

THE INTERNATIONAL JOURNAL OF HUMANITIES & SOCIAL STUDIES

How Creating Learning Outcomes Are Affecting Performance in Geometry of Students for Senior Secondary Schools in Science, Technology, Education, Mathematics and Society Domain

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Abstract:

This study aims to find how performance of students from senior secondary school is getting affected by creative learning outcomes in Maiduguri Metropolis, Borno State, Nigeria. A comparison group before-after quasi-experimental design has been adopted to test hypothesis. One hundred and eighty students have been selected as sample from a population of four hundred and sixty (460) in three senior secondary schools using stratified randomly sampling technique. A high reliability index (.675) had been noticed while validating using Geometry Performance Test (GPT) through test retest while conducting pilot study. Mean, standard deviation and Analysis of Covariate (ANCOVA) had been used as statistical tools. As outcome this study revealed that creative learning outcomes significantly affected the performance of students. As a reason the application of geometry-based knowledge had been highlighted. It had been highlighted that without creative learning outcomes students face severe problems in science, technology, education and mathematics related problems solving. As a recommendation practice of creative learning had been suggested to find solution against poor geometry performance in Nigeria.

Keywords: Creative learning outcomes, student performance, geometry, senior secondary schools, mathematics.

Introduction

The importance of Mathematics and its relevance to national development, made many countries realised mathematic education as a national priority; the foundation upon which subsequent higher level of education depends on, as the mirror of civilization and a science of immutable truths (Maduabum and Odili, 2006; Okereke, 2006; National Mathematical Advisory Panel, 2008). Kiplagat, Role and Makewa (2012) reaffirmed that study of mathematics had been treated as one of the most important subjects from long time back. The National Policy on Education of federal republic of Nigeria stipulated that teaching of problem solving in the classroom is very essential means of preparing the students for problem-solving challenges outside the four walls of the classroom (Fajemidagba, Salman & Ayinla, 2012). In view of the above importance and problems attached to mathematics education in general and geometry in particular. Several studies were done and still going on the effects, impacts and applications of the theoretical frameworks for the learning of geometry. Also, there are educational challenge in classrooms and a theoretical challenge in the research on the development and learning of mathematical knowledge in general and geometry in particular. Furthermore, the processes of mathematical knowledge acquisition are so complex that required different approaches in accordance with expectations from studies of knowledge transfer.

Researchers on geometry at some levels of learning in recent times have attempts to studies some theoretical model of students' geometry performance. They also required approaches expected for transferring knowledge and approaches that will help the students and teachers in discovery approaches in geometry. Some were concerned with development of geometrical skills, abilities, values and attitudes for recognizing, visualizing, describing, sorting, naming, classifying, understanding, remembering, applying, analyzing, evaluating, creating, exploring and registers of mathematics terms in general and geometrics terms in particular. For instance, the theoretical frameworks for the learning of geometrical reasoning advocated by Van Hiele called Van Hielegeometric thinking levels have many studies on the effects, impacts and applications by Abdullah1 and Effandi (2013) Cononoiah (2012)Gneim (2012) Edrogan, Akkaya, and Akkya (2009) Idris (2009),Olkun, Sinoplu and Deryakulu (2005), Bang (1994), Pegg (1992) and Fuys, Geddes and Tischler (1985). The Van Hielegeometric thinking levels describe the development of geometrical reasoning based on at least five levels

Mathematics has grown beyond ordinary counting, arithmetic and algebra. It is also noticed that mathematics has metamorphosed into statistics, calculus and geometry in our world today. Geometry as one of the branches of mathematics is a Greek word, where geo means "Earth" and metria means "Measurement" (Prakash, 2013). This shows the significance of geometry as a subset of mathematics full of shapes, size, relative position of figures and the properties of space. According to some people geometry study is very significant. For instance, students have serious problems when symbols as in geometric representation and models are used to express nature (Kurumeh, 2004; Obodo, 2002), many students have fear and loathsome experiences about mathematics especially when it involves geometry (Burns as cited by Adewale, 2011) and some students with problems in a subject, for instance mathematics, of which geometry is a core part, finds ways to continue to do poorly than others (Xin, 1999)

In Nigeria, mathematics curriculum consists of number and numeration, algebraic processes, mensuration and geometry as well as statistics at the Universal Basic Education levels. While senior secondary school levels curriculum covers number and numeration, algebraic processes, trigonometry, geometry and statistics. Geometry is a critically useful skill in everyday life and in mathematics, as encapsulated in the Nigerian Educational Research and Development Council (NERDC) (2007).

As per Betiku (2001) and Obioma (2005), many pupils had deficiency in knowledge in mathematics. Studies have also reaffirmed that students at the secondary education lack skills in answering almost all the questions asked in general mathematics especially in Geometry of circles and 3-dimensional problems (The West African Examination Council (WAEC), 2005; 2006). In Nigeria, the NERDC for both Universal Basic Education and senior secondary levels mainly prepare the syllabus. But students preferred to answer questions on number and numeration, algebraic processes and statistics. In facts there were apparent advantages and merits attached to skills in answering questions in geometry of circles and 3-dimensional problems. Such advantages and merits include time management, easy to earn higher marks and less space consumption compared with the other aspects of mathematics at the secondary education. It is assumed or expected also that the students at the end of their secondary education are supposed to answer or do better on any questions drawn from any aspect of mathematics that asked. Furthermore, they were expected to show a clear understanding of the problem in their working. But all these assumptions or expectations were not displayed by the student work. The researchers therefore postulated that something was wrong with regards to the nature of learning outcomes in mathematics education in general and geometry aspect in particular.

The Aristotelian idea popularized by Locke was the first theory called *tabula rasa* advocated for the mind can be seen as a blank slate which is imprinted with knowledge initially through experience and later through reasoning as well (Ausubel, 1968). Keil (1990) confirmed that a great deal of research has demonstrated that learning is influenced by the learner's nature of learning outcomes, but little is known about the processes by which the nature of learning outcomes is deployed.

Anderson and Krathwohl (2001) argued that as the taxonomy reflects different forms of thinking and thinking is an active process then verbs should be appropriately used rather than nouns. Hence the synthesis was renamed as create. This implies create is an outcome or product of thinking not a form of thinking per se. The authors also define creating learning outcome as putting elements together to form a coherent or functional whole; reorganize elements into a new pattern or structure. How the nature of learning outcomes in geometry can affect the senior secondary schools' students in Maiduguri Metropolis, Borno state is the main purpose. Creating learning outcomes implies compile information together in a different way by combining elements in a new pattern or proposing alternative solutions. It's also refers to verbs that contained adapt, build, change, choose, combine, compile, compose, construct, create, delete, design, develop, discuss, elaborate, estimate, formulate, happen, imagine, improve, invent, make up, maximize, minimize, modify, original, originate, plan, predict, propose, solution, solve, suppose, test, and theory.

1.1. Objective of the Study

The primary objective is as follows:

To find the effect of creating learning outcomes on the performance of students in Geometry domain for senior secondary school students in Maiduguri Metropolis, Borno State.

1.2. Hypothesis

The alternative hypothesis is as follows:

- H_a : creating learning outcomes does have a significant effect on student's performance in geometry among senior secondary school students in Maiduguri Metropolis, Borno State.

2. Method

Comparison group before-after quasi-experimental design had been adopted to test samples (180 senior secondary school II (SSSII) students). A Mathematics Performance Test (MPT) contains two sections served as instrument for the study. Section A has 35 multiple choices which measured the prior knowledge of basic geometry and mensuration concepts. Section B contained ten written questions on angles subtended by chords in a circle, angles subtended by chords at the centre, perpendicular bisectors of chords and angles in alternate segments, the angle which an arc subtends at the centre is twice the angle it subtends at the circumference, and angles in the same segment of a circle are equal and angles in a semi-circle is a right angle. The item was validated by experts and pilot tested to obtained the reliability index of 0.675 using test-retest. Before the commencement of the treatments, the researcher administered a pre-test to the participants of each school. Their responses were scored. Creating learning outcomes were applied on the experimental group whereas,

only geometry topics and placebo was being applied on the control group. The classes have one lesson per topic making five lessons per class for the duration of the experiment.

All participating schools receive ten lessons during entire experiment. Post-test was being administered after the treatments. Data analysis had been conducted on scores obtained by both pre-test and post-test. To test hypothesis, ANCOVA with pre-test as covariate, gender and status as fixed factors, and post-test as dependent variable had been treated. Specifically, H_{01} (teaching prior knowledge of basic geometric and mensuration concepts does not have significant effect on creating learning outcomes in geometry) was tested using ANCOVA with pre-test of creating learning outcomes, as covariate and status, as fixed factors and post-test scores on creating learning outcomes as dependent variable.

The statistical assumptions underlying the choice of the appropriateness of this analysis of covariance in this study include homogeneity of population variance that is confirmed with Levine's test of Equality of Error variance and Univariate normal score distribution in each cell was found. Others involve the use of pre-test and post -test design where pre-test was served as covariate, whereas post-test is dependent variable.

ANCOVA is used in experimental studies such as quasi-experimental pretest posttest design. In other word, when researcher want to remove the effects of some antecedent variable like using pretest scores as covariates in pretest posttest experimental designs (Vogt, 1999). Thus, the ideal application for an analysis of covariance in an experiment like this study was that subjects are randomly assigned to treatments and the expected value of the covariate mean for each group was the same. Therefore, any differences were attributed only to chance, as the covariate was measured before the treatments. These had primarily reduced the error term and remove any bias in the dependent variable means caused by change group differences on the covariate (Howell, 2002; Huck, 2004; Leech, Barrett, & Morgan, 2005).

SPSS 16.0 had been used for analysis. Vogt (1999) identified the assumptions underlying the ANCOVA: cases should be in a random sample from the population, and the scores on the dependent variable such as post-test scores on general cognitive performance should also be independent like pre-test of general cognitive performance, as covariate, gender and status, as fixed factors of each other, which is the assumption of independence. Results and Discussion

For creating learning outcomes, no significant difference has been noticed by the result of ANCOVA in table 2 for experimental and control groups in pre-test. Significant difference has been noticed for different status groups. On the basic of geometric and mensuration concepts, significance difference has been noticed between experimental and control group in case of post-test. Creating learning outcomes in geometry is getting affected by teaching prior knowledge of basic geometric and mensuration concepts among senior secondary school. The mean of post-test of experimental group is 17.11 and higher compared to control group with mean 12.54. Hence it can be said that discussing prior knowledge improves performance in area of geometry. Significant difference has been noticed in the area of gender difference. Females have performed better compared to men provided they had taught some prior knowledge. This study had shown similar results with another study conducted by Bruner (1966). This study had revealed that students should actively form mathematical worlds by finding their experiences (Cobb, Yackel & Wood, 1992). This current study had adopted Quasi-experimental design and Analysis of covariance. This study also supports the findings of De Corte (1992), where difference in performance had been noticed for different genders. Here also prior knowledge had been in focus (Dorchy, 1996). The thinking style of children is completely different compare to older or adults. With age problem tackle power improves and refines a lot. Experimental group had shown 4.57 positive mean differences compared to control group. Significant difference was noticed between experimental and control groups in post-test as partial eta squared in respect of status was $0.44 > 0.005$ level. Interaction of gender and status is also significant as the partial eta squared in respect of status and gender was 0.08. Male and female interaction also had been seen significant with partial eta squared in respect of gender was $0.07 > 0.05$. A significant difference has been noticed between the male and female as the mean of post-test scores of males was 14.12 and female were 15.53 which clearly indicates the favourable situation w.r.t female. This result was related to Fennema, (1981) study which shows that females tend to achieve higher than males on lower -level cognitive problems in mathematics, while males tend to achieve higher than females on more complex cognitive problems. Damarin (1990) retested Fennema, (1981) by reaffirming that wide publication of gender differences and the corresponding lack of publication regarding the lack of gender differences have been combined to influence female.

Group	Gender	Pre-Test		Post Test	
		Mean	Std. Dev.	Mean	Std. Dev.
Experimental	Male	10.24	2.36	17.17	1.64
	Female	10.22	2.10	17.04	2.30
	Total	10.23	2.30	17.11	1.99
Control	Male	9.66	3.02	11.08	2.63
	Female	9.84	2.72	14.01	3.76
	Total	9.75	2.87	12.54	3.39
Total	Male	10.23	2.22	14.12	3.76
	Female	10.03	2.42	15.53	3.30
	Total	10.13	2.33	14.83	3.59

Table 1: Mean and Standard Deviation of Effect of Teaching Prior Knowledge of Basic Geometric and Mensuration Concepts on Creating Learning Outcomes

Source	Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Precre	0.279	1	0.28	0.04	0.84	0.00
Status	924.86	1	924.86	136.90	0.00	0.44
Gender	88.71	1	88.71	13.13	0.00	0.07
Status * Gender	104.77	1	104.772	15.51	0.00	0.08
Error	1182.36	175	6.76			
Total	41873.25	180				
Corrected Total	2312.74	179				

Table 2: Result of ANCOVA on Effect of Teaching Prior Knowledge of Basic Geometric and Mensuration Concepts on Creating Learning Outcomes in Geometry:
Key: Precre = Pre-Test of Creating Learning Outcomes

3. Conclusions and Recommendations

This study measured the effect of teaching prior knowledge of geometric and mensuration concepts (areas, perimeters, constructions of angles, basic properties and volumes of two and three dimensional shapes, identification and properties of angles) on student creative learning outcomes in geometry (angles subtended by chords in a circle, angles subtended by chords at the centre, perpendicular bisectors of chords and angles in alternate segments, the angle which an arc subtends at the centre is twice the angle it subtends at the circumference, and angles in the same segment of a circle are equal and angles in a semi-circle is a right angle) among Borno State senior secondary school. The Bruner's (1966) constructivism theory was used as a basis for measuring the degree of effect of teaching prior knowledge of geometric and mensuration concept by using general cognitive performance, remembering, understanding, applying, analyzing, evaluating and creating learning outcomes in geometry among Borno state senior secondary students. Literature reviewed showed that learning is a cognitive activity in which students actively construct knowledge by interpreting new information in the light of their prior knowledge and existing beliefs. Also, meaningful learning occurs when there is an interaction between the learner's existing knowledge and the new learning material. Based on the study, previous knowledge of geometry helps to enhance creating learning outcomes in geometry. This research also investigates the effect of teaching in case of creating learning outcome in the area of mathematics. This study also can be replicated in other comparative analysis. More studies can be conducted for experimenting cognitive recital, identification, considerate, applying, analyzing, measuring and creating learning outcomes in other aspects of mathematics for Federal or States senior secondary school pupils. These areas can also be studied based on gender differences.

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