EFFECT OF UTILIZING INSTRUCTIONAL MATERIALS IN TEACHING PROBABILITY ON ACADEMIC PERFORMANCE OF STUDENTS IN KATSINA-ALA TOWNSHIP SECONDARY SCHOOLS, BENUE STATE

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ABSTRACT

This study was a Quasi-experimental research aimed at determining the effect of instructional materials in teaching probability at senior secondary school two in Katsina-Ala township secondary schools. It was a randomized pre-test post-test control group design in which four mixed-sex secondary schools were purposively selected for study. A sample size of 40 students was randomly selected from stream B of SS 2 in each school sampled. The sample comprised 20 male and 20 female students. Data for the study was collected using Mathematics Achievement Test (MAT) and instructional material for probability designed for the study. The ten-item test instrument was pilot tested and the coefficient of reliability obtained was 0.7. Mean achievement ($\bar{x}$), standard deviation and variance were used to answer the research questions and t-test was used to test the hypotheses at 0.05significance level. The findings were that instructional materials improve students' achievement in probability and that achievement in probability was not sex-biased. The researchers therefore recommended regular organization of workshops to update mathematics teachers' skills in the use of instructional materials to help improve students' performance in mathematics.

Introduction

Mathematics is a compulsory subject in all primary and secondary schools in Nigeria. This is because, mathematics is so invaluable to humanity and the existence of society that the learning of the subject is considered very important for human existence, since its study improves one's mental ability to reason logically, make accurate calculations, take rightful decisions on issues and behave rationally in almost all situations. On a general note, mathematics is all about finding solutions to human problems. Therefore, students are expected to have mastery of key concepts and skills in mathematics to enhance their self-development and that of the society in general.

On the other hand, according to Apav (2014) the knowledge of logical reasoning, principles, processes and relationships acquired through the learning of mathematics manifests itself in aesthetic values of the discipline as seen in manufacturing, building and construction, printing, footballing, etc. Harbor Peters (2000) summarized the role of mathematics to society as the gate and key of all sciences, for without its knowledge and ability to apply its skills, techniques, principles and theories, it will be practically impossible to make an inroad into science and technological advancement.

Despite the picture of importance and vital role portrayed of mathematics, there is very low interest and therefore very poor performance in the subject, at the ordinary level of education in Nigeria (Obodo, 2004; Obasanya, Adegbija & Olumorin, 2008).

According to Adebule & Ayoola (2015), the teaching and learning difficulties in mathematics in the country may be traced to the abstract methods of teaching the subject among other factors. Agwagah (2001) notes that, mathematics teachers in Nigeria, in most cases, do not use instructional materials in teaching mathematics at the ordinary level of education, which is the foundation stage of schooling, so that most of the mathematics concepts are taught abstractly. This may be due to non-availability of the instructional materials or lack of knowledge on how to use them. The teachers, in most cases, therefore resolve to teach the pupils, using traditional methods such as lecture method which is teacher-centered. This method does not actively involve the learner in the teaching/learning process, therefore making students to lose interest in the subject.

Omoifo & Oloruntegbe (2000) advocate the use of new methods and techniques of teaching mathematics such as laboratory method, project method, enquiry method which encourage the development and utilization of techniques of teaching that make use of a lot of instructional materials.

Kay (2005) is of the view that effective teaching of mathematics should emphasize active learning. The learner must be personally involved in the teaching/learning process through the use of instructional material and laboratory activities.

According to Kay (2005) instructional materials stimulate pupils' desire to learn and increase their interest and assist assimilation and retraction of what is learnt, culminating in good academic performance in the pupils.

However, the current debate among scholars in mathematics classroom instruction regarding the use of instructional materials is how to provide instructional environment, conditions and methods that will help achieve learning goals for students with different skills and ability levels in a class (Saritas & Akdemir 2009). Moreover, the recent West African examination council results analyses in mathematics indicate that, from 2009-2013 the worst performance of students in mathematics were from word problems, probability and graphical functions (WAEC 2013).The researchers' confirmation survey conducted in January 2013 in the offices of four Vice Principals(Academics), on the performance of senior secondary school students in these areas of mathematics at senior secondary school examinations in Katsina-Ala township secondary schools corroborated the WAEC 2013 assertion.

On the other hand, some researchers view gender as a factor in the poor performance of students in the problem areas identified by WAEC 2013 (Obioma, 1985; Obodo, 2006; Okereke, 2006). According to Okereke (2006), girls particularly 'run' away from mathematics and mathematics related courses regardless of the approach a teacher adopts in teaching.

It is in the light of the issues raised above that this study seeks to examine the effect of utilizing instructional materials in teaching probability on the academic performance of students in mixed secondary schools in Katsina-Ala township secondary schools, to determine whether non-use or the wrong use of instructional materials is the cause of students' poor performance in probability or if the poor performance is sex-biased.

This study is therefore part of efforts by educators, particularly mathematicians in Nigeria to find solutions to the poor performance of pupils in mathematics, especially at SSCE as identified by the WAEC Chief Examination Officer. The findings of the study would therefore provide strong empirical basis for improvement in the use and appropriate presentation strategies of instructional materials in teaching probability at secondary school level.

The study centered on determining the effect of using instructional materials in teaching probability at senior secondary two (SS2) within the sampled secondary schools, in Katsina-Ala township. Probability was chosen for study because of the high failure rate identified by WAEC (2013). Secondly, probability is widely used by individuals and

companies in forecasting, planning and playing of games. Hence its importance to human beings is viable enough to ensure its proper understanding and application.

The duration for the study was first term of 2017/2018, covering only the sampled mixed-sex secondary schools in Katsina-Ala township. Within this duration, the students were taught in two different conditions each with a different method.

Two theories were considered to give credence to the study. They were:

i. Jean Piaget's theory of cognitive growth and
ii. Robert Mill Gagne's Instructional theory in maximizing the effect of utilizing instructional materials in teaching.

Piaget (1970) discovered that, cognition which is an active and interactive process of the mind with the environment takes place in four stages; sensory motor stage (0- 2 years); pre-operational stage (2-7 years) concrete operation stage (7-11 years) and formal operation stage (11-18 years). Piaget discovered that, the nature and make up of intelligence change significantly overtime. During the formal operation stage which is considered in the study, the child is able to see many relationships at a time and is able to co-ordinate many variables due to their matured thought processes. Hence the use of concrete materials in teaching at this level of education will help the students in knowledge retention, recall and application.

On the other hand, Gagne (1995) in his "conditions of learning" theory of maximizing the effect of utilizing instructional materials in teaching on academic performance of pupils states that, "different types and levels of learning exist and each of these types and levels require instruction tailored to meet the needs of the pupils". The focus of the theory is on retention and honing of intellectual skills of pupils in a hierarchy. Identify a topic; identify measureable learning outcomes, planning the instructional strategies, bearing in mind the fact that, the measurable outcomes have internal and external conditions that support them. The external conditions are the instructional aids while the internal conditions are skills and capabilities that the learner has already acquired. The study is therefore anchored on the constructivist aspect of the theory with the notion that learning occurs through mental association-ship. Therefore in a constructivist class room, the learners are actively involved, the environment is democratic, activities are interactive and students-centered, the teacher only facilitates the process of learning such activities as experimentation laboratory activities, research projects, field trips.

Studies conducted in this area of mathematics education (the use of instructional materials in teaching) are in agreement that instructional materials improve students' understanding and application of concepts in mathematics. One of such related studies was carried out by Koran (2001) in Kaduna State, Nigeria, titled "The effect of motivation on students' achievement in mathematics based on gender in secondary schools in Kaduna state". The population for the study was all secondary school students in the state. A sample of 1000 students was drawn from 10 secondary schools, selected at random from 213 government grant-aided secondary schools across the state. The sample consisted of 500 male and 500 female students from SS2.A pre-test, post-test, quasi-experimental research design was used for the study. The result of the study showed that the average performance of the students in pre-test scores was very low across the sampled secondary schools. However, the average performance of the experimental classes was far higher than those of the control classes. A mean difference of 27.3 in favour of the experimental classes was found to be significant at 0.05 level. On the other hand, the difference between the average performance of male and female students was not significant at 0.05 level.

Similarly Okigbo and Osuafor (2008) carried out a study on junior secondary school students in Ekwusigo local government area of Anambra state, Nigeria, titled "The effect of using mathematics laboratory activities in teaching geometry on achievement of student in

mathematics". The purpose of the study was to determine the effect of geometry instructional materials in mathematics laboratory on male and female students' achievement in mathematics and make recommendations to the state government for necessary actions. The population of study was all junior secondary school students in secondary schools approved by the state government. A sample size of 300 students comprising 140 male and 160 female students was drawn from 10 secondary schools selected at random. Pre-test, post-test, non-randomized quasi-experimental research design was used for the study. Adequacy of geometry instructional materials in the laboratories was used as moderator variable while correct use of the materials and achievement were the major variables of interest.

Analysis of co-variance (ANCOVA) was used to analyze the data collected. The findings were that students in the experimental group achieved higher scores than those who were taught the same topics without interacting with the instructional materials. Therefore, there was significant difference between the control and experimental groups at 0.05 level of significance. On the other hand, the difference in the achievement of male and female students was negligible.

The studies reviewed have shown that, instructional materials impact positively on students' achievement in mathematics. However, sex was not a major factor in the poor performance of the students.

In this study however, the researchers verified the effect of utilizing instructional materials on students' achievement in probability at senior secondary two (SS2).
Specifically, the study sought to:

- Determine the difference in the mean achievement of male and female students, if it exits.
- Determine the difference in the mean achievement of students taught probability without instructional materials and those taught using instructional materials.

The following research questions were addressed in the study:

1. What is the difference in the mean achievement scores of male and female students in probability?
2. What is the difference in the mean achievement scores of the students taught probability using instructional materials and those taught without instructional materials?

The following null hypotheses were then tested in the study at 5% level of significance:

Hoi: There is no significant difference in the mean achievement scores of male and female students in probability in the sampled secondary schools in Katsina-Ala township.

Ho_2: There is no significant difference in the mean achievement scores of the students taught probability using instructional materials and those taught without instructional materials.

Method

A quasi-experimental research design was used for this study. It was a two-group randomized pre-test post-test control group design. This design was used to ease the difficulty of studying the many arms of SS2 classes in the township secondary schools.

The target population was SS2 students with a total population of 421 students during the time of study (Source; Ministry of Education Science and Technology Area Office Katsina-Ala, 2018).

A sample of 40 students was drawn randomly from four arms of SS 2 classes, purposively sampled from four schools in the town. The four schools purposively sampled were mixed-sex secondary schools with adequate and qualified number of mathematics teachers. Stream B of SS2 classes were sampled for study. This was to avoid studying a

science stream which was stream A, in all the township secondary schools. This was because much fewer girls offer sciences in the township secondary schools, therefore it was more appropriate to study a class stream with a more balanced gender population.Hence a total of 20 male and 20 female students formed the sample of 40 students. Furthermore, the simple random sampling technique was used to assign the class streams sampled, to control and experimental groups, by drawing a class stream with the school's name written on it from a lucky-dip container without replacement.

***Table 1*:** Group, school, sex and number of male and female students sampled for study.

Group	School	Male	Female	Total in Each group
Experimental	N.K.S.T. Sec. Sch.	5	5	20
	Demonstration Sec. Sch.	5	5	
Control	St. Gerard's Sec. Sch.	5	5	
	Govt. Day Sec. Sch.	5	5	20

Mathematics achievement test (MAT) was used as the instrument for data collection. It was a ten-item essay test instrument constructed based on SS2 mathematics syllabus on probability. The test instrument covered the three domains of knowledge (cognitive, affective and psycho-motor). Probability instructional materials (PIM) such as dice, coin, pack of playing cards, bottle covers etc. and lesson plan based on demonstrating the use of the instructional materials were also used in the data collection process.

After undergoing face and content validation by two experts in mathematics education, the instruments were pilot tested on two classes of SS2 students in schools not sampled for study, using the test-retest method. The coefficient of reliability obtained was 0.7. According to Nikto and Brookhart (2007, p.82) "moderate level of reliability of 0.7 is tolerated as ensuring validity of items". Hence the coefficient of reliability obtained was high and the instrument was adequate and reliable to obtain the required information sought for under a conducive environment, using appropriate teaching strategies.

In each school sampled, the mathematics teacher for SS 2 was trained to assist in data collection process. Two of the teachers in the control classes taught the students probability using their lesson plans, while the researchers taught probability in the experimental classes with the aid of instructional materials.

The data were collected in two phases. Phase one was administration of pre-MAT which took one week. Treatment of the experimental classes was done for 3 weeks. While the usual mathematics teachers of the control classes were teaching the classes, the researchers were on the other hand teaching the experimental classes. Thereafter, the MAT was then given to the teachers teaching the control classes to administer under the researchers' supervision. Similarly, this was done to the experimental classes by the researchers.

The data collected through pre-MAT and post-MAT were classified accordingly for experimental and control groups, as well as into sex. The test was scored objectively. Correct solution to each question attracted 10 marks and wrong solution attracted 0 mark. No mark was awarded for partial correct solution of any problem.

Descriptive statistics of mean and standard deviation were used to answer the research questions and t-test (separate variance formula) was used to test the hypotheses at 0.05 level of significance.

Result and Discussion of Findings

The results of the analyses of data collected were presented in this section in the order the research questions have been stated and the research hypotheses raised.

Research Question 1

What is the difference in the mean achievement scores of male and female students in probability?

Table2: Pre-test mean achievement of male and female students and the difference between them.

Sex	N	Pre-test mean ($\bar{x}$)	S.D	Mean difference
Male	20	31.2	4.2 (S^2- 17.64)	
				1.8
Female	20	29.4	4.1 (S^2=16.81)	

The result in Table 2 shows pre-test mean score for male students of 31.2 while that of the female students was 29.4. The mean difference in favour of the male students was 1.8. This clearly shows that, the students were at the same cognitive ability level about probability theory in the sampled classes.

Furthermore, the post-test analysis in Table 3 shows a similar result.

***Table 3*:** post-test mean achievement, standard deviation and variance of male and female students in the experimental group and the difference between their mean achievement.

Sex	N	Pos-test mean ($\bar{x}$)	S.D	Mean difference
Male	20	45.1	2.1 (s^2- 4.41)	
				0.3
Female	20	44.8	2.0 (s^2=19.36)	

Results in Table 3 show a post-test mean score of 45.1 for male students with standard deviation of 2.1 and variance of 4.41,while the post-test mean score of the females was 44.8 with standard deviation of 2.0 and variance of 19.36. The post-test mean difference between the sexes was just 0.3 in favour of the male students.

From the two tables (Tables2 and 3) it was clear that the difference in mean performance between the male and female students in probability was very small.

Research Question 2

What is the difference in the mean achievement scores of the students taught probability using instructional materials and those taught without instructional materials?

***Table 4*:** post-test mean, standard deviation, variance and mean difference between students who were taught probability using instructional materials and those taught without instructional materials.

Group	N	Post-test mean ($\bar{x}$)	S.D	Mean difference
Experimental	20	53.5	1.2 (S^2_1= 1.44)	
				17.3
Control	20	36.2	4.1 (S^2_2=16.81)	

Table 3 shows post-test mean achievement score of experimental groups of 53.5 with standard deviation of 1.2 and variance of 1.44, while the post-test mean achievement of the control group was 36.2, with standard deviation of 4.1 and variance of 16.81. The post-test mean difference between the two groups was 17.3 in favour of the experimental group. This

indicates that, the treatment given to the experimental group improved their performance more than the control group that did not receive the treatment. Moreover, the standard deviation among the scores of students in the experimental group was very small (1.2), while that of the control group was very large (4.1), indicating a high disparity in their achievement after treatment.

Hypotheses 1: There is no significant difference in the mean achievement scores of male and female students in probability in the sampled secondary schools in Katsina/Ala township.

***Table 5*:** t-test calculated based on pre-test mean, variance and the number of male and female students in the sampled schools.

Sex	N	$(\bar{x})$	S^2	df	t-cal	critical t-value
Male	20	31.2	17.64	38	1.74	2.03
Female	20	29.4	16.81			

Analysis of Table 5 shows that there was no significant difference in the pre-test mean achievement of male and female students in probability before the experiment was conducted. The analysis shows the calculated t-value of 1.74 and critical t-value at 5% level of significance of 2.03 which means that the null hypothesis 1 cannot be rejected.
Further analysis in Table 6 shows a similar result.

***Table 6*:** t-test calculated based on the post-test mean, variance and the number of male and female students in the experimental group.

Sex	N	$(\bar{x})$	S^2	df	t-cal	critical t-value
Male	20	45.1	4.41	38	1.12	2.03
Female	20	44.8	4.0			

The result in Table 6 shows a post-test mean score of 45.1 and 44.8 for male and female students respectively in the experimental group with variances of 4.41 for the male and 4.0 for the females, t-calculated at 38 degrees of freedom was 1.12, which is less than the critical table value of 2.03 at 0.05 level of significance. Therefore hypothesis 1 cannot be rejected.

Hypothesis 2

There is no significant difference in the mean achievement scores of the students taught probability using instructional materials and those taught without instructional materials.

***Table 7*:** t-test calculated based on post-test mean score, variance and the number of students in the experimental and control groups.

Group	N	$(\bar{x})$	S^2	Df	t-cal	critical t-value
Experiment	20	52.5	9.6	38	14.7	2.03
Control	20	36.2	18.1			

Analysis in Table 7 shows a significant difference in the mean achievement scores of the experimental and control groups at 0.05 level of significance, since the t-calculated of 14.7 is greater than the critical t-value of 2.03 at 0.05 level. Therefore hypothesis two is not accepted as there is a significant difference in the mean achievement of the two groups.

Discussion

The analysis of data clearly shows a little difference in both pre-test and post-test mean achievement of male and female students in both control and experimental groups with the mean differences being insignificant at 0.05 level of significance. This means that sex has

little effect on achievement of students in probability. Hence research questions 1. 3 and 4 have been answered in the negative (no); that there is no significant difference in the achievement scores of male and female students in probability in the study area.

On the other hand there was a remarkable and significant difference in the achievement scores of students in the control group and those in the experimental group. Hence research question 2 and hypothesis 2 have both affirmed that there is a significant difference in the performance of students taught probability using instructional materials and those taught without instructional materials.

Conclusion

The findings of this study clearly show that students are more comfortable, and achieve better results in probability theory and concepts, when instructional materials are used in teaching the topic, than when the topic is taught abstractly. Instructional materials make students interested in the topic since the abstract nature of the topic is completely removed. Secondly, sex has insignificant effect on the performance of students in probability.

The following recommendations have therefore, been made: workshops should be organized regularly to update mathematics teachers' knowledge on the best way to handle instructional materials in the class, at this level of education. Strict supervision of mathematics teachers in our schools should be done to ensure that appropriate instructional materials are used in teaching each mathematics topic to improve students' performance.

The findings of the study have added a couple of facts to the field of mathematics that, sex is not a major determining factor in students' performance in mathematics, and that many topics in mathematics that seem abstract to students can be made real with the use of appropriate instructional materials.

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