings, it was recommended among others, that the fishing tools instructional approach should be adopted in the teaching of geometry in basic and secondary school levels of the education system.

Introduction

It is a well- known fact that the subject mathematics affects all aspects of human life and that the social, economic, scientific and technological aspects of man are centred on numbers. Being the basic skill that underlies all scientific and technological skills, mathematics is generally seen as the language of most branches of science and technology. It is closely related to school subjects such as Physics, Chemistry, Computer science, Economics, Geography, Biology, among others, that deal with numeration, variation, graphs, fractions, logarithms and indices, algebraic processes, solution of equations, as well as areas and volume computations. Expectedly, a sound background in basic mathematical principles has become a pre-condition for progression to tertiary education and thus one of the key requirements for a gainful professional employment. For instance, in 2013, when teachers were recruited in Rivers State, a sound background in basic mathematical

knowledge was an advantage for gainful employment (Ministry of Education, Port Harcourt, 2014).

However, majority of Nigerian school children generally dread the subject. Most of them consider mathematics difficult, complex and abstract. Worse still, many students do not immediately see the applicability of the subject to their lives and to the world of work and so wonder why they should be troubled with the study of the subject. Except as a requirement for admission into institutions of higher learning, most students do not see any other need for mathematics learning. Thus, the teaching and learning of mathematics has been problematic in schools (Lassa, 2012). Failures in GCE, WAEC and NECO examinations have been high and have become worrisome to all stakeholders. In another dimension, students dislike certain topics such as geometry, because they feel the topics are difficult and cannot be understood easily (Eraikhuemen, 2003). It has also been revealed that some teachers lack techniques and materials in teaching some topics, to the extent that if they had a chance they would not teach such topics. Also, the teachers believe that the topics are difficult and not easy to teach. For these reasons, many students in secondary schools experience difficulties in the learning of some aspects of the mathematics curriculum, especially geometry.

Geometry, as one of the oldest branches of mathematics, is the science of space and extent that deals with position, shape and size of bodies (Sidhu, 2006). Among other branches of mathematics, geometrical concepts of the senior secondary school mathematics curriculum, represents the most difficult area (Chief Examiner's report, 2005; Kurumeh, 2007; Olunloye, 2010; Abakpa and Igwue, 2013). Even though various instructional techniques have been adopted by teachers to improve students' achievement in mathematics, very few of these appear to have focused on the teaching of geometry. Helpful as these measures may be, they have not proved to be effective for the improvement of students' performance in mathematics, especially geometry. There is therefore, need to explore the effectiveness of other alternative teaching approaches such as the fishing tools instructional approach that is based on the learner's cultural background, in the improvement of students achievement and retention in geometry. Therefore, the problem of the study, put in question form is: What is the effect of fishing tools instructional approach on students' achievement and retention in geometry?

Purpose of the Study: The main purpose of this study was to investigate the effect of fishing
tools instructional approach on students' achievement and retention in senior secondary school geometry. Specifically, the study sought to determine:

(i). Students' mean achievement scores in geometry of two- and three-dimensional objects.
(ii). Students' mean retention scores in geometry of two- and three-dimensional objects.
(iii). Mean achievement scores of male and female students taught geometry of two- and-three dimensional objects.
(iv). Mean retention scores of male and female students taught geometry of two- and three-dimensional objects.

Research Questions

The following research questions were raised:

1. What are the mean achievement scores of the students taught geometry of two- and three- dimensional objects using the fishing tools instructional approach and those taught with the conventional (lecture) method?
2. What are the mean interest scores of the students taught geometry of two- and three- dimensional objects using the fishing tools instructional approach and those taught with the conventional (lecture) method?
3. What are the mean achievement scores of male and female students taught geometry of two- and three- dimensional objects using the fishing tools instructional approach?
4. What are the mean retention scores of male and female students taught geometry of two- and three- dimensional objects using the fishing tools instructional approach?

Hypotheses

The following null hypotheses were posed and tested at 0.05level of significance:

1. There is no significant difference in the mean achievement scores of students taught geometry of two- and three- dimensional objects using the fishing tools instructional approach and those taught with the conventional (lecture) method.
2. There is no significant difference in the mean retention scores of students taught geometry of two- and three- dimensional objects using the fishing tools instructional approach and those taught with the conventional (lecture) method.

3. There is no significant difference in the mean achievement scores of male and female students taught geometry of two- and three-dimensional objects using the fishing tools instructional approach.
4. There is no significant difference in the mean retention scores of male and female students taught geometry of two- and three- dimensional objects using the fishing tools instructional approach.
5.

Method

Design: The study adopted the quasi-experimental design. Specifically, the study was a non- equivalent control group design. The design is presented diagrammatically as shown below:

Area of the Study: The study was carried out in Andoni Education zone of Rivers State, Nigeria. The zone has twelve (12) senior secondary schools altogether that are public and co-educational.

Sample and Sampling Technique: A sample of 200 SS1 students (104 males and 96 females), out of a population of 2518 SS1 students, participated in the study. Purposive sampling technique was employed to sample four (4) co-educational schools that have the highest population of two hundred (200) students and above and with a minimal difference between the number of male and female students. Out of the four schools selected, the first two schools selected were randomly assigned to the experimental group, and the other two were the Control group. In each school an intact class was drawn through simple random sampling technique. The experimental group was taught using the Fishing Tools Instructional Approach (FTIA), while the control group was taught using the conventional (lecture) method.

Instrument for Data Collection: Data were collected using a 50-item Geometry Achievement Test (GAT) administered at different stages as Pre-GAT, Post-GAT and Geometry Retention Test (GRT). The post-GAT and the GRT had the items of GAT reshuffled. The instrument was validated by five experts in Measurement and Evaluation and Mathematics Education at the University of Nigeria, Nsukka. The reliability coefficient of GAT was calculated using Kuder-Richardson's formula (K-R 20). The reliability coefficient stood at 0.82.

Data Analysis: The data collected were analyzed using mean and standard deviation for answering the research questions while Analysis of Covariance (ANCOVA) was used for testing the hypotheses at 0.05 level of significance.

3. There is no significant difference in the mean achievement scores of male and female students taught geometry of two- and three-dimensional objects using the fishing tools instructional approach.
4. There is no significant difference in the mean retention scores of male and female students taught geometry of two- and three- dimensional objects using the fishing tools instructional approach.
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Data Analysis: The data collected were analyzed using mean and standard deviation for answering the research questions while Analysis of Covariance (ANCOVA) was used for testing the hypotheses at 0.05 level of significance.

The Experiment: The experiment was conducted during school period on the timetable for 4 weeks using the Fishing tools instructional approach and the conventional approach respectively. Geometry Retention Test was administered two weeks after the post-test. Also, adequate measures were taken to control extraneous variables from introducing bias into the study.

Results

The results are presented in the tables according to the research questions and hypotheses that guided the study.

Research Question 1: What are the mean achievement scores of students taught geometry of two- and three- dimensional objects using the fishing tools instructional approach and those taught with conventional (lecture) method?

Table 1: Mean and Standard deviation of pre-test and post-test scores of students taught geometry of two- and three- dimensional objects using fishing tools instructional approach and those taught with conventional (lecture) method.

Group	N	Pre-test $\bar{x}$	SD	Post-test $\bar{x}$	SD	Mean gain
FTIA	100	14.40	4.09	35.35	7.12	20.95
Lecture method	100	14.12	4.01	14.48	2.57	0.36

The result presented in table 1 shows that the students taught geometry of two- and three-dimensional objects using the fishing tools instructional approach (experimental group) had a pre-test mean of 14.40 with standard deviation of 4.09 and a post-test mean of 35.35 with standard deviation of 7.12. The mean gain for the group was 20.95. The control group taught with lecture method, had a pre-test mean of 14.12 with standard deviation of 4.01 and a post-test mean of 14.48 with standard deviation of 2.57. The mean gain for this group was 0.36.For each group, the post-test mean was greater than the pre-test mean with the experimental group having a higher mean gain.

Research Question 2: What are the mean retention scores of the students taught geometry of two- and three- dimensional objects using the fishing tools instructional approach and those taught with the conventional (lecture) method?

Table 2: Mean and Standard deviation of retention scores of the students taught geometry of two- and three- dimensional objects using the fishing tools instructional approach and those taught with the conventional (lecture) method.

Group		Pos-test		Retention score		Mean gain
	N	$\bar{x}$	SD	$\bar{x}$	SD	
FTIA	100	35.35	7.12	36.02	6.99	0.67
Lecture method	10	14.48	2.57	14.56	2.59	0.08

Table 2 shows that the students taught geometry of two- and three dimensional objects using the fishing tools instructional approach had a post-test mean of 35.35 with standard deviation of 7.12 and retention mean score of 36.02 with standard deviation of 6.99. The mean gain for this group was 0.67. The control group taught using the lecture method had a post-test mean of 14.48 with standard deviation of 2.57 and retention mean score of 14.56 with standard deviation of 2.59. The mean gain for the group was 0.08.For each group, the retention mean was greater than the post-test mean, with the experimental group having a higher mean gain.

Research Question 3: What are the mean achievement scores of male and female students taught geometry of two- and three- dimensional objects using fishing tools instructional approach.

Table 3: Mean and Standard deviation of achievement scores of male and female students taught geometry of two- and three- dimensional objects using fishing tools instructional approach.

Gender		Pre-test		Post-test		Mean gain	Mean gain Difference
	N	$\bar{x}$	SD	$\bar{x}$	SD		
Male	52	14.92	3.75	36.96	7.81	22.04	
Female	48	13.83	4.40	33.60	5.84	19.77	2.27

The result presented in table 3 shows that the male group had a pre-test mean of 14.92 with a standard deviation of 3.75and a post-test mean of 36.96 with a standard deviation of 7.81. The mean gain for the male group is 22.04. The female group on the other hand, had a pre-test mean of 13.83 with a standard deviation of 4.4. and a post-test mean of 33.60 with a standard deviation of 5.84. the mean gain for the female group is 19.77. For each of the two groups, the post-test mean achievement score is greater than the pre-test mean achievement score with the male group having higher mean

Table 2: Mean and Standard deviation of retention scores of the students taught geometry of two- and three- dimensional objects using the fishing tools instructional approach and those taught with the conventional (lecture) method.

Group		Pos-test		Retention score		Mean gain
	N	$\bar{x}$	SD	$\bar{x}$	SD	
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achievement score by 3.36. The mean gain difference is 2.27 in favour of the male group.

Research Question 4: What are the mean retention scores of male and female students taught geometry of two- and three- dimensional objects using fishing tools instructional approach.

Table 4: Mean and Standard deviation of retention scores of male and female students taught geometry of two- and three- dimensional objects using fishing tools instructional approach.

Gender		Post-test		Retention score		Mean gain	Mean gain difference
	N	$\bar{x}$	SD	$\bar{x}$	SD		
Male	52	36.96	7.81	38.46	7.90	1.50	
Female	48	33.60	5.84	34.46	5.53	0.86	0.64

The result presented in table 4 shows that the male group had a post-test mean score of 36.96 with standard deviation of 7.81 and a retention mean of 38.46 with standard deviation of 7.90. The mean gain is 1.50. The female group had a post-test mean of 33.60 with standard deviation of 5.84 and a retention mean of 34.46 with standard deviation of 5.53. The mean gain is 0.86. For each group, the retention mean score was greater than the post-test mean score. The difference in the mean retention score of the male and female students is 4.00, with the male students having the higher mean score.

Hypothesis 1: There is no significant difference in the mean achievement scores of students taught geometry of two- and three- dimensional objects using the fishing tools instructional approach and those taught with conventional (lecture) method.

Table 5: Analysis of Covariance (ANCOVA) of the mean achievement scores of students taught geometry of two- and three- dimensional objects using the fishing tools instructional approach ad those taught with conventional (lecture) method.

Source	Sum of Squares	df	Mean Square	f	Sig,
Corrected Model	25938.216[a]	4	6484.554	846.752	.000
Intercept	1222.611	1	1222.611	159.648	.000
Pre-test Achievement	3842.869	1	3842.869	501.801	.000
Methods	20973.914	1	20973.914	2.7393	.000
Gender	38.649	1	38.649	5.047	0.03
Methods*Gender	79.954	1	79.954	10.440	.001
Error	1493.339	195	7.658		
Total	151583.000	200			
Corrected Total	27431.555	199			

a. R Squared = .946 (Adjusted R Squared = .946)

The result in table 5 shows that an f ratio of 2.739 with associated probability value of 0.00 was obtained with regard to the mean achievement scores of students taught geometry of two- and three- dimensional objects using the fishing tools instructional approach and those taught with conventional (lecture) method. Since the associated probability (0.00) was less than the 0.05 set as level of significance, the null hypothesis (H_{01}) which stated that there is no significant difference in the mean achievement scores of students taught geometry of two- and three- dimensional objects using the fishing tolls instructional approach and those taught with conventional (lecture) method was rejected.

Hypothesis 2: There is no significant difference in the mean retention scores of students taught geometry of two- and three- dimensional objects using the fishing tools instructional approach and those taught with conventional (lecture) method.

Table 6: Analysis of Covariance (ANCOVA) of the mean retention scores of students taught geometry of two- and three-dimensional objects using the fishing tools instructional approach and those with conventional (lecture) method.

Source	Sum of Squares	df	Mean Square	f	Sig.
Corrected Model	28471.998[a]	4	7118.000	2.1294	.000
Intercept	4. 528	1	4.528	13.547	.000
Post test score	5182.094	1	5182.094	1.5504	.000
Retention	8.007	1	8.007	23.955	.000
Gender	7.872	1	7.872	19.575	.003
Methods * Gender	1.569	1	1.569	4.694	.031
Error	65.182	195	.334		
Total	156454.000	200			
Corrected Total	28537.180	199			

a. R Squared = .998 (Adjusted R Squared = .998)

The result in table 6 shows that an f ratio of 23.955 with associated probability value of 0.00 was obtained with regard to the mean retention scores of students taught geometry of two- and three- dimensional objects using the fishing tools instructional approach and those taught with conventional (lecture) method. Since the associated probability (0.00) was less than 0.05 set as level of significance, the null hypothesis (H_{02}) which stated that there is no significant difference in the mean retention scores of students taught geometry of two- and three- dimensional objects using the fishing tools instructional approach and those taught with conventional (lecture) method was rejected.

Hypothesis 3: There is no significant difference in the mean achievement scores of male and female students taught geometry of two- and three-dimensional objects.

The result for this hypothesis is presented in table 5. The result shows that an f-ratio of 5.047 with associated probability value of 0.03 was obtained with regard to the mean achievement scores of male and female students taught geometry of two- and three- dimensional objects. Since the associated probability (0.03) was less than 0.05 set as level of significance, the null hypothesis (H_{03}) which stated that there is no significant difference in the

mean achievement scores of male and female students taught geometry of two- and three- dimensional objects was rejected.

Hypothesis 4: There is no significant difference in the mean retention scores of male and female students taught geometry of two- and three- dimensional objects.

The result for this hypothesis is presented in table 6.

The result in table 6 shows that an f-ratio of 19.575 with associated probability value of 0.00 was obtained with regard to the mean retention scores of male and female students taught geometry of two- and three-dimensional objects. Since the associated probability (0.00) was less than 0.05 set as level of significance, the null hypothesis (H_{04}) which stated that there is no significant difference in the mean retention scores of male and female students taught geometry of two- and three- dimensional objects using the fishing tools instructional approach was rejected.

Summary of Findings

The following are the summary of the findings:

1. There was a significant difference in the mean achievement scores of students taught geometry of two- and three- dimensional objects using the fishing tools instructional approach and those taught with conventional (lecture) method, with those taught using the fishing tools instructional approach having a higher mean gain. This indicates that the fishing tools instructional approach improved students' achievement in geometry of two- and three- dimensional objects.
2. There was a significant difference in the mean retention scores of students taught geometry of two- and three- dimensional objects using the fishing tools instructional approach and those taught with conventional (lecture) method, with those taught using the fishing tools instructional approach having a higher mean gain. This means that the fishing tools instructional approach improved students' retention in geometry of two- and three- dimensional objects.
3. There was a significant difference in the mean achievement scores of male and female students taught geometry of two- and three-dimensional objects using the fishing tools instructional approach. This indicates that the fishing tools instructional approach improved the achievement scores of both male and female students, but with the males having greater improvement.

4. There was significant difference in the mean retention scores of male and female students taught geometry of two- and three- dimensional objects using the fishing tools instructional approach. This indicates that the fishing tools instructional approach improved the retention scores of both male and female students, with the males retaining more than the females.

Discussion

Students' Achievement in Geometry

In table 1, the mean achievement score of the experimental group in post test is higher than that of the control group. This indicates that the use of the fishing tools instructional approach improved students' achievement in the geometry of two- and three- dimensional objects. This result was confirmed by the result in table 5, which revealed that the method was a significant factor on students' achievement in geometry. Hence, studentswho were taught geometry of two- and three- dimensional objects using the fishing tools instructional approach achieved higher than those taught using the conventional (lecture) method. The findings of this study support the findings of previous researchers such as Ogbonna (2004, 2007) and Kurumeh (2004, 2007), where experimental group proved better than the control group. The above researchers used the constructivist and ethno mathematics instructional approaches respectively. The finding equally agrees with that of Adekanye (2008), who confirmed that appropriate method and instructional materials lead to students' improvement in mathematics in general and geometry in particular. The finding may have been as a result of the active and cooperative participation of the students due to the fact that the approach used was practical in nature, from the learners' environment, project-oriented and therefore ensured students' activity. This confirms the reports of Obodo (2004) and Uka (2006), who averred that teaching method should be practical, applicable and project-oriented. The use of the fishing tools must have helped the students to develop self-confidence and enthusiasm in solving problems in geometry. This type of exposure to practical and applicability of mathematics/geometry in concrete situation and learners' cultural background made geometry easy to understand thereby resulting in higher achievement.

Students' Retention in Geometry

Results of the study show that the students in the experimental group obtained higher mean retention score (36.02) than those in the control group (14.56) (Table 2). This was further confirmed by the ANCOVA result (Table 6), which shows that the experimental group significantly retained higher

than the control group in the geometry of two- and three- dimensional objects taught using fishing tools instructional approach. The finding of this study is in accordance with those of Iji (2003), Ogbonna (2007), and Eze (2008), who confirmed that the use of new practical approaches enhances students' retention. Iji (2003), explored the effects of logo (LMP) and basic (BPM) programmes on achievement and retention in geometry of junior secondary school students, and revealed that the students taught with LMP and BPM achieved higher than those taught with the conventional method. In the same vein, Ogbonna (2007), explored the effects of two constructivist instructional models on students' achievement and retention in number and numeration, and reported that the IET and TLC constructivist instructional models enhanced significantly students' achievement and retention in mathematics. Also, the finding of the present study is in agreement with that of Anyor and Iji (2014), who worked on the effect of Integrated curriculum delivery strategy on secondary school students' achievement and retention in Algebra in Benue state, Nigeria, and found among other things, that the strategy (ICDS) enhanced students' achievement and retention in the Algebra taught during the period of the study.

Influence of Gender on Students' Achievement in Geometry

The results in tables 3 and 5 reveal that there was a significant difference in the mean achievement scores of male and female students taught geometry of two- and three dimensional objects using the fishing tools instructional approach with the males outperforming the females in the GAT. This finding is not in agreement with those of Ogbonna (2007) and Adekanye (2008), whose studies found the females achieving higher than the males in mathematics and geometry. Also, Meremikwu (2002, 2008), found among other things, that the mathematics achievement of girls in single-sex school was significantly better than male counterparts. The result of this study is also not in compliance with the findings of Ogbonna (2004), Utin (2005), Harworth, Dale and Plomin (2008), and ASA (2005) which revealed no significant difference in the achievement of male and female students in mathematics. However, the results of this study are in line with those of Lassa (2000, 2012) and Steen (2003), who documented male superiority over females in special ability. Also, Osborne and Dillon (2010) and Ogunkunle (2009), reported significant differences in achievement in favour of boys. The results could be due to the fact that mathematics has been male-stereotyped since it is regarded as abstract, difficult and has attributes which boys are attracted to.

Conclusion/Recommendations

This study has shown that the fishing tools instructional approach enhanced students' achievement and retention in geometry of two- and three-dimensional objects. Also, there was a significant difference in both the achievement and retention of male and female students taught geometry of two- and three- dimensional objects. Moreover, there was significant interaction between fishing tools instructional approach and gender on students' achievement and retention in geometry of two- and three-dimensional objects .Based on these findings the following recommendations were made:

- Teachers should adopt the fishing tools instructional approach for the teaching of geometry.
- Curriculum planners in primary and secondary schools should include the fishing tools instructional approach as one of the necessary instructional approaches to the teaching of mathematics, especially geometry.
- Teacher training institutions such as institutes of education, faculties of education and colleges of education should incorporate fishing tools instructional approach in their mathematics methods courses, to ensure proper training of teachers in the innovative approach.
- Government, through Ministry of education, and professional associations should organize public lectures, seminars and workshops on fishing tools instructional approach in schools, as a way of marketing the new approach in teaching and learning process.
- Government and non-governmental organizations (NGOs) like multinational companies and well meaning individuals should sponsor further researches into the possible application of fishing tools instructional approach in other aspects of science and technology.

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