IMPROVING STUDENTS PERFORMANCE THROUGH USING MODELS IN TEACHING SOLID GEOMETRY IN JUNIOR SECONDARY SCHOOLS IN HONG LOCAL GOVERNMENT AREA, NIGERIA

Abstract

The aim of this paper was to determine the influence of using models as instructional materials on student's performance in mathematics in Hong Local Government Area, Adamawa State. Many potential Junior Secondary Students each year failed to be enrolled into Senior Secondary Schools just because of fail in mathematics. While the specific objectives of the study were to determine the effect of using models on students academic achievement in mathematics and to determine the influence of gender difference when taught with models. The research employed experimental study design on a targeted population of all Junior Secondary Students in Hong Local Government Area. A sample of 240 students both male and female participated in the study. Out of the four randomly selected schools, two were assigned experimental group and the remaining two, control group. Data were obtained through testing the groups at the end of the treatment and was analysed using the appropriate statistics at 0.05 level of significant. From the presentation and data analysed, findings revealed that teaching mathematics with models as instructional materials improved students performance. The result further, revealed gender difference in favour of boys than girls. Based on the findings, it was recommended among others that, schools should provide best designed Models in support of the teacher's improvisational ones, with simple and durable materials that will facilitate instruction.

Key words: Instructional Models, Solid Geometry, Stereometry, Students performance, Hong Local Government Area.

Introduction

In looking forward for means of improving and enhancing teaching-learning process, in order to attend high level of achievement, good instructional materials are among the best means to do so. When teaching Mathematics in junior secondary school level, apart from text books as instructional materials, models are best instructional materials, especially in teaching topics such as geometry and stereometry. Because, mathematics is a subject that deals with three dimensional object (x, y, z) under the topics of solid Geometry and Stereometry. The solid geometry was the traditional name for the geometry of the three dimensional objects (x, y, z), which now been referred to as "basic solids". While stereometry deals with the measurement of volume and area of the various basic solids, such as cylinders, circles, cones, pyramids, cubes, cuboids and prisms. These basic solids are also referred to as regular solids. The irregular solids

include stones, grains, leaves, animals (Amoeba) and the like. While regular solids are the "basic solids", which include cubes, cuboids, cones, pyramids, circles, prisms and cylinders.

Around 360 B. C. Pythagoreans and Platonist dealt with the regular solids. First Pythagoreans dealt with cubes, cuboids and circles. Later on Platonist dealt with prisms, cones and cylinders, known as Platonic solids, prominently in the philosophy of Plato. Then for much understanding of basic solids, that is solids geometry and the stereometry, in teaching-learning process in mathematics it is good to use the real objects/solids representation. Where the real solids are not available or where their sizes, weight, cost or danger in using them, may not permit their usage. A teacher can use a substitute which is either a reduced/enlarge scale of the real solid. And such a substitution is been referred to as model (Agboo, 2000).

Mathematics teaching-learning process in our schools especially in Hong Local Government Area, Junior secondary schools are facing many challenges ranging from lack of proper instructional materials to negative students towards it such as fear of the subject due to lack of learning motivations as a result of poor methods of the teaching-process Adolphus, (2011). Also Oleyede (2007) revealed that, it is an open secret that most of our schools lack instructional materials and teaching aids. In fact, in some schools, most especially the junior secondary schools, even text books as teaching aids are not available, talk less of others.

Model as instructional materials, especially when dealing with topics, such as basic solids/geometry as well as stereometry in mathematics, give a teacher an opportunity of active participation of his learners. Thus providing learning motivation that enhance instruction. Okoronka (2011), also highlighted that, there are three learner characteristics that is to be considered for positive attitude formation in a teaching-learning process. These are cues,

reinforcement and participation. Where cues deal with clarity, variety, meaningfulness and strength of the learner explanation. Then, reinforcement, dealt with the amount of acknowledgement the learner receive for learning. While participation, pertains to the extent to which the students are allowed to engage actively in the learning-process. Where all these are basically linked to the teacher's instructional method, then the assimilation of the concept of geometry will be enhanced. These characteristics are also typical with model as instructional materials. So model based instruction has its theoretical underpinning in cognitive science and principles of knowledge construction.

Studies of Gilla and Tommy (2004) suggested that models should be used in teacher education, and that students, teachers should be asked to explicitly and in detail establish the connections between models and abstract idea of mathematics. This would give better performance. They also found that there are some models that do not reflect the mathematical ideas properly. Teachers should make efforts to overcome the difficulties in the use of models during mathematics instruction. They further opine that instruction using models as instructional materials improved student's performance significantly.

O'Neil and Pohman (2006) revealed that models as instructional materials motivate students in a science class. And has significantly influence on student's performance. They summarized as instructional materials such as models, improved students achievement in mathematics. Jiny (2003) revealed also that instructional materials such as models facilitate instruction and improves learner's performance. He also agreed that there is gender difference in student's performance in favour of male students.

Psychological theorists are also not left behind on highlighting the importance of models as instructional materials in the teaching-learning process. Example, Brunner (1960) as related in Oleyede (2007), thus instruction should be based on Brunner's view. That is children passes through three main level of processing information, that he calls enactive, iconic and symbolic. Where:

i. The enactive – is the earlier stage of a child where the child's world is being represented through objects in terms of their immediate sensation of them.

ii. Iconic – the later stage of the child where his world to be represented by the use of mental images standing for objects.

iii. Symbolic – where the child world to be represented by transforming action and images into symbolic system to enable knowledge encoding.

Therefore, this theory matched with the concept of models where representation through objects – means models object of 3 - dimensional shapes; representation by the use of mental images – mean mental models. And symbolic representation by transformation of action and images into symbolic system – means by symbolic models.

Gagne's theory too, is not left behind, where essential to Gagne's idea of instruction as what he calls condition of learning which are of two types, as:

1. Internal Condition – which deals with previous learned capabilities of a learner, that is the learner's previous knowledge.
2. External Condition – This deals with stimulus that presented to the learner externally, as instructional materials.

Combining the two conditions on instruction, especially by using models, would definitely stimulate the learner and promote the transfer of knowledge or information from perception through the stages of memory retention. In support of this, Agboo (2000) illustrated that models have several advantages as a teaching-aid. They enable the teacher to use representational objects in places of the real objects. This can aid understanding better than mere description or discussion. The construction of models also provides opportunity for active participation by the students, thus enhancing learning and providing motivation. Making models affords students opportunity to be active and creative. Because models depict objects in three dimensions as said above, all of which can be observed. And models allow what is small in nature to be magnified or what is complex to be simplified. Models can be handled, manipulated, assembled and observed very closely. Learning is therefore been facilitated, since several senses are brought into play and the relationship of several parts is made much more clear by the use of models. Therefore, models build learners curiosity and creativity, especially in learning difficult subjects, such as mathematics. So model based instruction has its theoretical underpinning in cognitive science and principles of knowledge construction. This means that, using models more especially experts model, as instructional of the learner materials would engage and enhance the metal model that leads to a better learning. And using models in teaching basic solids in mathematics afford not only teachers, but learner/students opportunities, which include clarity, reinforcement, participation and creativity when dealing with other science/technical subjects. In short, model based instruction encourages students centeredness instruction. But problems with models as instructional materials include cost in obtaining them and time consumption at presentation.

The purpose of this paper is therefore, to find out the effectiveness of using the model as instructional materials in teaching basic solids in mathematics. This is to determine its influence

on student's achievement in mathematics at junior secondary school levels, especially here in Hong Local Government Area.

Statement of the Problem

To bring about improvement in the teaching of geometry in mathematics, research is needed which will provide classroom teachers with more information as to how children learn geometry every day. The problem under consideration in this study is to investigate a particular spatial ability that of teaching basic solid figures, by the use of models, and to determine what relationship exists between this ability and achievement.

Since the implementation of the Junior Secondary School Certificate Examination (JSCE) by the National Policy on Education (2004) which was intended to improve achievement of learners, especially in sciences, such as Mathematics, our recent experiences from JSCE results so far have shown that, we have failed to achieve this goal. And this is due to many factors; such as students negative attitudes due to fear of the subject, which can be attributed to the negative attitude of teachers, due to inappropriate teaching methods. Especially while dealing with some complex topics. Example Basic Solids in learning complex topics in mathematics. That is why; this paper is interested in finding out the effectiveness of one of the methods of using Models, as instructional materials in teaching Basic Solids, in mathematics.

Purpose of the Study

The main purpose of this paper is to determine the influnce of using models as instructional materials on student's academic performance in mathematics. While the specific objectives are:

i. To determine the effect of using models on students academic performance in mathematics.

ii. To determine the influence of gender differences when taught with models.

Research questions

i. What is the effect of using models on student's academic performance in mathematics?

ii. What is the influence of gender differences when taught with models?

Research Hypotheses

$H_{o1:}$ there is no significant effect of using models on student's academic performance in mathematics.

$H_{o2:}$ there is no significant influence of gender differences when taught with models in mathematics class.

Methodology

The study adopted the non-equivalent, pre-test, post-test Quasi-Experimental control group design. A schematic representation of the study design summarized as follows:

$O_1 \quad X_1 \quad O_2$

$O_3 \quad X_2 \quad O_4$

Where O_1 and O_3 are the pre-test scores on X_1 and X_2 respectively, O_2 and O_4 are the post-test scores to X_1 and X_2 treatments. X_1 and X_2 represent the experimental and control group treatments respectively.

Population and sampling

The population of this study consists of all Junior Secondary 3 students in Hong local Government Area. The sampling was done based on simple random sampling technique. Four schools were drawn from the population where, 2 schools were experimental group and the remaining 2 the control group. Intact classes were used in order to avoid disruption.

Instrumentation

The instrument has been adapted by the researcher from the Standardized Achievement Test (SAT) of the Junior Secondary School Examinations (JSCE) Question papers. The instruments need not to undergo much validation process again, since it is an adopted one, already with elements of validity in it. But still, the instrument has been given to experts again for more revalidation process. While the sampling content to be covered by the instrument remain fixed as done in a systematic manner by the mathematics specialist through an extensive review of syllabus and textbooks common to most Junior Secondary School, has been assisted by Universal Basic Education (UBE) in Adamawa State.

Being an instrument that has been adapted, there has been less test-retest process for reliability. But still pilot testing was done and was based on Guttmann's split-half with a coefficient of reliability of 0.86.

Data Collection

Data for this study were collected through administration of pre-test and post-test. The general research treatment procedure was carried out in five major stages, namely, preliminary stage; pre-treatment stage; treatment stage; post-treatment stage; and post-test stage. The experiment

lasted for twelve weeks including one week for briefing and orientation of teachers for the experimental treatments and two weeks for revision and post-testing for all groups. All the test scripts were retrieved for marking and score the tests based on the student's performance.

Data Analysis

The statistical tools used for the analysis in this work were descriptive statistics and z-test, t-test for testing the hypotheses.

Results and Findings

Research Question1: What is the effect of using models on student's academic performance in mathematics?

Table 1: Summary of Descriptive Analysis of the Post-test Scores of Experimental and Conventional Group Samples.

Group	N	$\overline{X}$	SD	SE
Experimental	120	69.46	12.95	3.36
Conventional	120	58.20	20.21	

From table 1, calculated mean for the experimental group is 69.46 with standard deviation of 12.95. While the calculated mean for the conventional group is 58. 20 and the standard deviation of 20.21. We can conclude from this result that experimental group performed better than the conventional group. You can see that even the standard deviation supported the argument.

Research Question 2: What is the influence of gender differences when taught with models?

Table 2: Summary of the Experimental Group Performance for Gender Influence.

Gender	N	$\overline{X}$	SD
Male	67	68.41	13.59
Female	53	56.50	12.52

Table 3: Summary of the Conventional Group Performance for Gender Influence.

Gender	N	$\overline{X}$	SD
Male	65	52.32	14.54
Female	55	46.51	13.42

From Tables 2 and 3, we observed that the results of both the experimental and conventional group from the post-test, the performance was in favour of male students. So, teaching with models improved male students than female students in mathematics performance.

Research Hypotheses 1: There is no significant effect of using models on student's academic performance in mathematics teaching.

Table 4: The Z-test Analysis of the Differences Between the Mean of the Results.

Group	**$\overline{X}$**	**SD**	**N**	**SE**	**Z-cal.**	**Z-critical**
Experimental	68.46	12.95	120	3.39	4.68	1.960
Conventional	52.60	20,21	120			

Table 4 had revealed that the z-value is greater than the critical value (4.68 > 1.960). It means that the null hypothesis is rejected. Therefore, the result of the post-test scores, suggested that the differences between the mean achievements of experimental and conventional groups in the mathematics class, is statistically significant.

Research Hypotheses 2: there is no significant influence of gender differences when taught with model in mathematics class.

Table 5: Summary of the t- Distribution Analysis of Gender Difference in Mathematics Performance.

Gender	**N**	**$\overline{X}$**	**SD**	**Df**	**SE**	**t-cal**	**t-tab**
Male	132	67.09	13.58	238	3.69	0.07	1.96
Female	108	58.70	12.51				

From Table 5, the calculated t-value is greater than critical value at 0.05 level of significant with 238 degree of freedom. This is an evidence to show that there is significant difference in favour of male students.

Discussion of Findings

The findings of the study based on the presentation and analysis of tables, revealed that students taught with models as instructional materials, performed better in a Mathematics class, as supported by Gilla and Tommy (2004), Audu (2006) and Jimy (2003). This study showed therefore that treatments generally improve the students learning performance.

Models are useful tools to better understand not only the learning processes of students, but also ourselves as educators. At a glance the models might provide only more questions, but a careful study of the models can provide starting points to begin developing more appropriate educational experiences for our society's next generation.

Gender disparity in participation was also revealed in the results of the study. This is not unusual in Nigeria and in developing countries around the world as the participation show concordance with the total number of inter-gender enrolment in the schools. Male enrolment in schools have been higher than their female counterpart due to gender imbalance in school enrolment which tends to occur whenever there is a disparity in the access of males and females to education. The obvious disparity between boys and girls is found in overall enrolment. In Nigeria the gender gap favouring boys in school enrolment, has been found to be consistently high (Amasuomo, 2006; Otite, 2006). Some Nigerian parents tend to give priority to the schooling of boys rather than girls especially in large families where funds are insufficient. The Nigerian girl child is more likely not to enroll in school or drop out of the school system as a result of poor socio-economic

status of parents, early marriage, premarital pregnancy, household duties, and parents' preference for the education of boys rather than girls and sexual harassment.

Schools should provide best designed Models in support of the teacher's improvisational ones, with simple and durable materials that will facilitate instruction.

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